Upper Klamath Basin Nonpoint Source Pollution Assessment and Management Program Plan

Klamath Tribal Water Quality Consortium

September 2018

YUROK TRIBE

KARUK TRIBE

HOOPA VALLEY TRIBE

RESIGHINI RANCHERIA

QUARTZ VALLEY INDIAN RESERVATION

Upper Klamath Basin Nonpoint Source Pollution Assessment and Management Program Plan

Klamath Tribal Water Quality Consortium

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1 OVERVIEW

The Consortium produced this Nonpoint Source Assessment and Management Program Plan (NPS Plan) to address water quality issues in the Upper Klamath Basin which affect the Lower Klamath Basin (Figure 1). Developing this plan was a prerequisite for the Consortium to be eligible to apply for Clean Water Act (CWA) Section 319(h) funding from the U.S. Environmental Protection Agency to support Upper Basin partners in implementing water quality improvement projects.

This NPS Plan covers the portion of the Klamath Basin that is upstream of Iron Gate Dam near Hornbrook, CA, excepting the Lost River and Butte sub-basins. Water quality problems in the Upper Klamath Basin and its tributaries have been well documented in the Oregon Department of Environmental Quality Total Maximum Daily Loads (TMDLs) for Upper Klamath Lake (ODEQ 2002) and Upper Klamath and Lost rivers (ODEQ 2010b), California North Coast Regional Water Quality Control Board Klamath River TMDL (NCRWQCB 2010), evaluations of techniques for water quality improvement (Stillwater Sciences et al. 2012, 2013), an Environmental Impact Statement/Report for the proposed removal of the Klamath Hydroelectric Project (US DOI and CDFG 2012), and numerous other studies by federal, tribal, and state agencies. At Iron Gate Dam near the California border, the Klamath River water is often of insufficient quantity and poor quality to meet the needs of fish, wildlife, and humans. To address this problem, the Consortium's goal is to improve land and water management in the Upper Klamath Basin area to improve the quality of water entering the Lower Klamath Basin.

In the NPS assessment (sections 2 through 10 below), the Consortium reviews available scientific information regarding the causes and potential solutions for the NPS pollution in the Upper Klamath Basin, including a review of existing NPS management efforts. The assessment identified categories of NPS pollution that are likely impacting water quality and then ranked them based on their relative importance. The following two categories are high priority, due to the widespread extent and severity of impacts:

- Agriculture
- Hydromodification and Habitat Alteration

The following two categories are much lower priority given their lesser contribution to NPS pollution within the NPS Plan area:

- Forestry
- Urban

The NPS management plan (section 11) then proposes a schedule (Table 9) of tasks and best management practices (BMPs) and identifies potential funding sources (section 11.4) to address the causes of the NPS pollution.

The entire NPS Plan area is outside the reservations of the Consortium member Tribes; however, some of the area is within the ancestral territory of Shasta Indians who are enrolled members of QVIR. Consortium member Tribes have limited legal authority to mandate changes in land and water management; therefore, the Consortium's NPS Plan relies on voluntary measures and collaboration with entities already doing work in the area. Rather than "re-invent the wheel," the Consortium intends to support organizations and programs that are already implementing effective projects to restore water quality. The vast majority of the projects and approaches recommended in this NPS Plan are already being evaluated or worked on by these entities. The

Consortium's intention in listing those projects in the NPS Plan is to demonstrate awareness of those activities, not to claim a lead role. The Consortium will continue to develop working relationships with entities addressing water quality issues in the Upper Klamath Basin.

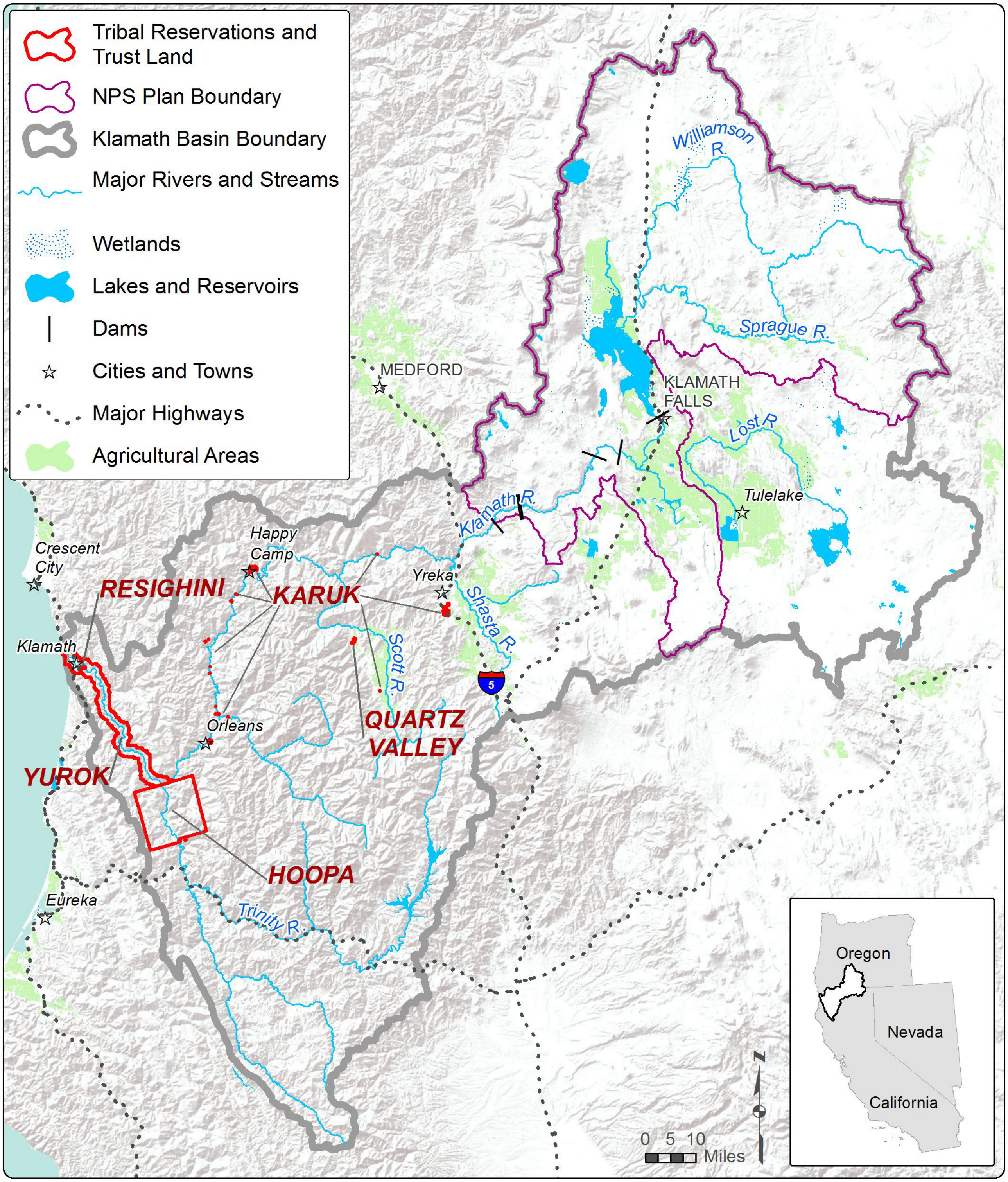

Figure 1. Map showing location of Consortium member Tribes' reservations and trust lands in the Klamath Basin. The dotted red line is the outline of the NPS project area.

2 INTRODUCTION

The Consortium produced this Nonpoint Source Assessment and Management Program Plan (NPS Plan) to address water quality issues in the Upper Klamath Basin which affect the Lower Klamath Basin (Figure 1). The Consortium used the U.S. EPA's (2010) *Handbook for Developing and Managing Tribal Nonpoint Source Pollution Programs Under Section 319 of the Clean Water Act* and the Yurok Tribe's (2014) *NPS Assessment and Management Program Plan* as the primary templates for this NPS Plan.

2.1 PROJECT AREA

The Klamath River Basin (Figure 1) is 12,680 square miles in area and originates in southern Oregon and extends to northern California before it reaches the Pacific Ocean at Requa in Del Norte County, CA (NCRWQCB 2010). Forty-four percent of the watershed lies within Oregon while the remaining 56 percent lies within California (ODEQ 2010b). This NPS Plan covers the portion of the Klamath Basin that is upstream of Iron Gate Dam near Hornbrook, CA, excepting the Lost River and Butte sub-basins (Figure 2). This area was chosen because it is the primary source of impacts to Klamath River water quality which extend all the way downstream to the Klamath Estuary.

While typically considered part of the Klamath Basin, the Lost River is excluded from the project area because it does not naturally connect to the Klamath River. Groundwater elevations suggest that groundwater from the Butte sub-basin drains to Lower Klamath Lake and the Klamath River (Gannett et al. 2007), but there is no surface water connection so the Butte sub-basin is not included in the project area.

The tributaries of the Klamath River originate at the southeast end of the Cascade Mountains in Oregon and converge into Upper Klamath Lake from which the Klamath River flows southwest into California and enters the Pacific Ocean near Requa, California. Major tributaries to Upper Klamath Lake include the Williamson, Wood, Sprague, and Sycan rivers and Sevenmile Creek/Canal. Six dams are present on the Klamath River between Upper Klamath Lake and the Shasta River. Major tributaries in the reservoir reach include Spencer Creek in Oregon and Jenny Creek in California. In California, major tributaries downstream of the dams include the Shasta, Scott, Salmon, and Trinity rivers. This NPS Plan focuses on the Upper Klamath River from Iron Gate Dam upstream, which includes multiple tributaries to the River (e.g., Wood, Williamson, Sprague, and Sycan rivers), lakes (Upper Klamath, Agency, and Lower Klamath lakes), and reservoirs (Keno, Copco, Iron Gate, and JC Boyle). The Klamath Straits Drain and other major irrigation and ditch systems are also included.

2.1.1 INCORPORATION BY REFERENCE OF CONSORTIUM MEMBER TRIBES' NPS PLANS

All five Consortium members have U.S. EPA-approved NPS plans for their reservations, ancestral territory, or relevant watersheds (HVTEPA 1997, Karuk Tribe 2003, QVIR 2007, QVIR 2008, YTEP 2014, Resighini Rancheria 2016). The Consortium hereby incorporates those previous NPS plans into this new Consortium NPS Plan by reference. This incorporation by reference will allow the Consortium to also be eligible to apply for USEPA Clean Water Act Section 319 funding for geographic areas covered by individual Tribes' NPS plans as well as the Upper Klamath Basin.

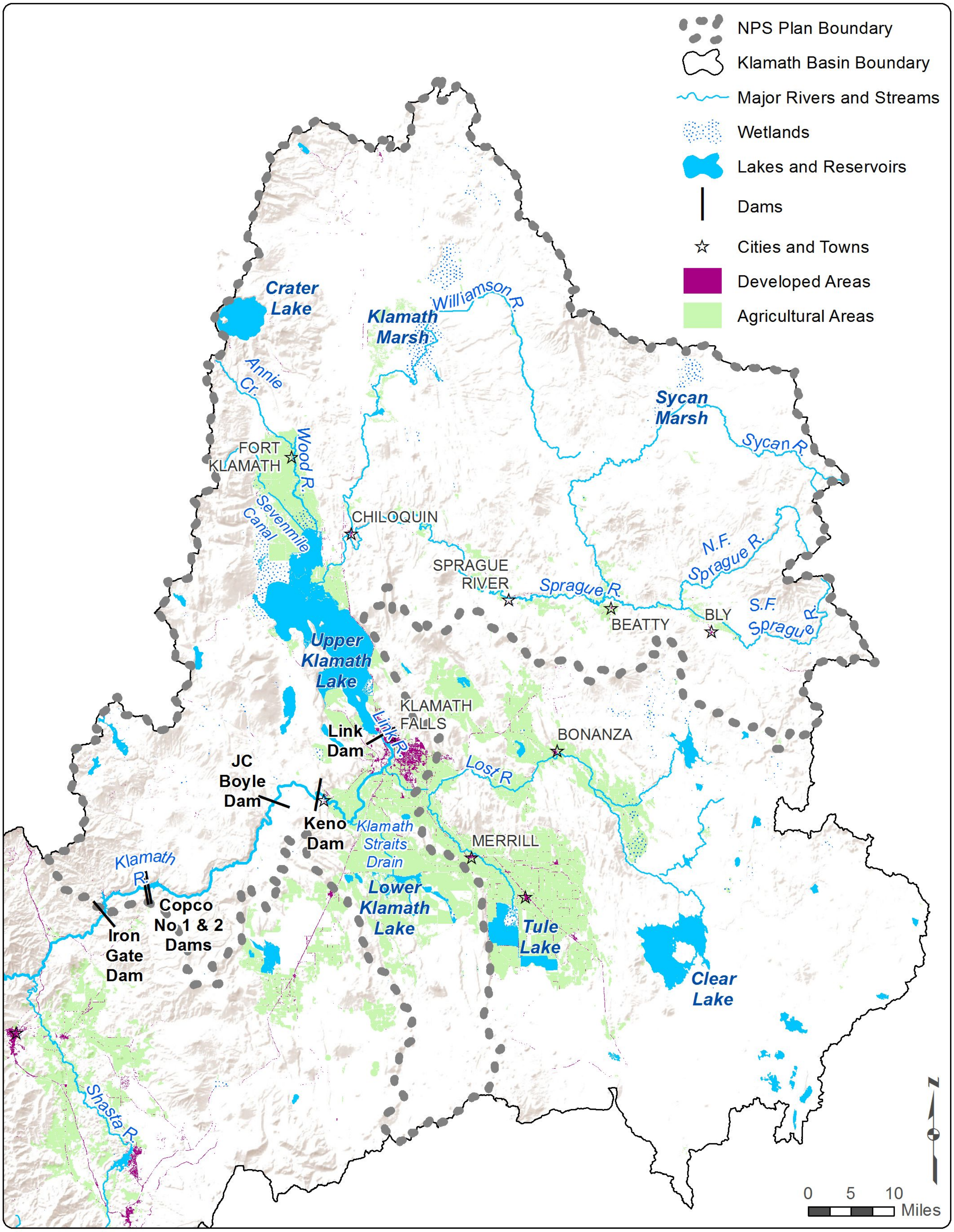

Figure 2. Map showing location of the Consortium's Upper Klamath Basin Nonpoint Source (NPS) Assessment and Management Program Plan area boundary.

2.2 TRIBES INVOLVED

2.2.1 THE KLAMATH TRIBAL WATER QUALITY CONSORTIUM

The Klamath Tribal Water Quality Consortium (Consortium) is comprised of five federally recognized Tribes, including the Yurok Tribe, Hoopa Valley Tribe, Karuk Tribe, Quartz Valley Indian Reservation and Resighini Rancheria. These Tribes reside within the California portion of the Klamath River Basin on reservation, trust, and fee lands (Figure 1). The federally recognized Klamath Tribes of Oregon (see section 9.2) is not a member of the Consortium but cooperate with the California tribes on water quality-related issues.

In 2002, over 34,000 adult salmon perished in a single event on the lower Klamath River, representing approximately 20% of the adult salmon returning to spawn. The cause of the die-off was fish pathogens that overtook salmon weakened by low, warm water flows in the Klamath River (USFWS 2003a, 2003b). From this occurrence, the Tribes within the California portion of the Klamath Basin saw a need to protect their threatened cultural resources through engagement of environmental management, monitoring, and policy development. Therefore, in 2003, the tribes formed the Klamath Basin Tribal Water Quality Work Group that worked collectively on a variety of water quality issues with success. In 2015, tribal collaborations were formalized by creating the Consortium. The Consortium serves to enhance the ability of tribes to work with state and federal partners to restore the Klamath Basin and its resources Consortium members depend upon (KTWQC 2017).

2.2.2 YUROK TRIBE

The Yurok Tribe is California's largest tribe**,** with nearly 5,000 enrolled members[1]. The Yurok Reservation lands extend from one mile on each side from the mouth of the Klamath River upriver for a distance of 46 miles, where the Yurok Reservation shares a border with the Hoopa Tribe. The Yurok Tribe maintains jurisdiction over waters that flow into and through the reservation for water quality purposes, regardless of the geographic origin of the water sources. The Yurok Tribe Environmental Program (YTEP) developed a Water Quality Control Plan for reservation waters in 2004 and in 2014 developed a Non-Point Source Assessment and Management Program Plan (YTEP 2004, 2014). The Yurok Tribe's application for financial assistance eligibility (FAE) under Section 319 of the Clean Water Act was approved by U.S. EPA on March 8, 2000.

[1] www.yuroktribe.org accessed January 2016

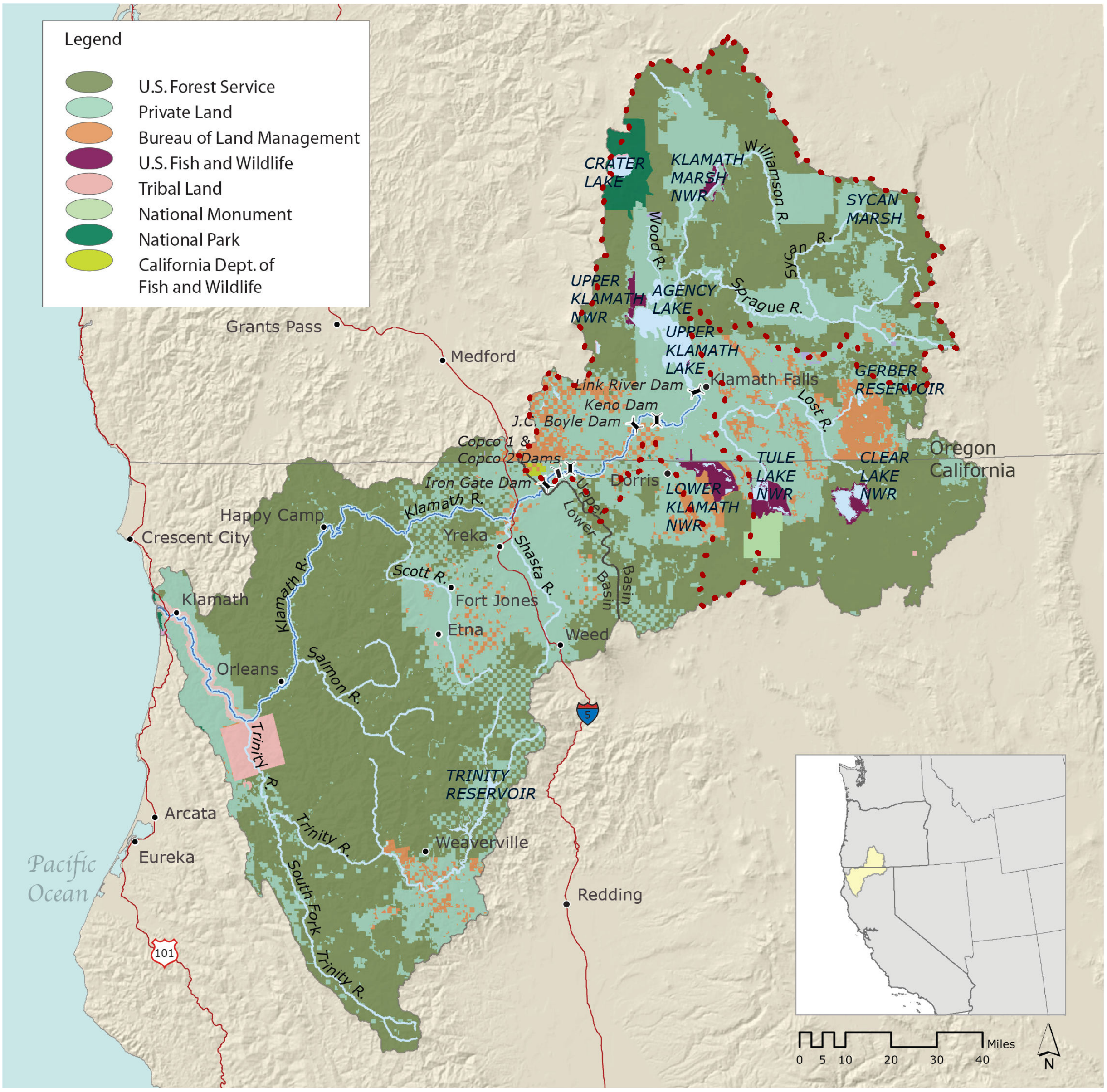

Figure 3. Map of land ownership in the Klamath Basin. The dotted red line is the outline of the NPS project area. Map adapted from Stillwater Sciences et al. (2012).

2.2.3 HOOPA VALLEY TRIBE

The Hoopa Valley Reservation has approximately 3,346 members and is the largest reservation in California, encompassing 93,702 acres. Hoopa tribal lands are located in the northeastern corner of Humboldt County in Northern California. The reservation is bisected in a north-south direction by the Trinity River while the Klamath River flows east-west through a portion of the northeastern part of the reservation (HVTEPA 2008).

The Hoopa Valley Tribe obtained treatment as a state (TAS) status by EPA in 1996 for purposes of water pollution control (http://www.epa.gov/wqs-tech/epa-approvals-tribal-water-quality-standards). From this, the Hoopa Valley Tribe maintains jurisdiction for water quality purposes over all waters that flow into and through the reservation, regardless of the geographic origins of water sources. The Hoopa Valley Tribal Environmental Protection Agency (HVTEPA) developed a Water Quality Control Plan for the Hoopa Valley Reservation in 2002 which was amended in 2008 (HVTEPA 2008) and is current being updated. The Hoopa Valley Tribe's application for FAE under Section 319 of the Clean Water was approved by U.S. EPA in March 1997.

The Hoopa Valley Tribe has also been a leader in tribal self-governance matters and currently has a proposal to U.S. EPA to conduct tasks that complement this NPS Plan. Proposed tasks are as follows:

- Participation in technical meetings, administrative processes and negotiations
- Development of water quality restoration strategies in collaboration with federal, state and tribal resource management agencies such as the Consortium.
- Development of conceptual plan to improve, mitigate, and correct water quality problems in the Keno reach, including near- and long-term actions.
- Design, implementation, and interpretation of scientific studies to improve understanding of current water quality conditions, the effect of poor water quality on the ecosystem, techniques for improving water quality, and response to implementation of water quality improvement strategies.
- Design, implementation, and publication of scientific studies focused on the impacts of poor water quality on fish health particularly *Ich* and *C. shasta* infections among Chinook and coho salmon.
- Pilot and mesocosm studies to test and demonstrate the efficacy of innovative techniques and treatments that can then be scaled up for implementation.
- Groundwater studies and management strategies to ensure maximum delivery of groundwater to the river, directly or indirectly.
- Studies and investigations on the efficacy and logistics of large scale engineered reverse infiltration galleries to treat poor quality river water or tailwater.
- Investigation of new surface water storage sites at strategic locations that could provide cold and high water quality releases year-round dedicated to fisheries benefits and water quality mitigation.

2.2.4 QUARTZ VALLEY INDIAN RESERVATION

The Quartz Valley Indian Reservation (QVIR) is located in Quartz Valley, which is in the Scott River sub-basin of the Klamath Basin in California. The original reservation boundary is 604 acres, but much of the land within it is privately owned by people who are not members of QVIR. QVIR has approximately 250 enrolled members, most of which live on the reservation. Some enrolled members of QVIR are Shasta Indians whose ancestral territory includes portions of the NPS Plan area. The Quartz Valley Tribal Environmental Program developed an EPA-approved NPS plan (QVIR 2008) and Quality Assurance Project Plan (QVIR 2016). QVIR developed a water quality control plan in 2017 which is currently being reviewed by U.S. EPA (QVIR 2017). QVIR's application for FAE under Section 319 of the Clean Water Act was approved by U.S. EPA on September 11, 2007.

2.2.5 KARUK TRIBE

The Karuk Tribe does not possess reservation lands but resides on 1,168 acres of tribal trust and private domain allotments that include properties along the middle portion of the Klamath River and its tributaries in Northern California. The Karuk Tribe Department of Natural Resources developed a Water Quality Control plan in 2002 and updated the document in 2014 (Karuk Tribe 2014). The Karuk Tribe's application for FAE under Section 319 of the Clean Water Act was approved by U.S. EPA on September 11, 2007.

2.2.6 RESIGHINI RANCHERIA

The Resighini Rancheria Reservation is situated on 228 acres located along the south bank of the Klamath River. The Resighini Rancheria Environmental Protection Authority (REPA) developed a Water Quality Ordinance in 2002 (updated in 2006) which sets water quality standards for the reservation (REPA 2006). In 2010, the REPA developed a surface water sampling and analysis plan (REPA 2010). The Resighini Rancheria's application for FAE under Section 319 of the Clean Water Act was approved by U.S. EPA on October 14, 2016.

2.3 GOALS AND OBJECTIVES

Although the Upper Klamath Basin does not contain land held by Consortium member Tribes, the Consortium seeks to apply BMPs and watershed improvements to improve water quality which impacts downstream tribal waters, fisheries, and quality of life. The Consortium supports holistic ecosystem management rather than single species management.

It is not the intention of the Consortium to initiate new unilateral projects, but rather to support established programs with sustained records of success.

The Consortium's objectives are to enhance and improve water quality and aquatic ecosystems in the Klamath Basin by:

- Supporting restoration programs already in place;
- Providing funding to support programs that improve the natural functioning of watersheds in the Upper Klamath River; and
- Providing technical support where needed for project development.

2.4 PUBLIC PARTICIPATION AND GOVERNMENTAL COORDINATION

NPS pollution is a community-wide issue and successful implementation of the NPS Plan will rely upon relationships between the Consortium, our partner entities, and the public, including tribal and non-tribal community members. Therefore, the Consortium sought public input on this NPS Plan by engaging public agencies that have a role in managing or protecting natural resources. The Consortium did an oral presentation[2] on the NPS Plan at the spring 2016 Klamath Basin Monitoring Program (KBMP) meeting which was attended by approximately 50 people, primarily representatives of entities involved in Klamath Basin water quality issues. The

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[2] The slides from the presentation are available online at: http://kbmp.net/images/stories/pdf/Meeting_Materials/Meeting_18/15_Asarian_Buxton_Presentation.pdf. The meeting agenda is available online at: http://kbmp.net/images/stories/pdf/Meeting_Materials/Meeting_18/KBMP_Spring_2016_Meeting_Agenda_Final_w_Summaries.pdf

Consortium and its consultants conducted phone meetings with many partner organizations to get input on the NPS Plan, and followed up with email correspondence.

In addition, the Consortium made a draft version of this document available for a 30-day public comment period starting August 19, 2016. Public notice was made by announcing the release of the document in each Consortium Tribe's newsletter, official website, and social media sites. The public notice was also listed on the KBMP website (http://www.kbmp.net). The Consortium received comments from 12 entities during the public comment period, as well as additional comments after the comment period. The Consortium reviewed all these comments, considered them thoroughly, and then made appropriate changes to the NPS Plan. A summary of the Consortium's responses to the public comments is included as Appendix C. An archive of electronic versions of the public comments is included in an electronic appendix which is available upon request.

3 METHODOLOGY

3.1 DATA SOURCES

Monitoring data and summaries are available for public use on the Klamath Basin Monitoring Program (KBMP, website: www.kbmp.net). KBMP is working to develop a monitoring program for the Klamath River basin that does not replace individual water quality monitoring efforts, but expands coordinated monitoring to benefit long-term collaboration. KBMP's goal is to include all agencies and organizations that engage in water quality monitoring in the Klamath River basin. Water quality monitoring in the basin is performed by over 20 tribal, federal, state, and county agencies and private and nonprofit groups throughout the entire Klamath Basin (Figure 4). Table 1 provides some links to access water quality data[3]. Individual tribes in the Consortium have their own environmental departments with expertise to derive, analyze, implement, and evaluate management decisions. The majority of the data collection programs were initiated in 2002 after the fish kill that occurred in the Lower Klamath River.

[3] Additional monitoring data links are available at http://www.kbmp.net/maps-data/links-data-reports

Table 1. Selected agencies and organizations with water quality monitoring programs within the Consortium's NPS Plan area and the mainstem Klamath River downstream. Table also includes instructions for accessing data. Entities that provide only a portion of their data online are listed as "Request."

Category	Agency/organization	Data Access
Tribal	The Klamath Tribes of Oregon	Request, http://www.ceden.org
	Yurok Tribe	Request, http://www.epa.gov/storet/, http://exchange.yuroktribe.nsn.us/lrgsclient/stations/stations.html
	Karuk Tribe	Request, http://www.epa.gov/storet/, waterquality.karuk.us,
	Hoopa Tribe	Request, http://www.epa.gov/storet/
	Quartz Valley Indian Reservation	Request, http://www.epa.gov/storet/, http://www.ceden.org,
	Resighini Rancheria	Request, http://www.epa.gov/storet/,
Federal	U.S. Bureau of Reclamation (Klamath Basin Area Office)	http://waterdata.usgs.gov/nwis
	U.S. Bureau of Land Management	Request
	U.S. Fish and Wildlife Service	Request
	U.S. Forest Service (Fremont-Winema, Klamath, Modoc)	Request, http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST/StreamTemperatureDataSummaries.shtml
	U.S. Geological Survey	http://waterdata.usgs.gov/nwis, http://or.water.usgs.gov/grapher, http://or.water.usgs.gov/projs_dir/klamath_ltmon/, http://or.water.usgs.gov/proj/keno_reach/monitors.html
State	California Department of Water Resources	http://cdec.water.ca.gov/, http://www.water.ca.gov/waterdatalibrary
	North Coast Regional Water Quality Control Board	Request, http://www.ceden.org
	Oregon Department of Environmental Quality	Request 2012-present, older data available at http://deq12.deq.state.or.us/lasar2,
Private	PacifiCorp	http://www.pacificorp.com/es/hydro/hl/kr.html, http://www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring,
Non-Profit	Trout Unlimited (Klamath Basin Rangeland Trust)	Request
	The Nature Conservancy	Request

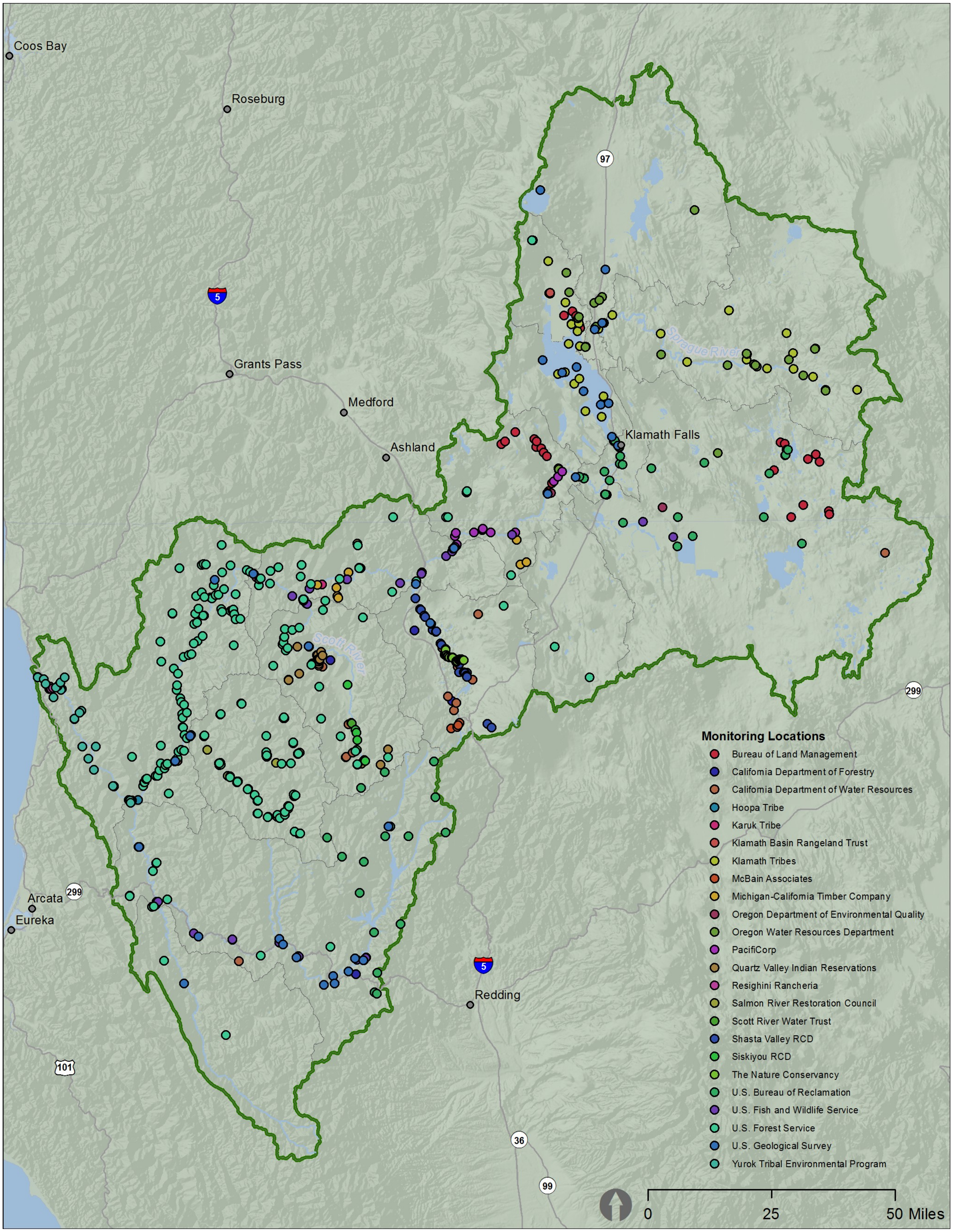

Figure 4. Map of monitoring stations in the Klamath River Basin, produced by the Klamath Basin Monitoring Program (KBMP).

3.2 PREVIOUS ASSESSMENTS

The Consortium relies on the monitoring efforts of the above-mentioned agencies and groups to determine the quality of waters and the sources of impairments. The large area of land the Klamath River Basin encompasses makes initiating a new and separate monitoring program inefficient and redundant. The Consortium assumes organizations (Table 4) perform effective quality control and assurances with data collection and analysis.

In addition to the basin-wide monitoring efforts, the Consortium relies heavily on a large number of previous analyses and syntheses of water quality information from reputable sources, including federal, state, tribal, academic, consultant, and non-profit organizations. These documents are cited in the appropriate sections below. A few of the documents most essential to the development of this NPS Plan are: Total Maximum Daily Loads (TMDLs) for Upper Klamath Lake (ODEQ 2002), Upper Klamath and Lost Rivers (ODEQ 2010b), and Klamath River (NCRWQCB 2010); lists of impaired water bodies from the states of Oregon and California; nutrient budgets for Upper Klamath Lake (Walker et al. 2012) and its tributaries (Walker et al. 2015); studies of Upper Klamath Lake ecology and water quality (Kann 1998, Kann and Smith 1999, Bradbury et al. 2004, Eilers et al. 2004, Kann and Welch 2005); evaluations of techniques for water quality improvement (Stillwater Sciences et al. 2012, 2013); Environmental Impact Statement/Report for the proposed removal of the Klamath Hydroelectric Project (US DOI and CDFG 2012); reports regarding water quality models for Keno Reservoir (Sullivan et al. 2011, 2013, 2014) and Upper Klamath Lake (Wood et al. 2008, Wherry et al. 2015).

4 LAND USE SUMMARY

4.1 CLIMATE

The following excerpt from Stillwater Sciences et al. (2012) summarizes the Klamath Basin's climate:

> "Annual precipitation in the Klamath Basin ranges from 15–150 inches per year, with drier conditions (15–40 inches per year) at the higher elevations of the upper basin (i.e., greater than 1,219 m [4,000 ft]) and wetter conditions (40–150 inches per year) at lower elevations and in coastal areas of the lower basin. The upper basin receives rain and snow during the late fall, winter and spring, with most winter precipitation falling as snow. The Upper Klamath Lake system freezes over intermittently from November through February, and can remain frozen for several months duration. Midwinter rains can occur in the lower-elevation areas (i.e., 914–1,219 m [3,000–4,000 ft]) of the upper basin, but due to a rain shadow effect of the Cascade Mountains annual rainfall is variable throughout this portion of the Klamath Basin (Risley and Laenen 1999), and ranges from a mean annual precipitation (1961–1990) level of 166.1 cm (65.4 in) at Crater Lake National Park in the Cascade Range to 34.3 cm (13.5 in) at Klamath Falls (Gannett et al. 2007)."

4.2 WATERBODIES AND HYDROLOGY

The Klamath River's water originates in tributaries that flow from the southeast boundary of the Cascade Mountains and from mountains that form the southwestern edge of the Great Basin (Figure 1, Figure 2). These tributaries converge into the large, shallow Upper Klamath Lake and its northern arm which is known as Agency Lake. The Wood River and Sevenmile Creek/Canal flow from the flanks of the Cascade Mountains into Agency Lake and then into Upper Klamath Lake. Another major tributary, the Williamson River, originates in the Winema National Forest and flows directly into Upper Klamath Lake. Two major streams contribute flow to the Williamson River, including the Sprague River and its tributary, the Sycan River, both of which originate in the forested mountains of the Fremont National Forest. The Williamson, Sprague, and Sycan rivers contribute 79% of the drainage area for Upper Klamath Lake (ODEQ 2002). Water levels in Upper Klamath Lake are regulated by Link Dam. The outlet of Upper Klamath Lake flows into the Link River, which flows 1.2 miles before entering Lake Ewauna. The Klamath River proper begins at the outlet of Lake Ewauna, which is currently part of Keno Reservoir impounded by Keno Dam.

Below Keno Dam are four additional dams on the mainstem Klamath River which form the core of the Klamath Hydroelectric Project (KHP) (see section 4.5 for additional information on dams on the Klamath River). Between Keno Dam and Iron Gate Dam (the lowest of the mainstem dams), the Klamath River flows increase substantially due to contributions from springs below JC Boyle Dam and tributaries including Spencer Creek, Shovel Creek, Fall Creek, and Jenny Creek. The Lost River was not historically a tributary of the Klamath River but is now connected via the Lost River Diversion Channel which can now flow either direction depending on conditions and management operations (see section 4.4.7 for details). The Lost River sub-basin is not part of this assessment.

Due to permeable geology, streams in the Upper Klamath Basin have relatively high summer base flows. Average groundwater discharge into streams of the Upper Klamath Basin upstream from Iron Gate Dam is about 2,400 cfs (1.8 million acre-ft/yr) (Gannett et al. 2007).

4.3 FISHERIES

The Consortium Tribes in California conduct robust, active fisheries programs, which help sustain tribal subsistence fishing practices that are culturally and economically significant to the Tribes. Tribal fishing centers on Chinook salmon (*Oncorhynchus tshawytscha*), but some coho salmon (*O. kisutch*) and steelhead (*O. mykiss*) are also caught. The Klamath Tribes of Oregon historically relied on the culturally significant fisheries of Chinook salmon, Lost River sucker (*Deltistes luxatus)* and Shortnose sucker (*Chasmistes brevirostris)*.

Historically, salmon have spawned, reared, and migrated to and from the tributaries in the basin. In 1918 with the installment of Copco 1 dam, fisheries habitat and spawning grounds upstream of the dam were entirely cut off from the lower Klamath River (Hamilton et al. 2005, Hamilton et al. 2016). Iron Gate Dam was built downstream in 1962, further reducing the habitat accessible to anadromous salmonids. Presently, over 420 miles of salmonid habitat in the Upper Klamath Basin is inaccessible due to the dams (U.S. DOI and CDFG 2012).

The Upper Klamath River, lakes and reservoirs contain a variety of coldwater and warmwater fisheries. Coldwater fish species found in the basin include native redband trout (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*) and non-native Eastern brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*). Warmwater fish species include non-native fathead minnow (*Pimephales promelas*) and yellow perch (*Perca flavescens*), both of which are known to predate upon the native endangered suckers (ESSA 2017). Additional warmwater fish include brown bullhead *(Ameiurus nebulosus*), largemouth bass (*Micropterus salmoides*), and pumpkinseed (*Lepomis gibbosus*). Federally listed endangered or threatened fish species present in the Upper Klamath Basin include bull trout, Lost River sucker, and shortnose sucker (ODEQ 2002).

4.4 SUB-BASINS

4.4.1 WILLIAMSON RIVER

The Williamson River (4th field HUC 18010201) watershed is approximately 1420 mi^2 and has an elevation range of 9,182 feet at the summit of Mount Thielsen to the Williamson River Delta (4,143 feet elevation), which is located on the northeast shores of Upper Klamath Lake. The Williamson River flows in a horseshoe shape, heading north, west, and finally south to Upper Klamath Lake. The Williamson River watershed is relatively low gradient as over 70% of the watershed has a slope of less than 8% and 50% of the watershed has a slope below 3% (David Evans and Associates 2005). The Klamath Marsh National Wildlife Refuge's 40,000 acres of wet meadows and open water wetlands lies in the middle of the Williamson River watershed and is managed by U.S. Fish and Wildlife Service (USFWS). The Williamson River flows into and out of the marsh. Surface flow downstream of the marsh is controlled by Kirk Reef, a basalt sill; during low water periods, approximately a half mile of the river channel goes dry in the vicinity of Kirk Reef. The watershed geology is predominately volcanic in origin, and consists of ash, pumice, and basalt. Due to the porous geology, many tributaries on the west side of the watershed flow subsurface before reaching the Williamson River as springs (David Evans and Associates 2005).

4.4.2 SPRAGUE RIVER (INCLUDING SYCAN RIVER)

The Sprague River (4th field HUC 18010202) watershed is 1580 mi^2, originates on the forested slopes within the Fremont-Winema National Forest at elevations above 7,000 feet and flows south and west towards its confluence with the Sycan River near the town of Beatty, Oregon. From here, the Sprague River flows west to its confluence with the Williamson River. The Sycan River originates at Winter Ridge (6,700 feet), which forms the eastern edge of the Klamath River watershed. The Sycan River flows northwest into Sycan Marsh and then south to its confluence with the Sprague River. Over half of the Sprague River watershed is owned by federal or state agencies. The remaining land is privately owned and managed for commercial timber or rangeland agriculture. The private agricultural lands (pasture and hay) are located in the alluvial valleys along the mainstem Sprague River (O'Connor et al. 2015).

4.4.3 WOOD RIVER AND OTHER TRIBUTARIES TO UPPER KLAMATH LAKE

The Wood River flows from the east side of Crater Lake National Park and terminates at Agency Lake near Chiloquin, Oregon. The Wood River meanders through predominantly agricultural lands consisting of irrigated pasture. Unlike the Williamson and Sprague Rivers, the Wood River watershed does not have its own 4th field HUC and is considered by USGS as part of the Upper Klamath Lake hydrologic unit (18010203). Additional tributaries to Upper Klamath Lake include Sevenmile Creek/Canal and Fourmile Creek/canal.

4.4.4 UPPER KLAMATH LAKE INCLUDING AGENCY LAKE

Upper Klamath Lake is a large (235 km^2) and shallow (mean depth 2 m) hyper-eutrophic lake. The broad, shallow morphology of Upper Klamath Lake affects water quality by enabling solar heating of water temperatures and wind-driven mixing (Wood et al. 2008). The size of Upper Klamath Lake has been reduced from its historic extent by the agricultural draining of wetlands surrounding the lake (Snyder and Morace 1997). The northern arm of Upper Klamath Lake is known as Agency Lake. Agency Lake is a smaller lake (35 km^2) and is shallow and eutrophic. Levee breeching in the Williamson River delta in 2007 and 2008 has increased connectivity between Upper Klamath Lake and Agency Lake (Wood et al. 2014).

4.4.5 LINK RIVER, LAKE EWUANA, KENO RESERVOIR, AND LOWER KLAMATH LAKE (LINK DAM TO KENO DAM)

Link River is a 1.2-mile reach of high-gradient river running from Link Dam (the outlet of Upper Klamath Lake) to Lake Ewauna (Figure 2 and Figure 5). The reach of the Klamath River downstream of Lake Ewauna is currently impounded by Keno Dam which forms Keno Reservoir, but was formerly part of Lower Klamath Lake. Lower Klamath Lake has been nearly drained from its original size of approximately 80,000 acres of wetlands and open water (Weddell 2000) (Figure 5). Prior to the construction of the railroad across the Klamath Straits, water from the Klamath River would fill Lower Klamath Lake during spring runoff and then reverse direction and flow back to the river in summer and fall (Weddell 2000). The northern half of the former lakebed is primarily private agricultural lands while the southern half is primarily in the Lower Klamath National Wildlife Refuge, part of which is also used for agricultural purposes. Water is delivered to agricultural lands near the refuge from the Klamath River via the Ady Canal and North Canal. When available, water is supplied to the refuge via Ady Canal. At various times, excess Tule Lake water is pumped into the refuge through the Sheepy Ridge Tunnel via Pumping Plant D. Keno Reservoir is held at nearly static elevation to optimize the system of irrigation diversions and agricultural drains.

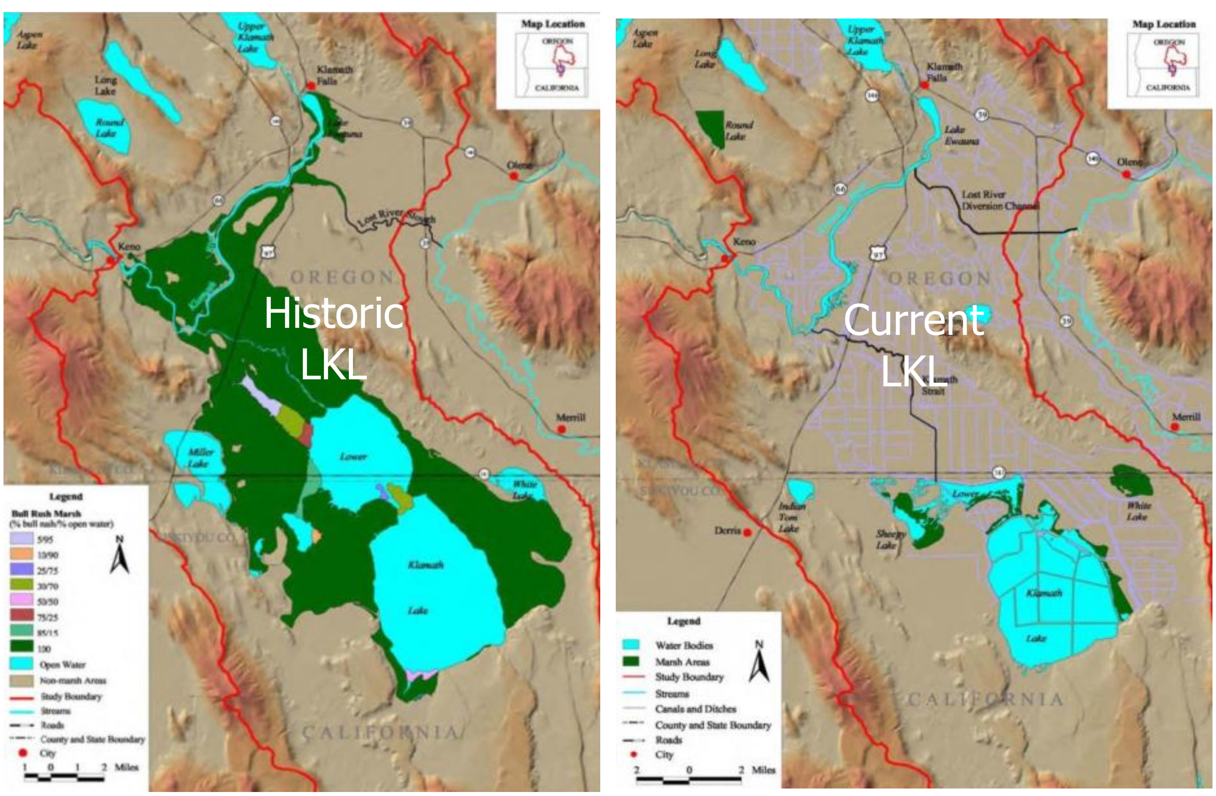

Figure 5. Map of historic and current Lower Klamath Lake (LKL) and wetlands. Source: USBR (2005).

4.4.6 HYDROELECTRIC REACH (KENO DAM TO IRON GATE DAM)

Downstream of Keno Dam, the Klamath River enters a steep canyon which includes some reaches that are impounded by dams (see section 4.5). The land use is primarily private timberlands with some U.S. Bureau of Land Management and U.S. Forest Service land and a few small ranches (Figure 7).

4.4.7 LOST RIVER (NOT INCLUDED IN NPS PROJECT AREA)

Historically, the Lost River received water from the Klamath River during high flow events when water would spill through the Lost River Slough (NRC 2004). The waters would flow toward Tule Lake, the terminus of the Lost River. The Lost River was formerly a closed basin with no natural surface outflow connectivity to other watersheds. The Lost River Diversion channel now connects the Klamath River to the Lost River, and water can flow via gravity in either direction, depending on the dual water management goals of drainage and irrigation. During the summer irrigation season, more water usually flows from the Klamath River into the Lost River than vice-versa. Water is also pumped at various times from Tule Lake via Pumping Plant D west through the Sheepy Ridge Tunnel into Lower Klamath National Wildlife Refuge. The contribution of the Lost River subwatershed to the overall quality of the Klamath River is seasonally variable. The amount of water pumped through Pumping Plant D has declined significantly in the past decade. This decline has been attributed to increased efficiency (including recirculation of water from Tule Lake to nearby agricultural lands) as a byproduct of high electricity prices, but increased groundwater pumping within the Tule Lake sub-basin (Pischel and Gannett 2015) may also have contributed.

The Lost River is highly altered from its historical condition, as eloquently summarized by USFWS (2001):

> "The Lost River can perhaps be best characterized as an irrigation water conveyance, rather than a river. Flows are completely regulated, it has been channelized in one six- mile reach, its riparian habitats and adjacent wetlands are highly modified, and it receives significant discharges from agricultural drains and sewage effluent. The active floodplain is no longer functioning except in very high water conditions."

Given the level of alteration, restoring the Lost River sub-basin would be a monumental task requiring conversion of thousands or tens of thousands of acres of farmland back to wetlands. This would require large amounts of money and political will which is unlikely to materialize. Therefore, the Consortium is not considering the Lost River watershed in this assessment to maintain focus on the main Klamath River and the greater possibility for restoration success. The problems of the Lost River can be addressed through treating the effluent prior to discharge into the Klamath River.

We do recognize that water flows back and forth between the Klamath River and Lost River, and that management changes in Lost River could help restore the Klamath River water quality. Examples include recirculating water from Tule Lake onto adjacent agricultural lands to reduce the amount of water pumped through the Sheepy Ridge Tunnel into Lower Klamath National Wildlife Refuge, some of which is ultimately delivered to the Klamath River through the Klamath Straits Drain. In addition, water conservation in Lost River has the potential to reduce the amount of water diverted from the Upper Klamath Lake and the Klamath River. The Consortium is not necessarily opposed to other entities doing water quality or water efficiency/conservation projects in Lost River, but the Consortium does not want to expend its own limited resources there.

4.5 DAMS AND DIVERSIONS

Water levels in Upper Klamath Lake are regulated by Link Dam near Klamath Falls, Oregon. Downstream of this location, there are an additional five dams on the Klamath River that form the Klamath Hydroelectric Project: Keno (River Mile 233), J.C. Boyle (RM 225), Copco 1 (RM 198) and 2 (RM 196), and Iron Gate (RM 190) (Figure 2). Fish passage at Link Dam was recently upgraded, but fish ladders at Keno and J.C. Boyle dams do not meet current fish passage criteria and there are no fish passage facilities at Copco 1 & 2 and Iron Gate dams (U.S. DOI and CDFG 2012). Below Iron Gate Dam, the Klamath River is free flowing to the Pacific Ocean. Keno, J.C. Boyle, and Copco 1 & 2 and Iron Gate dams do not store water for irrigation.

The Klamath Hydroelectric Settlement Agreement (KHSA) was drafted in 2010 and signed by PacifiCorp (operator of the dams), the U.S. Secretary of the Interior, Oregon and California governors, and multiple stakeholders. The KHSA called for the removal of Iron Gate, Copco 1 & 2, and J.C. Boyle dams, but it was never approved by the U.S. Congress. An amended KHSA was announced in 2016 which did not require congressional action. The amended KHSA calls for ownership of the lower four dams to be transferred to the newly formed Klamath River Renewal Corporation (KRRC) which is scheduled to remove them in 2021.

The U.S. Bureau of Reclamation Klamath Reclamation Project diverts water from Upper Klamath Lake, the Klamath River, and waterbodies in the Lost River basin for agricultural irrigation of >200,000 acres in California and Oregon. The Klamath Project has 19 major canals and laterals that form a 1200-mile-long irrigation network (USBR 2016a). There are additional diversions outside of the Klamath Reclamation Project, including both upstream and downstream of Upper Klamath Lake as well as directly from the Upper Klamath Lake. The total amount of applied irrigation water consumed by crops and pastures in the Klamath Basin upstream of Iron Gate Dam including Lost River and Butte Valley is approximately 766 million cubic meters (621,000 acre-feet) per year (Asarian and Walker 2016).

There are also two systems for diverting water from the Upper Klamath Basin into the Rogue River Basin. Diversions from the Jenny Creek watershed (tributary to Iron Gate Dam) into the Rogue River Basin were approximately 24,000 acre-feet per year in 1961-2000 (USBR 2012), equating to approximately 1.6 % of Iron Gate flows. Approximately 4,200 acre-feet of water are diverted annually from the Fourmile Creek (tributary to Upper Klamath Lake) drainage into the Rogue River Basin (RRVID 2018).

4.6 LAND USE AND OWNERSHIP

Land use in the Upper Klamath basin is predominantly public and private forestry. Agriculture and rangeland comprise only a small portion of the basin, but these activities are located in relatively sensitive areas of the basin, including valley bottoms and along the shores of UKL. In the Upper Klamath River watershed, large areas of wetlands have been drained, streams diked, and water diverted to support agricultural land use, which has resulted in increased concentrations of nutrients and sediment delivered to watercourses (Stillwater Sciences et. al 2012). A small portion of the upper basin is protected in Crater Lake National Park, Lava Beds National Monument, and in National Wildlife Refuges (ODEQ 2002).

Table 2. Land cover types in Upper Klamath Basin NPS Plan area based on the 2011 National Land Cover Database (Homer et al. 2015). Walker et al. (2015) found that in the Upper Klamath Basin this dataset regularly mischaracterized grazed areas as wetlands, herbaceous, or shrubland and therefore recommended that this dataset be used with caution.

Land Cover Type	Square Kilometers	Square Miles	Percent of Total
Forest	12977.1	5010.5	54.5
Shrub/Scrub	4755.4	1836.1	20.0
Grassland/Herbaceous	2176.4	840.3	9.1
Cultivated Crops, Pasture/Hay	1567.6	605.3	6.6
Wetlands	1134.9	438.2	4.8
Open water	731.9	282.6	3.1
Developed	298.1	115.1	1.3
Barren (Rock/Sand/Clay)	189.9	73.3	0.8
Total	23831.3	9201.3	100.0

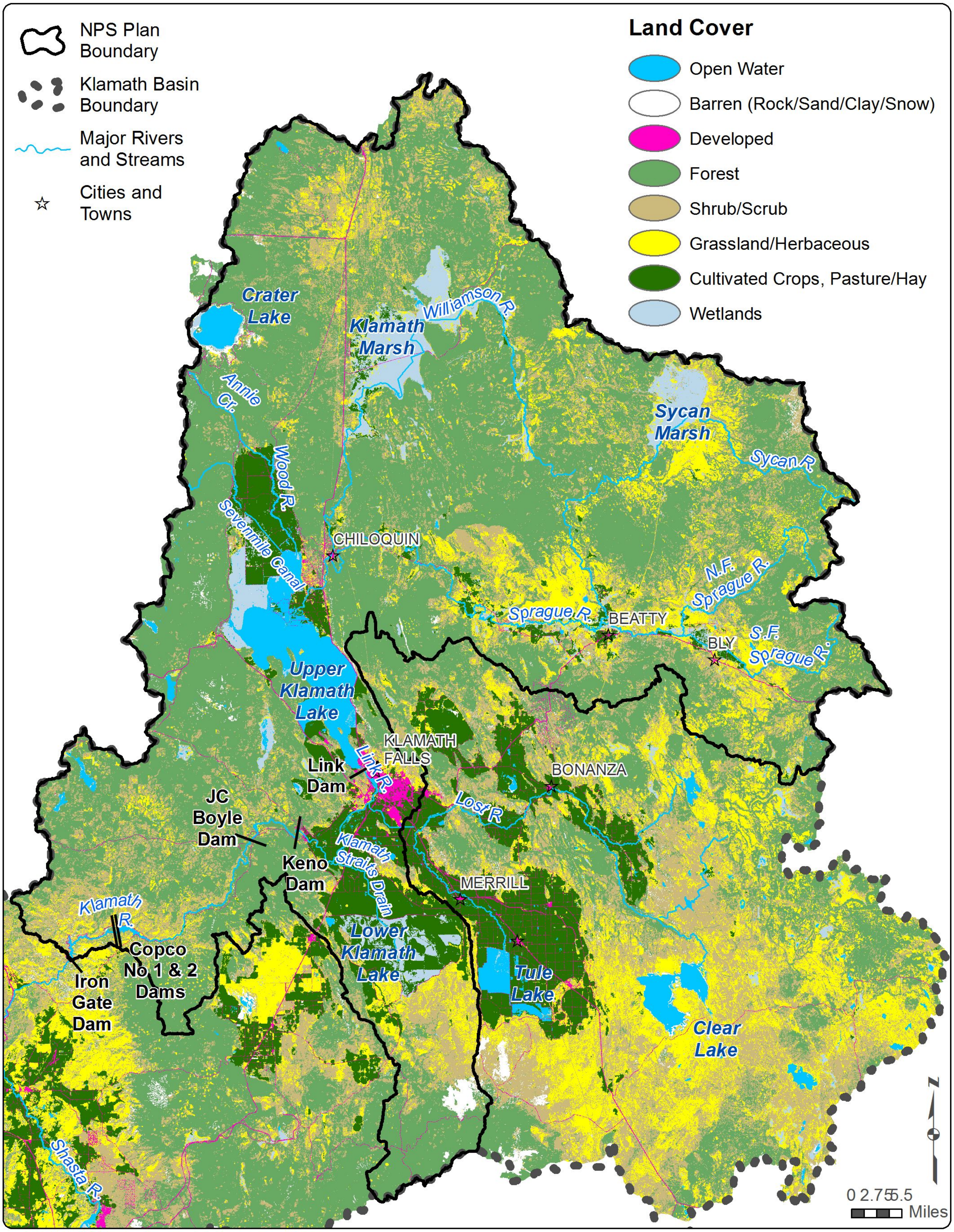

Figure 6. Map of land cover in the Upper Klamath Basin. Data are from 2011 National Land Cover Database (Homer et al. 2015).

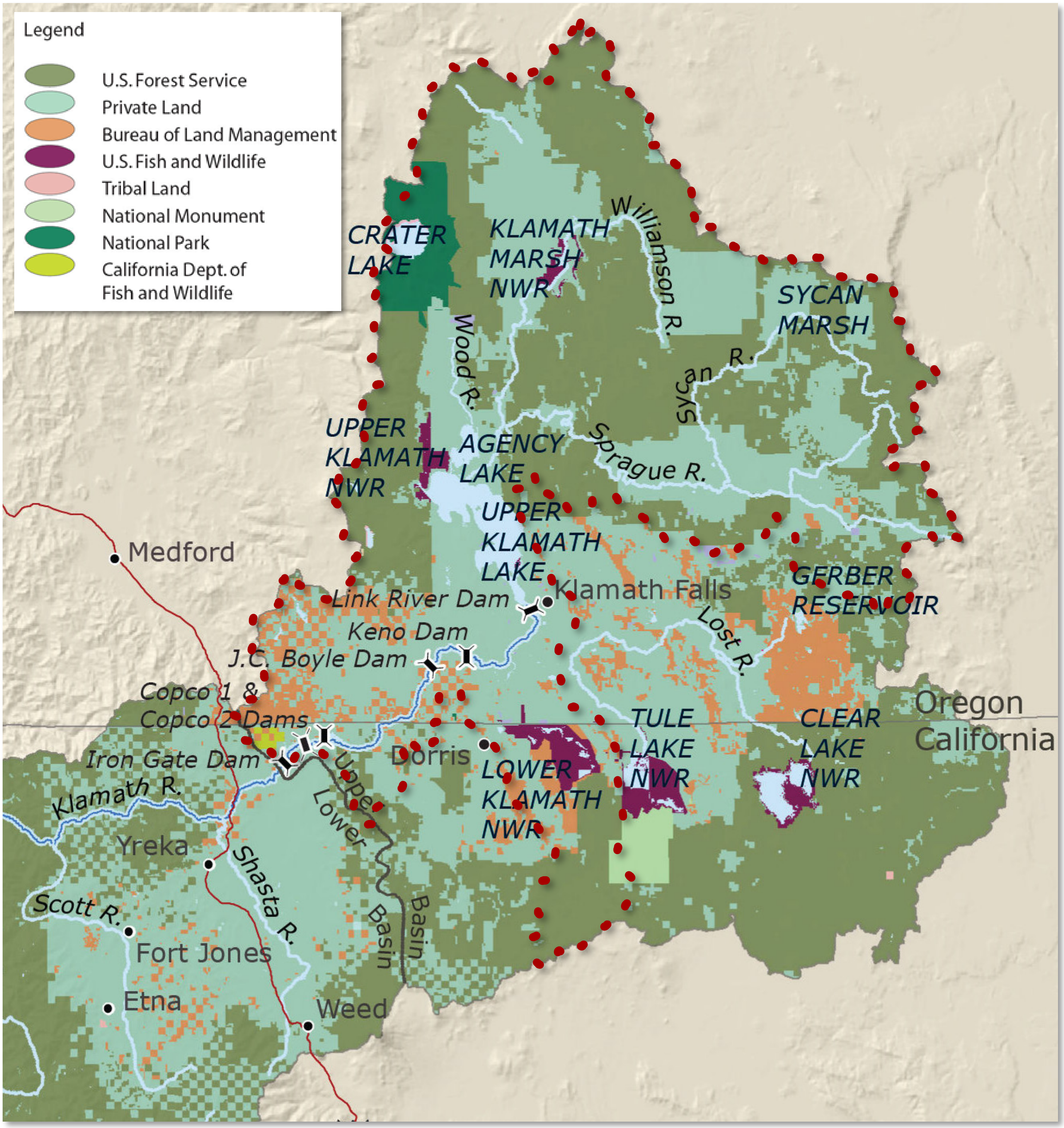

Figure 7. Map of land ownership in the Upper Klamath Basin. The dotted red line is the outline of the NPS project area. Map adapted from Stillwater Sciences et al. (2012).

4.6.1 NATIONAL WILDLIFE REFUGES

The USFWS manages three National Wildlife Refuges (NWRs) in the Upper Klamath Basin. The Klamath Marsh NWR contains 41,230 acres of wet meadow and open-water wetland habitat located along the Williamson River. The Upper Klamath NWR protects 15,000 acres of emergent marsh and open water around UKL, primarily on the western shore but also Hank's Marsh on the eastern shore. Lastly, the Lower Klamath NWR contains 50,092 acres of shallow marsh, open water, grassy upland, and cropland located southeast of the Keno Reservoir and the Klamath River. Of these three NWRs, the Lower Klamath NWR hydrology is the most impacted by allocation of water and in some years is unable to keep marshes wet.

4.6.2 FORESTRY

Residual impacts from past harvesting practices in the Upper Klamath River include abandoned or non-maintained roads that have not been fully decommissioned, single-aged tree stands reforesting clearcut areas, and vegetation removal. These activities modify groundwater and surface hydrology and can contribute high loads of sediment and associated nutrients to streams. The Freemont-Winema National Forest (NF), Klamath NF, and Modoc NF all have active timber management areas within the Upper Klamath Basin. Private timber companies also own and manage land for timber harvest.

4.6.3 AGRICULTURE

Agricultural activities in the Upper Klamath River area include cattle grazing and crop production. The majority of agricultural areas are located along the relatively flat valley bottoms near current or historic rivers, lakes, and wetlands. Due to the lack of summer precipitation, irrigation greatly increases agricultural productivity and therefore most agricultural lands are irrigated. Crops grown within the Upper Klamath Basin include cereals (barley, oats, and wheat), forage (alfalfa, hay, and irrigated pasture), and other crops (potatoes, sugar beets, onions, peppermint, horseradish, and pea seed) (Smith and Rykbost 2000). In the tributaries upstream of Upper Klamath Lake which are the primary focus of this NPS Plan, irrigated pasture for cattle grazing predominates (NRCS 2009, 2010).

4.6.4 URBAN

Klamath Falls is the largest metropolitan area in the Upper Klamath Basin (Figure 2). Located at the outlet of Upper Klamath Lake, the city limits of Klamath Falls cover 20.6 mi^2 with a population of 21,207. Other cities in the Upper Klamath Basin include Tulelake, Merrill, and Bonanza in the Lost River sub-basin and Chiloquin at the confluence of the Sprague and Williamson rivers. Unincorporated communities include Sprague River, Beatty, and Bly in the Sprague River Valley, Fort Klamath in the Wood River Valley, Keno near the Klamath River.

5 WATER QUALITY SUMMARY

5.1 SYNTHESIS OF UPPER KLAMATH BASIN WATER QUALITY IMPAIRMENTS AND LINKS TO NPS POLLUTION

Upper Klamath Lake has historically been a eutrophic lake, but land-use practices and hydrologic modifications in the past several decades have caused the lake to become hyper-eutrophic (ODEQ 2002). There is widespread agreement that excessive levels of phosphorus are the ultimate cause of the pH and DO impairment in Upper Klamath Lake (ODEQ 2002). The Upper Klamath Lake TMDL (ODEQ 2002) presents details of research that identified sources of phosphorus and the pathway of phosphorus-induced impairment of pH and DO in UKL.

Conversion of wetlands to agricultural land has increased the loading of phosphorus into Upper Klamath Lake. Phosphorus is contributed to Upper Klamath Lake when wetlands are drained, and their peat soils are exposed to oxygen which allows decomposition and leads to release of phosphorus which is then delivered to the lake through runoff or pumping. The reclaimed wetlands are then used for cattle grazing and crop production. Runoff from these land uses is high in nutrients, including phosphorus.

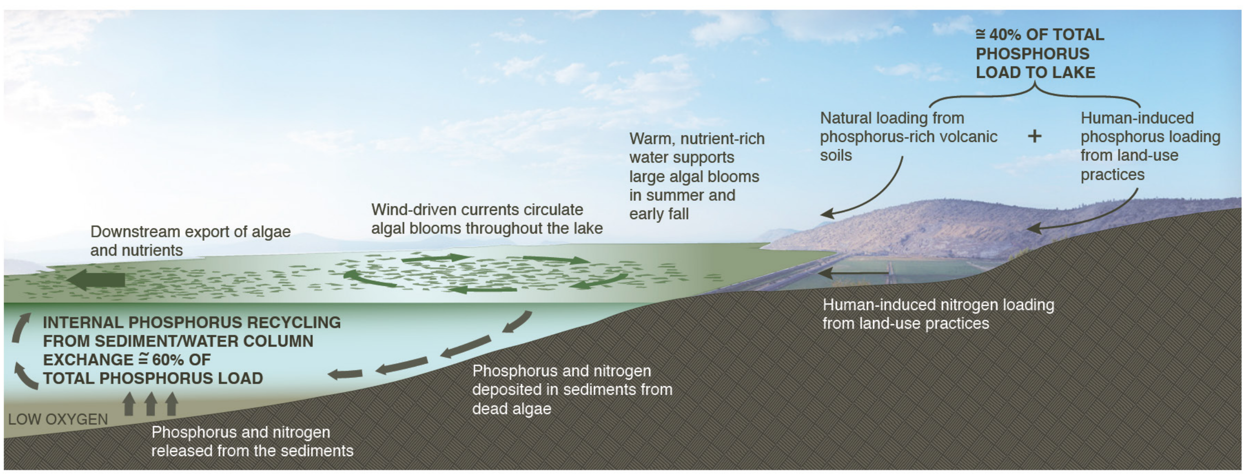

Figure 8. Seasonal nutrient mechanisms in Upper Klamath Lake at a watershed scale. Figure copied from Stillwater Sciences et al. (2013).

High internal and external phosphorus loads and naturally warm water temperatures trigger cyanobacterial blooms in Upper Klamath Lake. The nitrogen-fixing *Aphanizomenon flos-aquae* is the dominant cyanobacterial species but the toxigenic *Microcystis aeruginosa* also occurs. During daylight hours in peak bloom periods, photosynthesis raises water pH, whereas night-time respiration and bloom crashes result in low DO in Upper Klamath and Agency Lakes and in reservoirs downstream. Cyanobacteria blooms in Upper Klamath Lake are severe and can occur simultaneously throughout the entire lake. The senescence of the blooms results in anoxic environments as the cyanobacteria decompose. Dead cyanobacteria settle into the sediments; decomposition results in an internal source of inorganic phosphorus that may fuel blooms later that year and the following year (Figure 8). Cyanobacteria-rich waters flow out of Upper Klamath Lake through Link River and into Lake Ewauna and Keno Reservoir (Figure 9). For unknown reasons, cyanobacteria do not fare as well in Keno Reservoir as in Upper Klamath

Lake (Sullivan et al. 2011). Senescing and dead cyanobacteria settle to the bottom of Keno Reservoir; subsequent decomposition then consumes DO and may result in anoxic conditions (Sullivan et al. 2013, 2014).

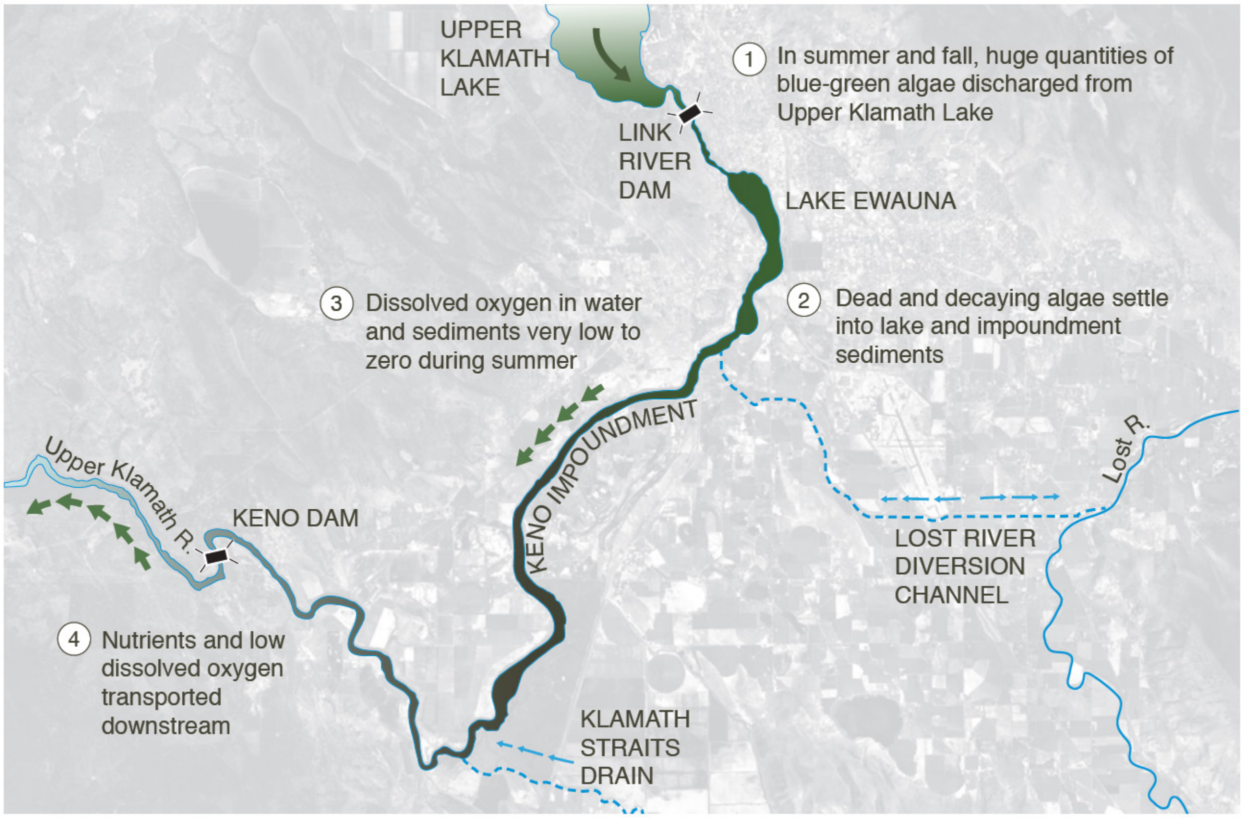

Figure 9. Effect of Upper Klamath Lake algal blooms on Keno Reservoir and the Klamath River downstream. Figure copied from Stillwater Sciences et al. (2013).

5.2 PHOSPHORUS

Primary external sources of phosphorus in the Upper Klamath Lake watershed include decomposing peat in drained wetlands, springs transporting phosphorus dissolved from geologic sources of volcanic origin, enhanced erosion due to degraded riparian conditions, and flood irrigation which transports livestock manure and organic matter into surface waters. External loads of phosphorus contributed to the lakes account for nearly 40% of phosphorus concentrations on an annual basis (ODEQ 2002). The Williamson, Sprague and Wood rivers contributed 65% combined external phosphorus load from nearly 85% of the watershed area (Figure 10). ODEQ recommended a 40% reduction in total external phosphorus loading to Upper Klamath Lake as a target condition for the TMDL (ODEQ 2002).

Drained wetlands contribute large amounts of nutrients to Upper Klamath Lake. When intact and functioning, most wetlands are a nutrient sink. The water that drains from reclaimed wetlands contains high concentrations of nutrients, including phosphorus and nitrogen (Snyder and Morace 1997, Kann and Walker 1999, ODEQ 2002). As wetlands dry after draining, aerobic peat decomposition releases additional nutrients into the waters pumped from the reclaimed areas (Snyder and Morace 1997, ODEQ 2002). Wetlands are most often drained for agricultural use, which includes cattle grazing and cultivation of crops (ODEQ 2002). Not only have the majority of wetlands around Upper Klamath Lake and Agency Lake been drained, so have wetlands in the Williamson and Sprague watersheds. Following the recognition of negative effects of wetland draining on habitat and water quality, significant progress has been made in the past two decades to begin the process of restoring lakeside wetlands in the Williamson River Delta (Wong and Hendrickson 2011) and the mouth of the Wood River (Carpenter et al. 2009). The percent of the lake's total external phosphorus load that is attributable to anthropogenic land-use activities declined from 38% (1992–1998) to 31% (2008–2010), in part due to wetland restoration which decreased the amount of drainage water pumped from agricultural lands into the lake (Walker et al. 2012).

Other human activities and land uses besides wetland conversion have also increased external loads of phosphorus to Upper Klamath Lake. A primary mechanism appears to be increased rates of erosion and transport of sediment-bound phosphorus (ODEQ 2002, Walker et al. 2015). For example, sediment cores within Upper Klamath Lake indicate an increase in various indicators (e.g. Ti, Al, tephra, and charcoal) of erosional inputs in the 20th century (Bradbury et al. 2004, Eilers et al. 2004, Simon and Ingle 2011). The Sprague River is an important source of particulate-bound phosphorus (ODEQ 2002, Walker et al. 2015). Woody vegetation has decreased in the past century in the valley bottoms along the Sprague River and Sycan River (O'Connor et al. 2015). Levees confine stream channels in parts of the Sprague River watershed, disconnecting floodplains and promoting incision which results in sediment being transported downstream rather than being deposited on floodplains (O'Connor et al. 2015). Monitoring of pastures in the Upper Klamath Lake basin found that large quantities of phosphorus can be exported into watercourses during first-flush irrigation events and storm events (Ciotti et al. 2010).

Recycled sediment and algal phosphorus (i.e., internal loading) in Upper Klamath Lake and Agency Lake contributes nearly 60% of total in-lake phosphorus concentrations on an annual basis (ODEQ 2002). Mechanisms for internal recycling vary spatially and temporally but likely include a combination of algal translocation, diffusion, pH or anaerobic-mediated release, microbial and macroinvertebrate metabolic cycling, bioturbation, and resuspension (Barbiero and Kann 1994; Laenen and LeTourneau 1996; Kuwabara et al. 2007, 2009, 2012; Simon et al. 2009; Simon and Ingle 2011). If external loads can be reduced, internally recycled phosphorus would likely reach a new lower equilibrium level within a few decades (ODEQ 2002, Wherry et al. 2015). We do not expect that lower levels of phosphorus would eliminate cyanobacterial blooms but rather may lower the magnitude and duration of blooms and their associated water quality impacts.

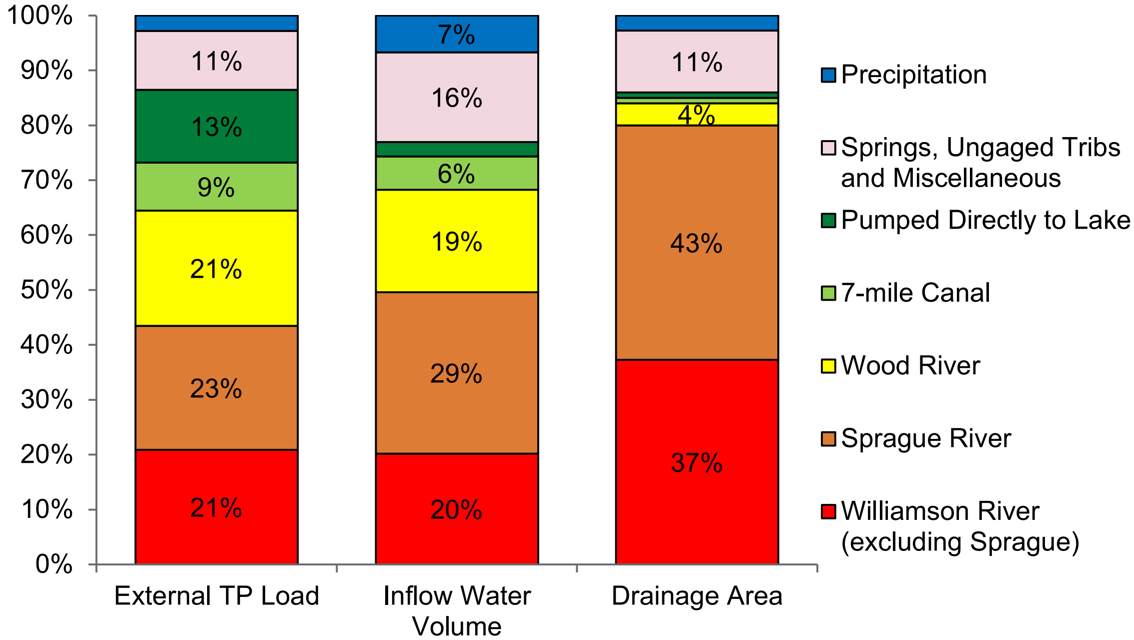

Figure 10. Relative contributions of tributaries and other sources to external total phosphorus (TP) load, inflow water volume, and drainage area to Upper Klamath Lake for hydrologic years 1992-2010. Figure adapted from Stillwater Sciences et al. (2012) based on data from Walker et al. (2012).

5.3 NITROGEN

The cyanobacterial species *Aphanizomenon flos-aquae* is capable of fixing nitrogen. Mass-balance nutrient budgets for Upper Klamath Lake find net-negative retention of nitrogen during the summer bloom period, consistent with large quantities of N being fixed (Walker et al. 2012). N:P ratios and overall nitrogen concentrations coming into UKL are very low, favoring nitrogen-fixers such as *Aphanizomenon flos-aquae* which can overcome nitrogen limitation (Kann 1998). Therefore, while nitrogen concentrations are monitored within the NPS Plan area, the Consortium's efforts focus on phosphorus because it is the most feasible means of controlling *Aphanizomenon flos-aquae* within UKL. Controlling *Aphanizomenon flos-aquae* in UKL is critically important since its large blooms are the proximal cause of poor water quality (e.g., high pH during bloom development, then low dissolved oxygen and high ammonium following bloom crashes) (ODEQ 2002). In addition, when *Aphanizomenon flos-aquae* cells die the nitrogen they previously fixed becomes available to fuel blooms, both in UKL and downstream in reaches of the Klamath River impounded by dams, of toxigenic *Microcystis aeruginosa* which is incapable of nitrogen-fixation (Eldridge et al 2013, Kann 2017). *Microcystis aeruginosa* thrives in environments with high levels of both nitrogen and phosphorus (Moisander et al. 2009, Chia et al. 2018) but without *Aphanizomenon flos-aquae* or other nitrogen fixers, nitrogen concentrations in UKL would be relatively low.

5.4 DISSOLVED OXYGEN AND pH

Due to prolific blooms and crashes of the cyanobacterium *Aphanizomenon flos-aquae*, low dissolved oxygen (DO) and high pH conditions can occur in Upper Klamath Lake during late spring, summer, and early fall. Low DO, high pH, and high ammonia concentrations have been identified as primary factors in the declines of the endangered shortnose sucker (*Chasmistes brevirostris*) and Lost River sucker (*Deltistes luxatus*) in Upper Klamath Lake (ODEQ 2002). DO concentrations in the lake can drop below the ODEQ warmwater aquatic life criterion of 5.5 mg/L for many weeks in a row (Kann 2010, Morace 2007). Endangered suckers and other native fish species including redband trout, blue chub, and tui chub have experienced fish kills in multiple years during periods of exceptionally poor lake water quality (Perkins et al. 2000). Annual timing is variable depending on the bloom cycle, but pH peaks in July during blooms and DO is often lowest in August when blooms are declining and water temperatures are warm (Jassby and Kann 2010).

DO conditions in Lake Ewauna and Keno Reservoir are even more acute than in Upper Klamath Lake, approaching anoxia for weeks or months at a time (Sullivan et al. 2013, 2014).

The Klamath Hydroelectric Project (KHP) has a direct effect on DO and pH levels in the Klamath River immediately below Iron Gate Dam (FERC 2007). During the summer season the reservoir often releases water with high pH and low DO (Asarian and Kann 2013), which could harm salmonid fish in the vicinity of the dam. Phytoplankton blooms from KHP reservoirs tend to decrease daily minimum dissolved oxygen concentrations in the Klamath River, presumably by reducing light availability and rates of production from periphyton (Genzoli 2013, Genzoli et al. 2015, Genzoli and Hall 2016).

Downstream of our NPS project area in the free-flowing reaches of the Klamath River, photosynthesis and respiration by periphyton (algae attached to the riverbed) and aquatic plants in the Klamath River can degrade dissolved oxygen and pH conditions, resulting in water quality that is chronically stressful to fish (NCRWQCB 2010, Asarian and Kann 2013).

5.5 TEMPERATURE

High water temperatures in Upper Klamath Basin streams are due in part to solar radiation facilitated by poor riparian conditions and contributions of irrigation return flows that are warmer than ambient river flows (ODEQ 2002). Other hydrologic modifications in the UKL watershed include water diversions, reduction in stream flows, streambed channelization, streambed armoring, dikes, and dams.

Upper Klamath Lake's shallow depth prevents thermal stratification and results in naturally high summer water temperatures throughout much of the lake; however, springs do provide cold-water refugia for fish and other organisms in the lake.

Primarily due to the thermal mass of Iron Gate and Copco reservoirs, the Klamath Hydroelectric Project significantly alters water temperatures in the Klamath River (PacifiCorp 2004, 2005; FERC 2007, US DOI and CDFG 2012) in ways that are detrimental to the various runs of anadromous fish in the Klamath River.

5.6 CYANOBACTERIAL TOXINS

Iron Gate and Copco reservoirs provide ideal habitat for the toxigenic cyanobacteria (blue-green algae) *Microcystis aeruginosa* by transforming turbulent free-flowing river reaches into stagnant thermally stratified impoundments that favor cyanobacterial proliferation. In the presence of abundant nutrients, the transformation from river to reservoir environment leads to massive blooms (Kann 2006; Kann and Corum 2006, 2007). Microcystin toxins produced by the toxic cyanobacteria *Microcystis* represent a substantial threat to human and animal health (OEHHA 2005; Kann 2006; Kann and Corum 2006, 2007; OEHHA 2012). The Klamath River is listed as impaired by microcystin toxins from Stateline to its confluence with the Trinity River (SWRCB 2015). Microcystin concentrations generally decline with distance downstream of Iron Gate Dam (US DOI and CDFG 2012) but frequently exceed public health guidelines between Iron Gate and Orleans, and occasionally exceed public health and water quality criteria as far downstream as the Klamath Estuary (HVTEPA 2013). Genetic fingerprinting research showed that Iron Gate Reservoir is the source of downriver *Microcystis* assemblages and that Iron Gate Reservoir was determined to be the principal source of *Microcystis* found throughout the lower 300 km of river separating the reservoir from the Pacific Ocean (Otten et al. 2015). Tissue sampling has documented bioaccumulation of microcystin in freshwater mussels from the Klamath River between Iron Gate Dam and the Yurok Reservation, yellow perch from Iron Gate and Copco reservoirs, juvenile salmonids in Iron Gate Hatchery, and steelhead and Chinook salmon in the Klamath River (Fetcho 2006, Kann 2008, OEHHA 2008, and Kann et al. 2010).

Microcystis and microcystin also occur upstream in Upper Klamath Lake (Kann et al. 2015), particularly in the northern part of the lake (Agency Lake), but typically at levels far lower than is observed in Iron Gate and Copco reservoirs (Kann 2006). For reasons that have not yet been determined, there were large blooms of *Microcystis* in Upper Klamath Lake in 2014, 2015, and 2017 (Kann 2017).

5.7 SEDIMENT

Several tributaries to the Klamath River are listed as sediment impaired on the 303(d) list (Appendix A). Land uses contributing sediment to waterbodies include timber harvest and associated roads, cattle grazing, other agriculture, and a lack of function riparian corridors. Sediment cores in Upper Klamath Lake show strong evidence of increased erosion inputs in the lake in the past century relative to previous periods (see section 5.2 above). Increased sedimentation can directly impact aquatic resources within tributaries. Sediment is a major contributor to phosphorus loading and algal blooms within Upper Klamath Lake because soils have high phosphorus contents due to their volcanic origin.

6 RESULTS

As discussed above in section 3, since the state of California and Oregon have already done a thorough analysis of impairment on individual waterbodies including the development of TMDLs (ODEQ 2002; 2010b, NCRWQCB 2010), we rely heavily on their existing assessments.

6.1 BENEFICIAL USES

Beneficial uses of the Klamath River and its tributaries and lakes in Oregon that have been identified by the Oregon Department of Environmental Quality (ODEQ) include direct human contact, agricultural, and aquatic life uses (Table 3). In California, designated beneficial uses are listed in Table 4 for the Middle Klamath River from Hornbrook Creek upstream to Copco Reservoir, not including tributaries.

Water bodies in California and Oregon are assessed and placed in a reporting category that represents levels of water quality attainment and support of beneficial uses. These categories

(Table 5) are developed according to U.S. EPA guidance for Integrated Reports (U.S. EPA 2005). The categories range from Category 1, where all beneficial uses are fully supported, to Category 5, where at least one beneficial use is not supported and a TMDL is required.

A beneficial use is considered not supported if a water body does not meet designated water quality standards. The standards are set by each state and approved by USEPA. Some standards are numeric (i.e., pH, dissolved oxygen, chlorophyll-a) while others are narrative, such as "no measurable surface water temperature increase resulting from anthropogenic activities is allowed" (ODEQ 2002). For example, ODEQ states the beneficial use for salmonid fish rearing is considered fully supported if water temperatures do not exceed 17.8°C (ODEQ 2002).

The majority of the beneficial uses in Oregon are impaired by parameters from non-point sources, including chlorophyll-a, pH, and temperature. In California, the Klamath River does not fully support the following beneficial uses that include cold freshwater habitat; rare, threatened and endangered species; migration of aquatic organisms; spawning, reproduction, and early development of fish; commercial and sport fishing; Native American cultural use; subsistence fishing; and contact and non-contact water recreation (NCRWQCB 2010).

Table 3. ODEQ Designated Beneficial Uses for the Upper Klamath River and other Basin waters in Oregon. The other waters include Williamson, Sprague, and Sycan watersheds and tributaries and lakes below Keno Dam. Table modified from ODEQ Designated Beneficial Uses Klamath Basin (340-41-0180) Table 180A (ODEQ 2005).

Designated Beneficial Use	Klamath River (Upper Klamath Lake to Keno Dam)	All Other Basin Waters
Domestic Water Supply	x	x
Industrial Water Supply	x	x
Hydropower	x	
Water Contact: Recreation	x	x
Irrigation	x	x
Livestock Watering	x	x
Wildlife and Hunting	x	x
Fishing	x	x
Commercial Navigation and Transportation	x	
Boating	x	x
Aesthetic Quality	x	x
Resident Fish and Aquatic Life	x	x
Salmonid Fish Rearing	x	
Salmonid Fish Spawning	x	
Anadromous Fish Passage	x	
Coldwater Fisheries	x	x

Table 4. NCRWQCB Designated Beneficial Uses for the Middle Klamath River from Hornbrook upstream to Copco Lake. Data modified from Water Quality Control Plan for the North Coast Region Table 2.1 (NCRWQCB 2011). E: Existing designated beneficial use; P: Potential beneficial use.

Designated Beneficial use	Hornbrook to Iron Gate Dam	Iron Gate Reservoir	Copco Lake
Municipal and Domestic Supply	E	P	E
Agricultural Supply	E	P	E
Industrial Service Supply	E	P	E
Industrial Process Supply	E	P	P
Groundwater Recharge	E		
Freshwater Replenishment	E	E	E
Navigation	E	E	E
Hydropower Generation	P	E	E
Water Contact Recreation	E	E	E
Non-Contact Water Recreation	E	E	E
Commercial and Sport Fishing	E	E	E
Aquaculture	P		
Warm Freshwater Habitat	E	E	E
Cold Freshwater Habitat	E	E	E
Wildlife Habitat	E	E	E
Rare, Threatened, or Endangered Species	E	E	E
Migration of Aquatic Organisms	E	E	E
Spawning, Reproduction, and/or Early Development	E	E	E
Shellfish		E	

Table 5. Assessment categories of water body support of designated beneficial uses. Categories are based upon USEPA guidance (2005) and utilized by California (SWRCB 2015b) and Oregon (ODEQ 2012). Category 3b is used by Oregon only.

Category	Definition
1	A water segment that supports all core beneficial uses.
2	A water segment that has some core beneficial uses supported.
3	Evidence is insufficient to make a supportive beneficial use determination.
3b	Potential concern, data are insufficient to determine beneficial use support.
4a	A water segment that has at least one beneficial use not supported and has a U.S. EPA-approved TMDL
4b	A water segment that has at least one beneficial use not supported and a TMDL is not required as an existing regulatory program addresses the issue.
5	A water segment that has at least one beneficial use not supported and a TMDL is required but not yet completed.

6.2 WATER QUALITY LIMITED WATERS

ODEQ has listed over 45 stream segments and six reservoirs and lakes as 303(d) water quality limited and either requiring a TMDL or a TMDL has been approved. The list was submitted by ODEQ to EPA in May 2011 and approved by EPA in March 2012. See Appendix A for the 2012 ODEQ impaired waters list for streams, lakes, and reservoirs in the Klamath Basin that are within Oregon state boundaries.

Some waterbodies are considered water quality limited but a TMDL is not required due to the pollutant not being regulated by TMDLs, including flow and habitat modifications. Phosphorus is a pollutant of major concern in the Upper Klamath Basin. The ODEQ TMDL (ODEQ 2002) for Upper Klamath Lake describes a clear relationship between phosphorus concentrations and the listed impairments of pH, dissolved oxygen, and chlorophyll-a, a finding corroborated by many other analyses (Kann 1993, 1998; Wherry et al. 2015). If phosphorus loading to Upper Klamath Lake and Agency Lake can be reduced, it is highly likely that the magnitude of algal blooms in Upper Klamath Lake would also be reduced (ODEQ 2002, Wherry et al. 2015), which would improve water quality of the Klamath River and its reservoirs downstream (NCRWQCB 2010, Sullivan et al. 2013).

The North Coast Regional Water Quality Control Board in California has designated the Klamath River as "impaired" for water temperature, dissolved oxygen (DO), organic matter (measured as Carbonaceous Biochemical Oxygen Demand, CBOD), total phosphorus (TP), total nitrogen (TN), and microcystin (NCRWQCB 2010). The NCRWQCB TMDL for the Klamath River (2010) states in reference to waters entering from Oregon that "current source loads have overwhelmed the historical renewal capabilities of the Klamath River, leading to its impaired status." Current annual loads of TP, TN, and CBOD in the Klamath River at Stateline (the Oregon-California border) are more than twice as high as estimated natural conditions (NCRWQCB 2010).

6.3 ATTRIBUTION OF IMPAIRMENTS TO NPS POLLUTION FOR EACH SUB-BASIN

Table 6. Sub-basin summary of impairments and causes of NPS pollution. For the sake of simplicity and usefulness, the table does not list every impairment for every specific waterbody but rather focuses on the most important impairments and causes at the sub-basin level. Waterbodies are listed separately in the Hydroelectric Reach because the waterbodies have different causes of impairment.

Sub-basin *Waterbody*	**Impaired Parameter**	**Severity**	**NPS Pollution Categories [i.e., Causes] and Importance**
Williamson River			*Primary:* Agriculture (AGR), Hydromodification and Habitat Alteration (HHA)
	Phosphorus	Moderate	
	Temperature	Moderate	
Sprague River			*Primary:* Agriculture (AGR), Hydromodification and Habitat Alteration (HHA)
	Phosphorus	High	
	Dissolved Oxygen	Moderate	
	pH	Moderate	
	Temperature	Moderate	
Wood River and other tributaries to UKL			*Primary:* Agriculture (AGR), Hydromodification and Habitat Alteration (HHA)
	Phosphorus	High	
Upper Klamath Lake including Agency Lake			*Primary:* Agriculture (AGR), Hydromodification and Habitat Alteration (HHA)
	Phosphorus	High	
	Algae	High	
	Chlorophyll-a	High	
	Dissolved Oxygen	High	
	pH	High	
	Ammonia	High	
Link River, Lake Ewauna, Keno Reservoir, and Lower Klamath Lake			*Primary:* Agriculture (AGR), Hydromodification and Habitat Alteration (HHA) *Secondary/Minor:* Urban (URB)
	Phosphorus	High	
	Algae	High	
	Chlorophyll-a	High	
	Dissolved Oxygen	High	
	pH	High	
	Ammonia	High	
	Temperature	Moderate	
Hydroelectric Reach (Keno Dam to Iron Gate Dam)			
Mainstem River and Reservoirs			*Primary:* Hydromodification and Habitat Alteration (HHA), Agriculture (AGR)
	Cyanobacterial toxins	High	
	Algae	High	
	Chlorophyll-a	High	
	Dissolved Oxygen	Moderate	
	pH	Moderate	
	Temperature	Moderate	
Spencer Creek			*Primary:* Forestry (FOR), Agriculture (AGR), Hydromodification and Habitat Alteration (HHA)
	Sedimentation	Moderate	
	Temperature	Moderate	

7 DISCUSSION

Linkages between nonpoint source pollution and water quality problems in the Upper Klamath Basin have been intensively studied for decades and are relatively well understood. Human activities have pushed the naturally eutrophic Upper Klamath Lake over the edge into a hyper-eutrophic state. Excessive loading of phosphorus into the lake has fueled prolific blooms of the nitrogen-fixing cyanobacterium *Aphanizomenon flos-aquae* which then severely degrade water quality conditions both within the lake as well as downstream when the algae decay, consume dissolved oxygen, and release ammonia.

Simply put, the key to reversing the problem is to find ways to keep phosphorus on the land and prevent it from entering Upper Klamath Lake and its tributaries. The ODEQ (2002) TMDL for Upper Klamath Lake called for a 40% reduction in the amount of phosphorus delivered to the lake. This should be the highest priority. A secondary strategy is to attempt to remove phosphorus that has already reached the tributaries, such as by routing water through treatment wetlands or restoring floodplain connectivity so that sediment-bound phosphorus deposits on floodplains rather than being transported downstream into the lake. A tertiary strategy, which is less desirable because it will only help the river downstream, not the lake itself, would be to intercept (with mechanical removal or treatment wetlands) algae at the outlet of the lake before it is discharged to the Klamath River downstream. Keno Reservoir, which is located downstream of Upper Klamath Lake, has some of the worst water quality in the entire Klamath Basin and will be a key bottleneck for recolonization of salmon into the Upper Klamath Basin once the dams are removed.

Human activities contributing phosphorus loads to Upper Klamath Lake include conversion wetlands to agricultural land, pumping of water from former wetlands directly into the lake or its tributaries, suppression of riparian vegetation by cattle grazing or mechanical disturbance, discharge of cattle manure into streams, return of irrigation tailwater to streams, construction of levees which confine stream channels and promote sediment transport rather than sediment retention, and roads and timber harvest which cause erosion in upland areas.

Cyanobacteria, including the toxigenic *Microcystis aeruginosa*, also bloom in the hydroelectric reservoirs downstream of Keno Dam. The most effective means for preventing these blooms is to remove the dams, as has been proposed, and convert the warm quiescent waters of the reservoirs back to turbulent free-flowing river reaches.

8 SELECTION OF BEST MANAGEMENT PRACTICES

8.1 CORE PARTICIPANTS

NPS pollution prevention is the responsibility of all those who live and work in the Upper Klamath Basin. As such, cooperation between all entities is vital to the health of the watershed.

The Consortium will combine sound science and local knowledge to decide which BMPs (see below) to support. It is not the Consortium's intention to initiate BMPs or restoration projects within the Upper Klamath Basin, but rather to support organizations and programs that already implement effective BMPs and projects that provide a positive impact to water quality. As part of that support, the Consortium will continue to develop working relationships with multiple federal and tribal agencies operating within the Upper Klamath Basin on water quality issues.

Table 7 identifies the institutions that are involved in the identification of NPS pollution and impaired waterways, selection and approval of BMP's for NPS pollution, implementation of NPS pollution BMPs and all other key planning and management documents. Additional discussion for each of these agencies is included in the Consortium's Nonpoint Source Pollution Management Program Plan (section 11) and/or section 9.

Table 7. Core participants for BMPs

Entity Category	Participant	Role
Tribal		
	Klamath Tribal Water Quality Consortium	Collaborates with entities who are working to restore water quality in the Upper Klamath Basin. Provides technical and financial support for projects to improve water quality.
	Quartz Valley Indian Reservation, Yurok Tribe, Karuk Tribe, Hoopa Tribe, and Resighini Rancheria	Member Tribes of the Klamath Tribal Water Quality Consortium.
	The Klamath Tribes of Oregon	Conducts water quality monitoring, plans/implements projects to improve habitat and water quality. Ancestral territory spans large portion of the Upper Klamath Basin.
Federal		
	US Environmental Protection Agency	Provides regulatory and technical assistance as well as grant funding for tribal environmental projects. Reviews and approves the Consortium's NPS Assessment Report and Management Plan.
	U.S. Bureau of Reclamation	Operates the Klamath Reclamation Project and provides funding for research, monitoring, habitat restoration, and water conservation.
	U.S. Fish and Wildlife Service	Provides funds for habitat restoration on private and tribal lands. Manages several National Wildlife Refuges.
	U.S. Bureau of Land Management (U.S. BLM)	Manages federal land including forests, rangelands, and the Wood River Wetland.
	U.S. Forest Service (USFS)	Manages federal land including forests and rangelands
	Natural Resources Conservation Service (NRCS)	Provides funding, technical oversight, and education for projects on private agricultural lands.
	National Oceanic and Atmospheric Administration (NOAA)	Provides funding under the Congressionally mandated Pacific Coastal Salmon Recovery Fund (PCSRF).
State		
	California State Water Resources Control Board (SWRCB) and North Coast Regional Water Quality Control Board (NCRWQCB)	Regulates implementation of California Nonpoint Source Plan, the North Coast Basin Plan, Waste Discharge Requirements, and Total Maximum Daily Loads. Promotes stewardship and collaboration.
	California Department of Fish and Wildlife	Provides funding for instream and upslope restoration projects. Provide permits for projects that require alteration of streambanks.

Entity Category	Participant	Role
	California Coastal Conservancy	Provides funding for habitat restoration projects.
	Oregon Department of Environmental Quality (ODEQ)	Regulates water quality in the State of Oregon. Coordinates with partners to implement Total Maximum Daily Loads and improve water quality.
	Oregon Department of Agriculture (ODA)	Designated Management Agency which develops implementations plan for addressing nonpoint source pollution from agricultural lands. Provides education and technical assistance to farmers and ranchers.
	Oregon Watershed Enhancement Board (OWEB)	Provides funding for habitat restoration projects.
Other Government		
	Klamath Soil and Water Conservation District (KSWCD)	Provides education, technical assistance, and financial assistance to farmers and ranchers.
	Klamath Basin Research & Extension Center (KBREC)	Provides education and technical assistance to farmers and ranchers.
Private Companies		
	PacifiCorp	Operates the Klamath Hydroelectric Project and provides funding for water quality projects under the Klamath Hydroelectric Settlement Agreement (KHSA).
Non-Profit Organizations		
	Klamath Watershed Partnership (KWP)	Provides outreach, education, and technical assistance to residents and agricultural operators. Implements projects to improve habitat and agricultural operations.
	The Nature Conservancy (TNC)	Acquires, manages, and restores land with high conservation value, including wetlands.
	Trout Unlimited/Klamath Basin Rangeland Trust (TU/KBRT)	Implements projects to improve water quality, water quantity, and fish habitat. Coordination and outreach with private landowners.
Other		
	Klamath Basin Monitoring Program (KBMP)	Coordinates basin-wide water quality monitoring and facilitates collaboration and information sharing.

8.2 PUBLIC PARTICIPATION AND GOVERNMENTAL COORDINATION

NPS pollution is a community-wide issue and successful implementation of the NPS Plan will rely upon relationships between the Consortium, our partner entities, and the public, including tribal and non-tribal community members. Therefore, the Consortium sought public input on this NPS Plan by engaging public agencies that have a role in managing or protecting natural resources. The Consortium did an oral presentation on the NPS Plan at the spring 2016 Klamath Basin Monitoring Program (KBMP) meeting which was attended by approximately 50 people, primarily representatives of entities involved in Klamath Basin water quality issues. The Consortium and its consultants conducted phone meetings with many partner organizations to get input on the NPS Plan, and followed up with email correspondence.

The Consortium made a draft version of the NPS Plan available for a 30-day public comment period starting August 19, 2016. Public notice was made by announcing the release of the document in each Consortium Tribe's newsletter, official website, and social media sites. The public notice was also listed on the KBMP website. Including additional comments that were received and accepted after the deadline, the Consortium received comments from 13 entities. The Consortium reviewed all these comments (including those received after the deadline), considered them thoroughly, and then made appropriate changes to the NPS Plan. A summary of the Consortium's responses to the public comments is included as Appendix C. An archive of electronic versions of the public comments is included in an electronic appendix which is available upon request.

9 EXISTING NPS CONTROL PROGRAMS

There are many groups Upper Klamath Basin working to reduce nonpoint source pollution within the Upper Klamath Basin. This section describes some of the active organizations and the types of projects implemented.

9.1 FEDERAL AGENCIES

9.1.1 U.S. BUREAU OF RECLAMATION

As noted in section 4.5 above, the U.S. Bureau of Reclamation (USBR) operates the Klamath Reclamation Project. USBR has several programs relevant to NPS control.

Under the Klamath Basin Water Supply Enhancement Act of 2000[4], USBR is authorized to conduct feasibility studies on ways to improve water supply, water quality, and fish and wildlife habitat. That source of funds is limited to reconnaissance, appraisal, and feasibility, and may not be used for implementation. USBR recently completed an initial assessment of potential projects to improve water quality and supply within the Klamath Reclamation Project (USBR 2016b). The assessment identified 39 site-specific projects which included treatment wetlands, water reuse, water recirculation, and water storage (USBR 2016b). USBR is now planning to further evaluate a subset of the projects included in the initial assessment (Rick Carlson, personal communication, June 17, 2016).

The Recovery Implementation Team (RIT) for Lost River and shortnose suckers was formed following the revision of the recovery plan for those species (USFWS 2012) and is funded by USBR. The RIT issues solicitations for projects and selects projects for funding. The projects typically focus on sucker biology and ecology but some also include linkages to water quality. Examples of previously funded projects included an ongoing adult sucker population monitoring program, lab studies on sucker tolerance for microcystin toxins, juvenile sucker cohort studies to track recruitment, and quantification of avian predation.

USBR also funds ongoing water quality monitoring, research, and analyses within UKL (Kann 1998, Lindenberg et al. 2009, Eldridge et al. 2014, Wood et al. 2013, Kann et al. 2015), and nutrient loading from lake tributaries (Kann and Walker 1999, Walker et al. 2012, Walker et al. 2015). Reclamation also funds USGS to deploy continuous water quality monitoring probes on the upper reach of the Klamath River from Link Dam to Keno Dam including monitors on Klamath Straits Drain and Lost River Diversion Channel, as well as flow gages and water quality sampling at some of those sites.

[4] https://www.govtrack.us/congress/bills/106/s2882

9.1.2 U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service (USFWS) Partners for Fish and Wildlife program funds and implements habitat restoration on private and tribal lands (USFWS 2013a). The Klamath Falls office of the USFWS coordinates the Partners for Fish and Wildlife projects within the Upper Klamath Basin. Potential projects include stream channel restoration, fish passage, riparian fencing and planting, wetland restoration, and spring reconnection. Although the goal of these projects is for fisheries and wildlife habitat restoration, many projects will have ancillary benefits to water quality. The Partners for Fish and Wildlife program has also provided funding for rye seed to improve soil health prior to planting dryland pasture mix (Brian Quick, KSWCD, personal communication, September 9, 2016). USFWS manages several national wildlife refuges within the Consortium's NPS Plan area. Along with its partners, the USFWS developed an innovative Walking Wetlands program on some refuge lands which involves a four-year rotation of crop production and inundation to create wetlands, resulting in nutrient retention, reduced weeds, wildlife habitat and improved crop production (USFWS 2013b).

9.1.3 NATURAL RESOURCES CONSERVATION SERVICE

The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) provides technical assistance in conservation planning concerning on-farm conservation implementation through federally funded programs supported by the Farm Bill. Through these programs, landowners can install fencing and watering systems to prevent cattle from trampling creeks and riparian areas, obtain subsidies for land put in conservation easement, implement irrigation improvements, build diffuse-treatment wetlands, and implement grazing rotational practices.

9.1.4 U.S. BUREAU OF LAND MANAGEMENT AND U.S. FOREST SERVICE

The U.S. Bureau of Land Management (BLM) manages forests and rangelands scatted around the Klamath Basin. Within the Consortium's NPS Plan area, the BLM's two most relevant holdings are upland areas between Keno Dam and Iron Gate Dam (Figure 3), and the Wood River Wetland at the mouth of the Wood River. BLM is currently restoring the wetland habitats in Wood River Wetland (Carpenter et al. 2009). The U.S. Forest Service owns much of the upland forests in the Consortium's NPS Plan area (Figure 3).

USFS and BLM forest lands are managed according to the Northwest Forest Plan (NWFP), a comprehensive federal ecosystem management strategy (USFS and BLM 1994). A primary feature of the NWFP is the Aquatic Conservation Strategy which includes watershed analyses, watershed restoration, and designation of riparian reserves and key watersheds.

9.1.5 U.S. ENVIRONMENTAL PROTECTION AGENCY

In collaboration within the Oregon Department of Environmental Quality and California's North Coast Regional Water Quality Control Board, the U.S. Environmental Protection Agency (U.S. EPA) developed and approved Total Maximum Daily Loads (TMDLs) specifying required water quality improvements within the Klamath and Lost rivers (U.S. EPA 2008, ODEQ 2010b, NCRWQCB 2010). U.S. EPA is actively involved in monitoring harmful algal blooms within the Klamath River and reservoirs, including processing cyanotoxin samples in its laboratory (Watercourse Engineering 2015).

9.2 THE KLAMATH TRIBES OF OREGON

The Klamath Tribes have lived in the Upper Klamath Basin since time immemorial. Following colonization by the United States and the resulting conflict, The Klamath Tribes signed a treaty in 1864 with the United States ceding much of their territory in exchange for a reservation and hunting and fishing rights. In 1954, federal recognition of The Klamath Tribes was terminated by the United States Congress. Federal recognition was restored in 1986 but the reservation was not returned (The Klamath Tribes 2015).

The Klamath Tribes' Natural Resource Department initiated an ongoing long-term water quality monitoring program for Upper Klamath Lake and its tributaries in 1990 (Kann 1998, Kann and Walker 1999, Walker et al. 2012). They also play a lead role in restoration planning in the Upper Klamath Basin.

9.2.1 WATER RIGHTS AND THE UPPER KLAMATH BASIN COMPREHENSIVE AGREEMENT (UKBCA)

The Oregon Water Resources Department (OWRD) began an administrative process for determining pre-1909 water rights in 1975, culminating in a Findings of Fact and Order of Determination (FFOD) in 2013 that The Klamath Tribes' water rights to Upper Klamath Lake and instream flows in the lake's tributaries dated to time immemorial. The Klamath County Circuit Court is now making the final adjudication, but while that process is pending The Klamath Tribes can enforce their water rights by making "calls" to OWRD to shut off diversions by junior water users (including some dating back as far as the 1860s) when instream flows are not met (Timmons 2016).

In response to the prospect of regular curtailment of irrigation diversions to meet tribal water rights, stakeholders upstream of Upper Klamath Lake negotiated the Upper Klamath Basin Comprehensive Agreement (UKBCA) which was signed in 2014 (UKBCA 2014). Signatories to the UKBCA included The Klamath Tribes, federal agencies, the State of Oregon, and water users. In exchange for implementation of the UKBCA's Water Use Program (WUP), Riparian Program, and Tribal economic development program, The Klamath Tribes agreed to not enforce their full water rights; however, the agreement was never implemented, in part because the U.S. Congress never approved the necessary funding and not enough landowners agreed to participate. Negotiations are ongoing regarding a potential new agreement to replace the UKBCA.

9.3 STATE AGENCIES

9.3.1 OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY AND OREGON DEPARTMENT OF AGRICULTURE

The Oregon Department of Environmental Quality (ODEQ) coordinates the State of Oregon's NPS programs, collaborating with many partners including other state agencies (ODEQ 2014). ODEQ developed Total Maximum Daily Loads (TMDLs) for two areas within the Consortium's NPS project area, first Upper Klamath Lake and its tributaries (ODEQ 2002) and then the Oregon portion of the Klamath and Lost River basins (ODEQ 2010b). ODEQ proposed revisions to the Klamath and Lost River TMDLs in 2017 and those revisions are currently being reviewed by U.S. EPA. The TMDLs specify many "Designated Management Agencies (DMAs)" which are required to develop implementation plans for addressing nonpoint source pollution, including from agricultural operations. Since adoption of the TMDLs, the Oregon Department of

Agriculture (ODA) has developed agricultural water quality management plans for Klamath Headwater and Lost River sub-basins in collaboration with Local Advisory Committees (LACs) and the Klamath Soil and Water Conservation District. The plans were first adopted in 2004 and have been subsequently revised (ODA 2011, ODA and LRLAWQAC 2015). The plans rely heavily on voluntary measures and best management practices. ODEQ worked with USBR, Klamath Water Users Association, and Klamath Irrigation District to develop TMDL implementation plans. ODEQ has also initiated work on piping projects throughout the Upper Basin.

ODEQ recently assessed status and trends in the Klamath Headwaters Subbasin (ODEQ 2017b) and produced a statewide NPS annual report with a chapter summarizing progress addressing NPS pollution in the Klamath Basin (ODEQ 2017a).

9.3.2 CALIFORNIA STATE WATER RESOURCES CONTROL BOARD AND NORTH COAST REGIONAL WATER QUALITY CONTROL BOARD

The North Coast Regional Water Quality Control Board (NCRWQCB) and its related agency the California State Water Resources Control Board (SWRCB) have developed TMDLs throughout the California portion of the Klamath Basin, including the Klamath River TMDLs within the Consortium's NPS project area (NCRWQCB 2010).

The California NPS Plan (SWRCB 2015a) describes California's approach to addressing NPS pollution and designates the Klamath River as a statewide NPS priority. The Plan says California will continue with its Watershed Stewardship Approach in the Klamath River, which emphasizes coordination, collaboration, and building partnerships among entities. Another important component listed in the Plan is the updating of the Waiver of Waste Discharge Requirements (WDR) for federal land management activities within the North Coast Region. This federal waiver was renewed in 2015 and attempts to reduce water quality impacts from the following activities: timber harvesting, roads, grazing, recreation, vegetation management, restoration, fire suppression, and fire recovery (NCRWQCB 2015).

9.4 OTHER GOVERNMENT

9.4.1 KLAMATH SOIL AND WATER CONSERVATION DISTRICT

The Klamath Soil and Water Conservation District (KSWCD) provides education, technical assistance, financial assistance, and equipment rentals to farmers and ranchers. KSWCD projects include dryland, riparian fencing, and livestock watering in collaboration with NRCS. KSWCD and NRCS designed and implemented a soil health program in the Sprague River valley (Quick 2014). The method for converting irrigated land to dryland pasture is a multi-year process with a specific sequence of cultural practices and plantings including a locally-adapted dryland seed mix (Quick 2014, Ferguson and Watkins 2015, OWEB 2016, USDA 2016a).

9.5 PRIVATE COMPANIES

9.5.1 PACIFICORP

PacifiCorp is a private company that operates the Klamath Hydroelectric Project (see section 4.5 above). As part of the Klamath Hydroelectric Settlement Agreement (KHSA), PacifiCorp agreed to fund a number of Interim Measures (IM) including $500,000 per year on water quality monitoring and $250,000 to evaluate approaches for improving water quality including pilot studies (PacifiCorp 2014). The Interim Measures Implementation Committee (IMIC) is an interagency group that advises PacifiCorp on its IM study plans. Two members of the Consortium (the Yurok Tribe and Karuk Tribe) are signatories to the KHSA and are active participants in the IMIC. Examples of projects evaluated in IM studies include reducing instream nutrient loads using treatment wetlands (Lyon et al. 2009; CH2M HILL 2012, 2014) as well as removal of algal biomass near Link Dam using stormwater technology (hydrodynamic separators, Watercourse Engineering, Inc. 2013, 2014a, 2014b) or other methods (PacifiCorp 2015, Carlson and Hughes 2016). Other IM studies have included oxygenation of Klamath Hydroelectric Project reservoirs (MEI 2008, Horne et al. 2009, CH2M HILL 2013, Austin et al. 2016). Under the KHSA, PacifiCorp has committed to spending $5.4 million to implement water quality improvement projects if the KHSA process reaches a critical milestone (i.e., dam removal is imminent). PacifiCorp and the IMIC have developed a framework for deciding on a priority list of projects for KHSA implementation (CH2M 2018). The categories included in the priority list of projects are: diffuse source treatment wetlands (DSTWs), riparian fencing and grazing management, irrigation efficiency and water management projects, and natural wetlands restoration (CH2M 2018).

9.6 NON-PROFIT ORGANIZATIONS

9.6.1 KLAMATH WATERSHED PARTNERSHIP

Klamath Watershed Partnership (KWP) has conducted watershed assessments for the Upper Williamson River, Upper Sprague River/Sycan River, and the Lower Sprague-Lower Williamson River, and plans to assess Upper Klamath Lake and the Klamath River. The Klamath Watershed Partnership is “a community-based non-profit organization focusing on the needs of landowners and natural resources sustainability.”[5] Working groups are organized in sub-watersheds and consist of community members. Through the Klamath Watershed Partnership, ranchers and landowners can get help through funding, education, and implementation of projects related to riparian restoration, grazing management, fencing, irrigation improvements, and fish screens on intake systems. KWP has been actively involved in education and outreach about stormwater and NPS pollution (KWP and ODEQ 2015). KWP also participated in the Klamath Tracking and Accounting Program (KTAP) which is an accounting system that quantifies ecosystem benefits from conservation projects through linking actions to needs of water quality improvement projects. Funding for upcoming fencing and grazing management projects will be provided by NRCS RCPP funds (see section 9.7 below). KWP also has a beaver management program[6] which provides education and technical assistance to landowners for managing beaver-related issues, including onsite mitigation as well as beaver relocation.

9.6.2 THE NATURE CONSERVANCY

One of The Nature Conservancy’s (TNC) primary objectives in the Klamath area is to rebuild wetlands around UKL. The Williamson Delta Wetland Preserve is TNC’s largest project in the UKL area, encompassing 5,500 acres of restored wetlands at the mouth of the Williamson River, providing rearing habitat for endangered suckers and reducing phosphorus concentrations (Wong and Hendrickson 2011). TNC recently acquired an 1,800 acre parcel on the north shore of Agency Lake. This property is referred to as the Fourmile Wetlands Preserve and is adjacent to the Sevenmile Canal and the USFWS’s Agency Lake Ranch (Hendrixson 2014). TNC has

[5] http://www.klamathparnership.org/aboutus.html
[6] http://www.klamathpartnership.org/BMP.html

enrolled the property in a USDA NRCS Wetland Reserves Program (WRP) easement and is re-flooding the land to restore wetlands. The Fourmile Wetlands Preserve is likely to eventually be re-connected to UKL once the dikes surrounding the Barnes Ranch and Agency Lake Ranch are breached.

9.6.3 TROUT UNLIMITED/KLAMATH BASIN RANGELAND TRUST

Klamath Basin Rangeland Trust (KBRT) was founded in 2002 and merged with Trout Unlimited (TU) in 2016. Projects TU/KBRT has implemented include building wetlands on agricultural land and monitoring the effectiveness of the wetlands for nutrient removal and storage, installing fish screens, improving fish passage, water transactions, riparian protection and enhancement, and stream reach restoration (KBRT 2011). Past projects have included monitoring the effects of converting water-thirsty crops to dryland-appropriate crops (NCRS 2010). TU/KBRT has developed strong working relationships with landowners, NRCS, KSWCD, USBR, USFWS, USFS, OWEB, USGS, USBLM, UKCAN and others.

TU/KBRT is leading the development of diffuse-source treatment wetlands (see section 11.6.1 below) in the Upper Klamath Basin (Scott 2016). Partners include landowners, USFWS, California State Coastal Conservancy, California Regional Water Boards, The Klamath Tribes, Oregon Water Resources Department, Oregon Watershed Enhancement Board (OWEB), PacifiCorp, and the National Fish and Wildlife Foundation. Two pilot projects have been implemented in the Wood River Valley and current plans are to complete approximately six more in the next few years.

9.7 PARTNERSHIP PROGRAMS

9.7.1 KLAMATH BASIN MONITORING PROGRAM (KBMP)

Klamath Basin Monitoring Program (KBMP) coordinates water quality monitoring in the Klamath Basin to reduce redundancy and share data, techniques, and resources (see section 3.1 above).

9.7.2 UPPER KLAMATH CONSERVATION ACTION NETWORK (UKCAN)

The Upper Klamath Conservation Action Network (UKCAN) is a partnership between the Klamath Basin Rangeland Trust (now Trout Unlimited), Klamath Soil and Water Conservation District, Klamath Watershed Partnership, Sustainable Northwest, The Klamath Tribes, The Nature Conservancy, and the Upper Klamath Water Users Association (Hendrixson and Bottcher 2015). The organizations involved in this partnership work towards habitat restoration and conservation, water use management, integrated strategic planning, project coordination, monitoring, and partnership development. The first funding source for UKCAN was a National Fish and Wildlife Foundation Keystone Initiative (Adelsberger et al. 2012). The Oregon Watershed Enhancement Board (OWEB) then approved the formation and funding of an Upper Klamath Special Investment Partnership (SIP) in 2012 (OWEB 2016). The area of focus for the SIP is from the headwaters of Upper Klamath Lake downstream to Link Dam, but also includes Spencer Creek which is a tributary to the Klamath River downstream near J.C. Boyle Reservoir.

9.7.3 KLAMATH REGIONAL CONSERVATION PARTNERSHIP PROGRAM (RCPP)

Klamath Regional Conservation Partnership Program (RCPP) was approved for $7.6 million of USDA funding in 2016 to restore wetlands and riparian habitats, improve water quality, increase instream flows in UKL tributaries, and increase farmers' drought resilience (USDA 2016b). Partners include TU/KBRT, TNC, KWP and the Klamath Lake Land Trust. The largest single project within the RCPP is the enrollment of the TNC's Fourmile Wetlands Preserve into a USDA NRCS Wetland Reserves Program (WRP) easement.

9.7.4 UPPER KLAMATH BASIN WATERSHED ACTION PLAN

The Upper Klamath Basin Watershed Action Plan is a collaboration between NGOs, State and Federal Agencies, Tribes, and others in the Upper Klamath Basin to identify and prioritize restoration actions in the region. The collaboration has been spearheaded by The Klamath Tribes, The Nature Conservancy, Trout Unlimited, USFWS, Klamath Watershed Partnership, ODEQ, and NCRWQCB and will include input and technical review from many other organizations, groups, and individuals. The Action Plan will include information about the categories of restoration projects needed to address impaired riparian function, reach-scale identification of candidate sites for specific restoration projects, and a prioritization framework. It will include a channel alignment analysis and riparian condition assessment. New or improved datasets being developed include mapping of points of diversion, irrigation returns, channelized reaches, levees/dikes/berms, riparian fencing, fish passage barriers, and the irrigation canal network. Action Plan will be integrated with the basin-wide Integrated Fisheries and Monitoring Plan (IFRMP, see section 9.7.5). The Action Plan is scheduled to be completed by the end of 2019.

9.7.5 INTEGRATED FISHERIES RESTORATION AND MONITORING PLAN (IFRMP)

The Pacific States Marine Fisheries Commission is collaborating with many entities to develop an Integrated Fisheries Restoration and Monitoring Plan (IFRMP, http://kbifrm.psmfc.org/) for the Klamath Basin. The plan will help agencies and Tribes with fisheries management jurisdiction to allocate funds in a coordinated manner to support effective restoration and monitoring. The IFRMP contains multiple phases. Phase 1, a synthesis report, was completed in August 2017 (ESSA 2017). Phase 2 is currently underway and will include conceptual models, objectives, performance indicators, and an initial prioritization framework. Phase 3 will identify the priority sequencing of restoration and assessment actions, design a formal monitoring and evaluation framework to support implementation of the plan, and document the protocols for these priorities.

9.7.6 KLAMATH BASIN RESTORATION AGREEMENT (KBRA)

The Klamath Basin Restoration Agreement (KBRA) was an agreement between Klamath Basin Tribes, irrigators, fishermen, environmental groups, counties, states, and federal agencies that aims to both restore Klamath Basin fisheries and provide stability to the local economies. Some Consortium members signed the KBRA while others did not. The KBRA called for tens of millions of dollars for water quality improvement projects. It also called for the breaching of dikes to reconnect the Wood River Wetlands, Agency Lake Ranch, and Barnes Ranch to Agency Lake. Congress never authorized the KBRA, and thus it expired on December 31, 2015. Negotiations are ongoing, and it may or may not be replaced by a future agreement.

10 CONCLUSIONS

As described in this assessment, the waters within the NPS Plan area are actually or potentially impaired from various NPS pollution sources. The NPS pollution categories in ranking of greatest concern are:

- Agriculture
- Hydromodification and Habitat Alteration

NPS pollution categories of secondary importance are:

- Forestry
- Urban

These NPS pollution categories currently contribute to water quality impairments. There are many NPS programs in place within the NPS Plan area. The Consortium proposes to assist Upper Basin partners with addressing NPS pollution sources through implementation of the Clean Water Act (CWA) Section 319 NPS Management Program (see section 11), which outlines additional short-term and long-term BMPs and program components that would be funded by various sources including, but not limited to, CWA Section 319(h) funding. Implementation of a CWA Section 319(b) NPS Management Program Plan will provide the framework for the Consortium's role in the selection and implementation of best management practices and NPS pollution mitigation strategies.

11 NPS MANAGEMENT PROGRAM PLAN

11.1 MANAGEMENT PROGRAM SUMMARY

The entire NPS Plan area is outside the reservations of the Consortium member Tribes; however, some of the area is within the ancestral territory of Shasta Indians who are enrolled members of QVIR. Consortium member Tribes have limited legal authority to mandate changes in land and water management; therefore, the Consortium's NPS Plan relies on voluntary measures and collaboration with entities already doing work in the area.

The Consortium will continue its ongoing participation in multi-agency efforts on Klamath River water quality, including the Klamath Basin Monitoring Program (KBMP, see section 3.1 above) comprised of experts from the ODEQ, SWRCB, NCRWQCB, USGS, EPA, USFWS, USBR, Klamath Basin Tribes and other government and community-based groups working on water quality issues within the Klamath Basin. The Consortium will also work with public and private landowners on the implementation of the NPS Plan.

11.2 ADMINISTRATION, PROJECT SELECTION, AND PRIORITIZATION

The first four paragraphs in this section summarize the general administrative and decision-making procedures of the Consortium, which are explained in more detail in the Consortium's Strategic Plan and Bylaws (KTWQC 2017). The remainder of this section discusses project selection and prioritization.

The Quartz Valley Indian Reservation (QVIR) is the Contract Manager within the Consortium, meaning that it is authorized to administer funds on behalf of the Consortium, and QVIR's

Environmental Director is the Consortium's Chair/Program Manager. Consortium decisions are made by majority vote of the Consortium's Steering Group, which is composed of one representative of each of the Consortium's five member Tribes.

Each fiscal year, the Steering Group will develop program funding proposals to be submitted to funding entities (including but not limited to the U.S. Environmental Protection Agency) by the Chair/Program Manager on behalf of the Consortium, and allocate budgets from awarded contracts/grants into specific tasks and sub-tasks (i.e., Annual Work Plan/Budget). These Consortium proposals would be additional to any that are funded through the self-governance initiative noted in section 2.2.3 above. When mid-year adjustments are necessary, the Steering Group will determine how to re-allocate funding among tasks and sub-tasks by a majority vote of Steering Group members via email or conference call.

If it is necessary to hire consultants/contractors to implement tasks described in the Annual Work Plans/Budgets, the Contract Manager shall prepare and publish Requests for Proposals (RFPs) when appropriate. The Steering Group shall select consultants/contractors based on majority vote and the Contract Manager shall then develop contracts with the consultants/contractors.

The Steering Group shall determine the frequency of its meetings, but shall meet in person at least once yearly. The Steering Group will also conduct conference calls approximately quarterly, and communicate approximately monthly via email. Additional meetings may be called by two or more parties or at the request of the Chair/Program Manager.

The Consortium anticipates that implementation of the NPS Plan will be part of the Consortium's Annual Work Plan. As with any other Consortium decisions, the Steering Group will decide on priorities including which projects to seek funding for in each year to implement the NPS Plan.

The Consortium intends to coordinate closely with Upper Basin partners when choosing projects. It is not the Consortium's intention to initiate new BMPs or restoration projects within the Upper Klamath Basin, but rather to support organizations and programs that already implement effective BMPs and projects that improve water quality. Priority will be given to projects that reduce the loading of phosphorus to Upper Klamath Lake, with the ultimate goal of restoring water quality within the lake and the Klamath River downstream.

Table 8 provides a summary of milestones for the management program plan.

Table 8. Management program initiation timeline and annual milestones.

Activities	Output	Date
Submit draft NPS Assessment and Management Program Plan to USEPA and public for review	Draft Assessment and Management Program Plan	August 5, 2016
Finalize NPS Assessment and Management Program Plan based on comments from USEPA and the public	Final Assessment and Management Program Plan	August 10, 2018
Attend spring and fall KBMP meetings to promote collaboration and coordination	2 meetings	April and November
Consortium in-person meeting to review potential projects and set priorities	1 meeting	Following start of fiscal year (typically July)
Consortium phone meetings to review potential projects and set priorities	Meeting(s)	As needed, based on grant deadlines
Collaborate with partner entities to develop and submit proposals to funding agencies to implement high-priority projects	Grant application	Varies according to funding source (January for EPA Tribal 319 competitive grants)

11.3 TECHNICAL ASSISTANCE

To implement the NPS Plan, the Consortium intends to rely heavily on local and regional expertise. In addition to the entities listed in Table 7, the Consortium will also engage the services of private consultants and contractors. A few examples of consulting firms engaged in the Upper Klamath Basin are Aquatic Ecosystem Sciences, Riverbend Sciences, Stillwater Sciences, Watercourse Engineering, CH2M/Jacobs, FlowWest, Ag Innovations, Mark Miller & Associates, and R2 Resource Consultants.

11.4 FUNDING SOURCES

A summary of federal and state assistance and funding resources are listed below. The program descriptions of cooperating agencies and how they relate to the abatement and control of NPS pollution within the NPS Plan area are as follows:

11.4.1 FEDERAL

U.S. ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency (USEPA) provides funding through grants administered in accordance with Section 319 of the Clean Water Act (CWA), which specifically addresses NPS pollution. These funds are available annually. There are two types of funding: base and competitive. Most Consortium member Tribes already receive base funding, which disqualifies the Consortium from also receiving base funds; however, the Consortium is eligible to apply for competitive funds. Competitive Tribal CWA 319 project implementation grants are open to proposals which are usually due in December-January. The Consortium anticipates that the EPA 319 competitive funds will be an important source for funding implementation of the NPS Plan.

The Consortium could also potentially apply for state competitive CWA 319 funds with proposals usually due in November-December of each year.

U.S. DEPARTMENT OF AGRICULTURE'S NATURAL RESOURCES CONSERVATION SERVICE

The NRCS is the primary agency responsible for providing technical, financial, and educational assistance to land users in planning and application of soil and water conservation measures. The NRCS provides funding to implement projects to minimize and prevent NPS pollution from impacting water quality. Funding is offered annually and proposals are usually due in December – January.

U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service (USFWS) provides competitive grants to federally recognized tribes to develop and implement programs to benefit wildlife species, including habitat restoration. The grants can be used to fund planning for wildlife and habitat conservation, fish and wildlife conservation and management actions, fish and wildlife-related laboratory and field research, natural history studies, habitat mapping, field surveys and population monitoring, habitat preservation, conservation easements, and public education that is relevant to the project. This funding is offered several times per year under different programs, often between November and April annually. Information on the USFWS Partners in Wildlife grant program for habitat restoration on private lands is available in section 9.1.2 above.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The National Oceanic and Atmospheric Administration (NOAA) provides for funding under the congressionally mandated Pacific Coastal Salmon Recovery Fund (PCSRF). The PCSRF funds projects, including tribal projects that improve the status of Pacific coastal salmon, prevent extinctions, and protect healthy populations. Funds are distributed annually through a competitive application process often between November and April. Until the dams are removed and salmon once again have access to the Upper Klamath Basin, PCSRF is unlikely to be a suitable source of funds for water quality restoration projects in the Upper Klamath Basin.

U.S. BUREAU OF RECLAMATION

The U.S. Bureau of Reclamation provides funding for water and energy conservation and efficiency projects through its WaterSMART program which was established in 2010. Entities eligible to submit competitive proposals include Tribes, states, irrigation districts, water districts, and other organizations with water or power delivery authority. WaterSMART projects previously funded within the Upper Klamath Basin include upgrades to irrigation water measurement systems, canal lining, conversion of canals to pipelines, and infrastructure improvements to reuse drainage water (Young 2015). Projects are required to have a 50% non-federal match. Each project type has a separate funding solicitation with its own deadline, which in 2018 ranged from May to July.

11.4.2 STATE

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

The California Department of Fish and Wildlife (CDFW) provides competitive grants under the Fisheries Restoration Grant Program for projects related to the protection/restoration of wild salmon, steelhead trout, and other fish habitats in California. Past projects funded under this program include sediment reduction projects and watershed education programs throughout coastal California. Project proposals are solicited annually, usually between October and April.

As with the PCSRF, this is unlikely to be a suitable source of funds for water quality restoration projects in the Upper Klamath Basin until the dams are removed.

CALIFORNIA COASTAL CONSERVANCY

The California Coastal Conservancy administers grants to fund projects that include natural resource protection and restoration in the coastal zone or affecting coastal areas. The Coastal Conservancy has funded several projects in the Upper Klamath Basin, including diffuse source treatment wetlands (Scott 2016) and a workshop to evaluate water quality improvement techniques (Stillwater Sciences et al. 2012, 2013).

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

California's State Water Resources Control Board (SWRCB) allocates grant funding from the USEPA under Section 319(h) of the CWA. The funds are allocated to support implementation and planning projects that address water quality problems resulting from NPS pollution. Projects are required to be located in a watershed that has an adopted/nearly adopted Total Maximum Daily Load (TMDL) for the constituent of concern and has been identified in the NPS Program Preferences. Projects focused on working toward achieving the goals of the TMDL to restore beneficial uses will be the most competitive in the selection process.

OREGON WATERSHED ENHANCEMENT BOARD

The Oregon Watershed Enhancement Board (OWEB) is a state agency that provides grants to improve habitat in streams, rivers, wetlands and natural areas. OWEB has funded many habitat restoration projects in the Upper Klamath Basin. One of the larger collections of OWEB projects was the Klamath Special Investment Partnership (OWEB 2016).

11.4.3 PRIVATE

As noted in section 9.5.1, if the Klamath Hydroelectric Settlement Agreement (KHSA) proceeds as scheduled, PacifiCorp would spend up to $5.4 million to implement Upper Klamath Basin water quality improvement projects, and up to $560,000 per year to cover project operation and maintenance expenses related to those projects. The list of projects would be developed by the Interim Measures Implementation Committee (IMIC) and approved by the Oregon Department of Environmental Quality (ODEQ) and California's State and Regional Water Boards.

11.5 CATEGORIES OF NONPOINT SOURCE POLLUTION

In the NPS assessment (see sections 1 through 10 above), the Consortium identified categories of NPS pollution that are likely impacting water quality, as shown below. The Consortium then ranked the identified categories of NPS pollution based on their relative importance.

The following two categories are high priority, due to the widespread extent and severity of impacts:

- Agriculture (AGR)
- Hydromodification and Habitat Alteration (HHA)

The following two categories are much lower priority given their lesser contribution to NPS pollution within the NPS Plan area:

- Forestry (FOR)
- Urban (URB)

The Consortium's strategy focuses on preventing NPS pollution and treating the sources of water quality impairment; however, under a category entitled Other (OTH), we also include tasks and BMPs to strategically target the symptoms of excessive eutrophication which result from multiple sources.

11.6 TASKS AND BMPS

In order to implement an effective, comprehensive NPS management program, all sources of pollution must be addressed in a manner that provides alternatives and flexibility. This document is designed to present a proposed strategy with flexibility in management and implementation. The goals and tasks outlined can be utilized, altered, and, prioritized to protect and restore water quality.

The tasks and BMPs listed in the following section are the Consortium's recommendations for improving water quality within the Upper Klamath Basin. The BMPs are categorized as either short-term or long-term tasks. Short-term tasks are defined as tasks that can be implemented immediately and implementation consists of defined tasks that will facilitate control on NPS pollution. Long-term tasks are defined as tasks that either require precursor tasks to be completed before implementation, or are ongoing management or operational changes.

Implementation of the following schedule (Table 9) depends on the availability of resources from U.S. EPA Clean Water Act Section 319(h) funds and the other funding sources listed in Section 11.4 above. The scope of the schedule is intended to err on the side of being comprehensive and it is unlikely that sufficient funds and landowner interest will be available to implement all tasks on the schedule. The Consortium reserves the right to alter or modify the schedule based on changes to needs, available resources, opportunities, our partners' priorities, and political reality. Priority will be given to projects that reduce the loading of phosphorus to Upper Klamath Lake, with the ultimate goal of restoring water quality within the lake and the Klamath River downstream.

As noted many times throughout this NPS Plan, the Consortium intends to collaborate with and support a wide range of existing entities working to improve water quality in the Upper Basin, including The Klamath Tribes, government agencies, non-profit organizations, community groups, and private landowners. The vast majority of the projects and approaches recommended in this NPS Plan are already being evaluated or worked on by these entities. The Consortium's intention in listing those projects in the NPS Plan is to demonstrate awareness of those activities and signal support, not to claim a lead role. The tasks and BMPs included in the Consortium's NPS Plan are fairly general. The Consortium anticipates that site-specific details will be developed in future plans such as the Upper Klamath Basin Watershed Action Plan (section 9.7.4 above).

Table 9. NPS implementation schedule by fiscal year (July 1 – June 30). Tasks are sorted first by NPS category and then by goal. Key to NPS categories: Agriculture (AGR), Hydromodification and Habitat Alteration (HHA), Forestry (FOR), Urban (URB), and Other (OTH).

Goal	Task	Year 1 (2018/ 2019)	Year 2 (2019/ 2020)	Year 3 (2020/ 2021)	Year 4 (2021/ 2022)	Year 5 (2022/ 2023)
Goal: Reduce runoff of phosphorus from land due to agricultural activities and prevent phosphorus delivery to important aquatic habitats downstream	Short-Term Task AGR-1: Restore riparian corridors to minimize transport of sediment and phosphorus into waterbodies	x	x	x	x	x
	Short-Term Task AGR-2: Implement pilot-scale diffuse-source treatment wetlands and monitor effectiveness	x	x	x	x	x
	Long-Term Task AGR-3: Implement many diffuse-source treatment wetlands		x	x	x	x
	Short-Term Task AGR-4: Find suitable locations and develop designs for large-scale treatment wetlands	x	x	x	x	x
	Long-Term Task AGR-5: Implement large-scale treatment wetlands	x	x	x	x	x
	Short-Term Task AGR-6: Evaluate effects and develop designs for reuse and recirculation of agricultural drain water	x	x	x	x	x
	Long-Term Task AGR-7: Implement projects to reuse and recirculate agricultural drain water	x	x	x	x	x
	Long-Term Task AGR-8: Implement projects to improve tailwater management	x	x	x	x	x
	Long-Term Task AGR-9: Education and technical assistance to farmers and ranchers	x	x	x	x	x
Goal: Increase instream flows by reducing irrigation demand	Long-Term Task AGR-10: Convert some irrigated pastures to dryland agriculture	x	x	x	x	x
	Long-Term Task AGR-11: Reduce summer irrigation and improve grazing management	x	x	x	x	x
	Long-Term Task AGR-12: Improve irrigation efficiency with piping projects	x	x	x	x	x
Goal: Restore riparian corridors and promote floodplain connectivity	Short-Term Task HHA-1: Develop parcel-specific riparian restoration plans	x	x			
	Long-Term Task HHA-2: Implement projects to restore riparian areas by constructing riparian fencing, planting riparian vegetation, and providing livestock with off-channel water sources	x	x	x	x	x
	Long-Term Task HHA-3: Mechanical manipulation to remove levees and restore channel sinuosity	x	x	x	x	x
	Long-Term Task HHA-4: Implement a beaver management program and consider deployment of beaver dam analogues	x	x	x	x	x

Goal	Task	Year 1 (2018/ 2019)	Year 2 (2019/ 2020)	Year 3 (2020/ 2021)	Year 4 (2021/ 2022)	Year 5 (2022/ 2023)
Goal: Restore wetlands around UKL and tributaries to improve water quality and habitat	Short-Term Task HHA-5: Develop wetland restoration plans	x	x	x	x	x
	Long-Term Task HHA-6: Implement wetland restoration plans	x	x	x	x	x
Goal: Eliminate effects of Klamath Hydroelectric Project on water temperature, algal toxins, and food web	Short-Term Task HHA-7: Develop plan and permitting to remove J.C. Boyle, Copco 1/2, and Iron Gate dams	x	x	x	x	x
	Long-Term Task HHA-8: Implement plan to remove J.C. Boyle, Copco 1/2, and Iron Gate dams				x	x
Goal: Reduce impacts of private forest management on aquatic habitats	Long-Term Task FOR-1: Improve riparian protections in Oregon Forest Practice Rules	x	x	x	x	x
Goal: Reduce sediment runoff from forest roads	Short-Term Task FOR-2: Conduct road assessments	x	x	x	x	x
	Long-Term Task FOR-3: Upgrade and decommission roads	x	x	x	x	x
Goal: Reduce delivery of urban stormwater contaminants to important aquatic habitats downstream	Long-Term Task URB-1: Provide outreach, education, and technical assistance to residents and businesses in Klamath Falls	x	x	x	x	x
	Long-Term Task URB-2: Minimize effects of new development on stormwater	x	x	x	x	x
Goal: Reduce organic matter loads discharged from UKL into Klamath River	Long-Term Task OTH-1: Conduct pilot-scale demonstration test of system to remove algal biomass at outlet of UKL		x	x		
	Long-Term Task OTH-2: Develop detailed design and engineering for system to remove algal biomass at outlet of UKL and obtain necessary permits			x	x	
	Long-Term Task OTH-3: Construct/operate full-scale system to remove algal biomass at outlet of UKL				x	x

11.6.1 AGRICULTURE

GOAL: REDUCE RUNOFF OF PHOSPHORUS FROM LAND DUE TO AGRICULTURAL ACTIVITIES AND PREVENT PHOSPHORUS DELIVERY TO IMPORTANT AQUATIC HABITATS DOWNSTREAM

Long-Term Task AGR-1: Restore riparian corridors to minimize transport of sediment and phosphorus into waterbodies

Many of the rivers and streams upstream of UKL have poor riparian function, resulting in erosion and delivery of phosphorus into waterbodies (ODEQ 2002, O'Connor et al. 2015, Walker et al. 2015). Reach-specific mapping of riparian conditions is included in the Upper Klamath Basin Watershed Action Plan (see section 9.7.4 above). Transforming these degraded reaches into robust riparian corridors is essential to reducing the inflow of phosphorus into UKL as well as generally improving aquatic habitats in the tributaries. Tasks and BMPs for restoring riparian function are listed below in section 11.6.2. Working with private landowners will be a key component of this effort.

Short-Term Task AGR-2: Implement pilot-scale diffuse-source treatment wetlands and monitor effectiveness

Diffuse-Source Treatment Wetlands (DSTWs) consist of multiple small-scale constructed wetlands placed throughout a given catchment rather than one large treatment wetland at the bottom of the catchment (Stillwater Sciences et. al. 2012, 2013). DSTWs are intended to provide on-site removal of sediment, nutrients, and herbicides/pesticides, particularly for first-flush runoff events. Ancillary benefits may include a reduction in peak flows.

DSTWs are essentially small-scale wetlands scattered throughout the watershed, and thus the basic design elements are similar to those of larger treatment wetlands. DSTWs in pastures and agricultural fields can be operated either as continuous flow-through systems or as intermittent flow-through systems. Given the importance of downstream water use in the Klamath Basin, these systems would not be designed as terminal wetlands, but rather they would treat on-site runoff such that there would be an outflow of water from each site. Since DSTWs are placed within agricultural fields, exclusion fencing is required to prevent cattle damage. Ideal locations of diffuse-source wetlands would be in areas with remnant wetlands that possess hydric soils and are in proximity to irrigation ditches and drains. Additional information on DSTWs, including cost estimates, can be found in Stillwater Sciences et al. (2012 and 2013).

As noted in section 9.6.3 above, Trout Unlimited and its partners are developing DSTWs in the Upper Klamath Basin, beginning with a few intensively monitored pilot projects in the Wood River Valley (Scott 2016). These pilot projects will provide data on effectiveness and hopefully lead to improved designs. There is also a need to evaluate the performance of DSTWs in other locations, such as the Sprague and Williamson River valleys upstream of Upper Klamath Lake, as well as to consider mercury and arsenic cycling in these features, both of which are present in the basin due to natural background or anthropogenic sources.

Long-Term Task AGR-3: Implement many diffuse-source treatment wetlands

If the initial demonstration projects in the Wood and Sprague valleys indicate that DSTWs are effective in reducing phosphorus at a relatively low per-unit cost, the Consortium would like to support the construction of many DSTW's throughout the Wood and Sprague valleys.

Short-Term Task AGR-4: Find suitable locations and develop designs for large-scale treatment wetlands

The larger the area of a treatment wetland, the greater the incoming amounts of nutrients and water the wetland can effectively treat (CH2M HILL 2012). Given the large volumes of water in the Klamath Basin, very large wetlands (on the order of thousands of acres or tens of thousands of acres) would be necessary to have basin-scale effects, but smaller-scale wetlands could have local effects. PacifiCorp and its consultants have conducted several treatment wetland evaluations including evaluating potential locations where wetlands could be sited (Lyon et al. 2009, CH2M HILL 2012) and a conceptual design for a demonstration wetland facility which could be used to quantify nutrient removal rates and water balances (CH2M HILL 2014). The USGS and its collaborators have modeled the potential water quality effects of adding treatment wetlands along Keno Reservoir (Sullivan et al. 2014).

The deployment of large-scale treatment wetlands in the Upper Klamath Basin is currently hampered by water rights (and water availability) issues (Stillwater Sciences et. al. 2012, 2013) and a lack of willing landowners; however, the Consortium still supports consideration of such wetlands given their potential to improve water quality. From the perspective of reducing phosphorus loading to UKL, areas adjacent to the lower reaches of Fourmile Canal, Sevenmile Canal, the Wood River, and Williamson River would be excellent locations for treatment wetlands, but in the Klamath Basin Restoration Agreement (KBRA) much of that area was slated for levee breaching and reconnection to UKL which limits the ability to use that area for highly managed treatment wetlands. USBR (2016b) evaluated the potential for using treatment wetlands to reduce nutrient loads in the Klamath Straits Drain prior to discharge into Keno Reservoir. The Klamath River TMDL (ODEQ 2010) requires loads of phosphorus, nitrogen, and biological oxygen demand in the Klamath Straits Drain to be reduced by approximately 90%. Other potential locations to consider for treatment wetlands include areas adjacent to Keno Reservoir such as the Miller Island Wildlife Refuge.

Long-Term Task AGR-5: Implement large-scale treatment wetlands

If water rights, water availability, and landowner willingness issues can be addressed, suitable areas identified, and designs developed, then large-scale treatment wetlands should be implemented.

Short-Term Task AGR-6: Evaluate effects and develop designs for reuse and recirculation of agricultural drain water

Agricultural drains such as the Klamath Straits Drain can have very high nutrient concentrations (Stillwater Sciences et. al. 2012). The discharge of such water into the Klamath River can increase nutrients concentrations in the river. One alternative to discharge of drain water into the river is to reuse it by recirculating it back into irrigation canals. The USGS modeled the water quality effects on the Keno Reservoir of recirculating water from the Klamath Straits Drain (Sullivan et al. 2014). The Klamath Drainage District completed the West Side Water Recycling Improvement Project in 2014 (KDD 2015) and received funding in 2016 to implement its East Side Water Recycling Project (KDD 2016) which combined should reduce the discharge of the Klamath Straits Drain by approximately 20,000 acre-feet. USBR (2016b) identified several potential areas where recirculation may be feasible. Due to evaporative concentration of salts in soils, salinity is a potential issue that would need to be taken into consideration in any recirculation project. One alternative is to divert drain water into a reservoir during the summer where it can be held for months and then later discharged to the river during later fall or winter when water quality is less impaired and nutrients will have less effect (i.e., due to cold temperatures and low solar energy, algal growth is limited during the winter regardless of nutrient conditions). Finding suitable sites for surface water storage in the Upper Basin is difficult and expensive (USBR 2011). The Consortium supports the evaluation of reuse and recirculation projects including development of project designs and engineering, as long as the project will not increase basin-scale consumptive water use (see discussion on Task AGR-12 below).

Long-Term Task AGR-7: Implement projects to reuse and recirculate agricultural drain water

If reuse and recirculation projects can be identified and designed to benefit water quality without negatively affecting instream flows, the Consortium would consider supporting implementation of such projects.

Long-Term Task AGR-8: Implement projects to improve tailwater management

Tailwater is water that runs off the lower end of a field during flood (surface) irrigation (Schwankl et al. 2007). Production of some tailwater is a normal and nearly unavoidable part of flood irrigation, but can detrimentally affect water quality if the water heats up and transports organic matter and nutrients into downstream waterbodies (Aqua Terra Consulting 2011). Flood irrigation is a common practice in Upper Klamath Basin pastures (USDA 2009) and improved tailwater management has been recommended as a component of efforts to reduce phosphorus loading to Upper Klamath Lake (Walker et al. 2015). Methods for minimizing the effects of tailwater on water quality include careful management, scheduling, capture and reuse (SVRCD no date, Schwankl et al. 2007). Tailwater can also be treated using Diffuse Source Treatment Wetlands (DSTWs).

The Consortium generally supports implementation of projects to improve tailwater management, particularly upstream of Upper Klamath Lake; however, it is important to consider to net effects of tailwater projects on watershed-scale water balances. For example, a project to capture tailwater (which currently flows back to a stream via overland flow and subsurface infiltration) and use it to irrigate a pasture that is not currently irrigated would likely result in reduced instream flows due to increased evapotranspiration (i.e., consumptive use) in the newly irrigated field. Additional information relevant to this topic is included below in Task AGR-12.

Long-Term Task AGR-9: Education and technical assistance to farmers and ranchers

Education and technical assistance are critically important to improving water quality in the Upper Klamath Basin. The Consortium encourages educational efforts to reduce detrimental effects of land and water management on water quality and habitat. Agencies involved with education and outreach to farmers and ranchers include the Natural Resources Conservation Service (NRCS), Klamath Soil and Water Conservation District (KSWCD), Oregon Department of Agriculture (ODA), Oregon Department of Environmental Quality (ODEQ), Klamath Basin Research & Extension Center (KBREC), Klamath Watershed Partnership (KWP), and Trout Unlimited (TU).

GOAL: INCREASE INSTREAM FLOWS BY REDUCING IRRIGATION DEMAND

Long-Term Task AGR-10: Convert some irrigated pastures to dryland agriculture

The Upper Klamath Basin Comprehensive Agreement (UKBCA, see section 9.2.1 above) called for inflows to Upper Klamath Lake to be increased by 30,000 acre-feet per year to be achieved by reducing the net consumptive use of water for irrigated agriculture (UKBCA 2014). The UKBCA was never implemented. An important mechanism for reducing the net consumptive use is to reduce the irrigated area. The Natural Resources Conservation Service, Klamath Soil and Water Conservation District, and local ranchers have developed and tested a seed mix and multi-year process to establish productive dryland pasture which does not require ongoing irrigation beyond the initial establishment period (Quick 2014, Ferguson and Watkins 2015, OWEB 2016, USDA 2016a). In addition to conserving water quantity, dryland pasture should also improve water quality by reducing tailwater. The Consortium supports the conversion of irrigated pastures to dryland agriculture where feasible as a means to increase instream flows.

Long-Term Task AGR-11: Reduce summer irrigation and improve grazing management

An alternative to reducing irrigated area is to apply less water to irrigated lands, such as by reducing the number of flood irrigation applications per year (KBRT 2011). Experiments in the Wood River valley showed that reduced irrigation (one irrigation event per summer) and improved grazing management (rotating cattle between pastures with a 30-day rest period between grazing cycles) only reduced forage production by 5% compared to conventional management (NRCS 2010, KBRT 2011). Reduced irrigation is not likely to work as well in the Sprague River valley, in part because the water table is lower than in the Wood River valley but also because the Sprague River valley has more hay and grains which do not produce as well without water. The Consortium supports reduced irrigation and improved grazing management as a method to reduce irrigation demand and improve water quality, where feasible.

Long-Term Task AGR-12: Improve irrigation efficiency with piping projects

ODEQ and other agencies are working to provide funding opportunities to increase irrigation efficiency for individual water users. One common method is to convert unlined irrigation conveyance systems and flood irrigation to piped delivery systems with sprinkler irrigation systems.

The Consortium supports irrigation efficiency projects if they take basin-scale water balances into account and it can be shown that *they would not result in a net increase in consumptive water use*, or that they provide special benefits such as increasing important coldwater refugia or reducing tailwater that is exceptionally detrimental.

Irrigation efficiency projects may improve water quality by reducing nutrient-laden tailwater or by leaving additional water in specific stream reaches, but it is important to realize that at a basin scale they also have the potential to have detrimental consequences on instream flows and water availability. In practice, improving irrigation efficiency can actually increase basin-scale consumptive use of water because it reduces return flows and aquifer recharge (Huffaker 2007, Ward and Pulido-Velazquez 2008, Contor and Taylor 2013). For example, consider the hypothetical example of converting from an unlined ditch and flood irrigation to a piped conveyance system and sprinklers. Under pre-project conditions, the water diverted into the ditch ends up spread among four places: 1) evaporated from the ditch (or adjacent vegetation) into the air and is lost from the system, 2) in the soil root zone where it is used by crops, 3) runs off the downstream end of the field and directly re-enters the stream, 4) seeps into groundwater aquifers where it either eventually re-enters a stream downstream at a spring or is available for later withdrawal at a well. The former two are consumptive uses, representing permanent loss from the system. Contrary to common assumptions, the latter two are not actually losses, but in fact are available for withdrawal by other water users downstream. The conversion of the canal to a pipeline would substantially reduce #3 and #4, so if the amount of water diverted into the pipe is the same as the amount of water that was formerly diverted into the canal, then there is potential for consumptive use to actually increase (i.e., by irrigating additional acres or fully irrigating a field that was only partially irrigated before). The only water really "saved" by the conversion project is #1. An exception is in areas with saline groundwater, where seepage of excess applied irrigation water into groundwater is also true loss (i.e., cannot be used for irrigation) (Perry et al. 2007). To avoid increasing consumptive use, it is necessary for irrigation efficiency projects to reduce the quantity of water diverted by an amount equal to or greater than the sum of previous tailwater and aquifer recharge.

11.6.2 HYDROMODIFICATION AND HABITAT ALTERATION

GOAL: RESTORE RIPARIAN CORRIDORS AND PROMOTE FLOODPLAIN CONNECTIVITY

Short-Term Task HHA-1: Develop parcel-specific riparian restoration plans

The Upper Klamath Basin Comprehensive Agreement (UKBCA, see section 9.2.1 above) called for the establishment of Riparian Management Areas along streams upstream of Upper Klamath Lake and a Riparian Action Plan including parcel-specific management and restoration actions would have been incorporated into a Riparian Management Agreement for each property within the Riparian Management Corridor (UKBCA 2014). The UKBCA was never implemented, and it is unclear if it will be replaced by a future agreement. Until a new agreement can be reached, landowner interest in participating in riparian corridor restoration will likely be limited.

Information being developed for the Upper Klamath Basin Watershed Action Plan (section 9.7.4 above) will be very useful in informing parcel-specific restoration plans.

Long-Term Task HHA-2: Implement projects to restore riparian areas by constructing riparian fencing, managing livestock access, planting riparian vegetation, and providing livestock with off-channel water sources

Once parcel-specific restoration plans are developed, they should be implemented. It is expected that management measures will include construction of riparian fencing, managing livestock access to riparian areas, providing livestock with off-channel sources of water and salt, and planting to encourage establishment of riparian vegetation. These efforts should be informed and guided by previous evaluations of restoration projects in the Upper Klamath Basin, including the NewFields and Kondolf (2012) report.

Long-Term Task HHA-3: Mechanical manipulation to remove levees and restore channel sinuosity

In some cases, such as where streams are strongly confined by armored levees and/or incised such as the South Fork of the Sprague River, natural geomorphic processes are sufficiently altered that passive restoration is unlikely to be successful or will take a very long time (O'Connor et al. 2015). In such cases, mechanical manipulations such as levee setbacks, excavation of new channels, or floodplain grading, may be necessary. It is expected that these areas will be identified in the parcel-specific restoration plans. Restoring floodplain connectivity in these areas will promote deposition of sediment onto floodplains and reduce downstream transport of sediment-bound phosphorus. An example of floodplain reconnection is the Klamath Lake Land Trust's removal of 1.5 miles of levees in the Sprague River Valley in 2015 (KLLT 2017). Mechanical manipulations can be extremely costly, so they should only be used when they are the only option likely to be effective. The Consortium recommends that channel and floodplain restoration planning efforts consider the use of beaver dam analogues (discussed in the following section) as a low-cost technique for reversing stream channel incision by aggrading stream channels; however, the Consortium recognizes that beaver dam analogues will only be suitable for some locations.

Long-Term Task HHA-4: Implement a beaver management program and consider deployment of beaver dam analogues

American beaver (*Castor canadensis*) are a keystone species which can profoundly alter stream ecosystems (Pollock et al. 2018). They are native to the Klamath Basin and are present throughout the basin (Friedrichsen 1996, Silloway 2010, Lanman et al. 2013). Dams created by beavers can retain sediment, reverse channel incision, restore floodplain connectivity, promote habitat complexity, increase channel sinuosity, create thermal diversity, recharge groundwater, and raise groundwater elevation (Pollock et al. 2014, Majerova et al. 2015). As a result, beavers and their dams can greatly enhance habitat quality for anadromous salmonids, including coho salmon (Pollock et al. 2004) and steelhead (Bouwes et al. 2016). An intensively monitored seven-year experiment in Oregon demonstrated significant increases in the density, survival, and production of juvenile steelhead following installation of beaver dam analogues (BDAs) which mimic the functions of natural beaver dams (Bouwes et al. 2016).

Beavers can cause problems for humans in floodplain areas by consuming crops and landscaping, flooding roads and property, and damming irrigation infrastructure. Non-lethal and effective methods have been developed for addressing many of these issues (Pollock et al. 2018). Recognizing the water supply and ecosystem benefits beavers provide, the Klamath Watershed Partnership has been providing education and technical assistance to landowners for managing beaver issues, including on-site mitigation as well as beaver relocation (though only a few relocations have been conducted due to stringent state regulations). The Consortium supports efforts to maintain and expand beaver populations, and considers beaver dam analogs to be a promising cost-effective technique for stream restoration.

GOAL: RESTORE WETLANDS AROUND UKL AND TRIBUTARIES TO IMPROVE WATER QUALITY AND HABITAT

Short-Term Task HHA-5: Develop wetland restoration plans

Most of the historical wetlands around Upper Klamath Lake (UKL) were diked, drained, and converted to agriculture (see section 5.2 above). Some of those historic wetlands, such as the mouths of the Wood and Williamson rivers, are now being restored back to wetlands; however, restoration of additional areas is necessary to help improve habitat and water quality conditions in UKL and the Klamath River downstream. Entities involved in restoring wetlands around UKL include The Nature Conservancy (TNC), U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation, Trout Unlimited, and The Klamath Tribes. The Klamath Basin Restoration Agreement (KBRA, see section 9.7.6) called for the breaching of dikes to reconnect the Wood River Wetlands, Agency Lake Ranch, and Barnes Ranch to Agency

Lake, with the goal of increasing water storage in UKL and restoring wetland habitat. TNC recently acquired approximately 4,000 acres adjacent to Agency Lake Ranch and Barnes Ranch which it is in the process of restoring back to wetlands, supported in part by the USDA NRCS Wetland Reserves Program (see section 9.6.2 and 9.7.3). The Consortium encourages those entities involved in wetland restoration to continue their work, and to expand the effort if additional areas become available. An essential step is the development of wetland restoration plans and designs for specific parcels.

Long-Term Task HHA-6: Implement wetland restoration plans

Once parcel-specific wetland restoration plans are developed, they should be implemented.

GOAL: ELIMINATE EFFECTS OF KLAMATH HYDROELECTRIC PROJECT ON WATER TEMPERATURE, ALGAL TOXINS, AND FOOD WEB

Short-Term Task HHA-7: Develop plan and permitting to remove J.C. Boyle, Copco 1/2, and Iron Gate dams

The reservoirs in the Klamath Hydroelectric Project (KHP) contribute to water quality impairments in the Klamath River (see section 4.5 above). The Klamath Hydroelectric Settlement Agreement (KHSA) is a multi-party agreement to remove J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams. All Consortium member Tribes support removing these dams, but only some Consortium member Tribes support the KHSA as the vehicle for achieving that goal. Regardless of what path is ultimately chosen for dam removal, the process will be complicated and take years of planning and studies including development of required environmental permits.

Long-Term Task HHA-8: Implement plan to remove J.C. Boyle, Copco 1/2, and Iron Gate dams

Once plans are developed for how to remove the dams and appropriate permits are obtained, the dams should be removed. The KHSA targets 2020 as the year in which dam removal would occur.

11.6.3 FORESTRY

Relative to agriculture (section 11.6.1) and hydromodification and habitat alteration (section 11.6.2), forestry is a small contributor to basin-scale NPS pollution in the Upper Klamath Basin but for the sake of completeness we include tasks to address it.

GOAL: REDUCE IMPACTS OF FOREST MANAGEMENT ON AQUATIC HABITATS

Long-Term Task FOR-1: Improve riparian protections in Oregon Forest Practice Rules

Riparian forests are important to streams because they stabilize streambanks, provide shade, and contribute wood which provides habitat structure. Anadromous fish are currently blocked from accessing the Upper Klamath Basin by a series of dams on the mainstem Klamath River (see section 4.3 above). Given that these dams are likely to be removed within the next decade through the KHSA or other means, it is important to start protecting and restoring habitat within the tributaries upstream of Iron Gate Dam. One tributary of particular importance is Spencer Creek, which has very high intrinsic potential to serve as coho salmon habitat but is currently a tributary to J.C. Boyle Reservoir (NMFS 2014). Modeling indicates that if streamflow and riparian conditions in Spencer Creek were restored to natural thermal potential (i.e., a wide riparian corridor with mature riparian vegetation and no water diversions) then water temperatures would be suitable for coho salmon rearing throughout almost the entire length of the creek (ODEQ 2010a). One factor that may retard recovery of aquatic habitats in these tributaries is weak regulation of private timberland in Oregon. Reviews of the Oregon Forest Practice Rules have found that they do not adequately protect riparian areas (NMFS 2014). Protections for small and medium-sized streams are particularly deficient (IMST 1999). Following experiments showing that harvest under the current rules increased stream temperatures, Oregon regulators initiated a process to increase riparian protections; however, the Klamath Basin is not included in the proposed revisions. Due to the Northwest Forest Plan and the Aquatic Conservation Strategy (USFS and BLM 1994), riparian protections on federal lands are much stronger than those on private lands in Oregon. The Consortium has no legal authority to alter the Oregon Forest Practice Rules; however, it can recommend changes when opportunities for public comment arise. If the Klamath Basin Restoration Agreement (KBRA, see section 9.7.6 above) is adopted, Oregon Department of Forestry's ability to strengthen water quality regulatory requirements on private forestry operations within the Klamath Basin may be limited[7].

Short-Term Task FOR-2: Conduct road assessments

Some areas within the Upper Klamath Basin have dense networks of roads which can produce sediment and impair streams. Field surveys of roads are necessary to determine which sections of roads have the potential to cause the most problems. Priority areas for road assessments would be the watersheds of tributaries with the highest potential to support anadromous salmonids.

Long-Term Task FOR-3: Upgrade and decommission roads

The highest-priority sites identified within the assessed areas would be targeted for upgrade treatments to reduce their potential to generate sediment. Treatments may include outsloping and culvert replacement. Roads that are no longer necessary would be considered for decommissioning (i.e., removal). The Freemont-Winema National Forests and U.S. Bureau of Land Management have an active road upgrade program in the Upper Klamath Basin (USFS and USBLM 2003).

11.6.4 URBAN

Given the limited urbanized area, urban stormwater is a minor contributor to NPS pollution within the Upper Klamath Basin and its impacts to water quality are far smaller than agriculture (section 11.6.1) and hydromodification and habitat alteration (section 11.6.2), but for the sake of completeness we include tasks to address it.

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[7] Excerpt from the KBRA "25.1.3. Forestry: Private forestry operations complying with water protection rules administered by the Oregon Department of Forestry, and with rule amendments, if any, adopted to implement the Fisheries Program, shall not be subject to further water quality requirements under Oregon Revised Statutes chapter 468B or 527, if any, arising solely from reintroduction and the designation or presence of new fish beneficial uses.

GOAL: REDUCE DELIVERY OF URBAN STORMWATER CONTAMINANTS TO IMPORTANT AQUATIC HABITATS DOWNSTREAM

Long-Term Task URB-1: Provide outreach, education, and technical assistance to residents and businesses in Klamath Falls

Despite the fact that urban stormwater contributes only a small fraction of the NPS pollution within the Upper Klamath Basin, educating urban residents about stormwater is important. Stormwater education contributes to residents' understanding of their role in the watershed and promotes appreciation and connection to rivers, lakes, and wildlife habitat. The Klamath Watershed Partnership has been actively involved in education and outreach about stormwater and NPS pollution (KWP and ODEQ 2015). The Consortium will seek to partner with KWP and other organizations promoting education and outreach about NPS pollution.

Long-Term Task URB-2: Minimize effects of new development on stormwater

Given the small contribution of urban stormwater to NPS pollution in the Upper Klamath Basin, the Consortium does not recommend costly retrofits to existing urban infrastructure to reduce NPS pollution; however, the Consortium does recommend that future urban development include Lower Impact Development (LID)[8] principles to increase infiltration and decrease stormwater runoff. LID features can be included in new development at relatively low cost if incorporated early in the design process. The only mention of stormwater runoff in Klamath County's current land development code[9] is a single sentence that states "The purposes of landscaping requirements are to maintain and enhance the appearance of structures and properties, to provide for visual privacy and a quality visual environment, and to provide areas on sites to absorb rainfall and reduce stormwater runoff." The land development code lacks the key LID principle that impervious surfaces (e.g., roofs and parking lots) should be sloped such that water is routed to landscaped swales and depressions where it can infiltrate. To minimize stormwater runoff, landscaped areas should not be islands hydrologically disconnected (i.e., elevated above the impervious area and separated by curbs) within the developed area, and impervious areas should not be sloped to concentrate water into hardened drains which rapidly carry water offsite.

11.6.5 OTHER

Tasks in this section are "band-aid" interventions to address the symptoms of excessive algal productivity in Upper Klamath Lake from Keno Reservoir downstream. These tasks are assigned to the "other" category because these symptoms are a result of multiple interacting categories of NPS pollution. As noted above in section 7, the Consortium is placing a much higher priority on treating causes (i.e., reducing phosphorus loading from the watershed) than on treating symptoms; however, it is worth considering treatment of symptoms as part of an integrated strategy.

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[8] LID is more commonly referred to as "Low Impact Development," but development conducted with LID principles still has impacts, and those impacts can in fact be great depending on the scale and location. As noted by Strecker (2001), "Low Impact Development" is a misnomer and therefore instead we prefer the term "Lower Impact Development."

[9] http://www.klamathcounty.org/depts/planning/downloads/Codes_Plans/LandDevCode/LDCChapter60.pdf

GOAL: REDUCE ORGANIC MATTER LOADS DISCHARGED FROM UKL INTO KLAMATH RIVER

Long-Term Task OTH-1: Conduct pilot-scale demonstration test of system to remove algal biomass at outlet of UKL

Several previous projects have evaluated the potential for removal of algal biomass near Link Dam to improve water quality in Keno Reservoir downstream. Technologies evaluated thus far included stormwater technology (hydrodynamic separators, Watercourse Engineering, Inc. 2013, 2014a, 2014b) and algal harvesting technologies (Stillwater et al. 2012, 2013; PacifiCorp 2015; Carlson and Hughes 2016; CH2M 2017). Removing algae would be beneficial for several other reasons: 1) modest direct reduction in downstream nutrients because algae contains phosphorus (Sullivan et al. [2013] predict that a 50% reduction in algae and particulate organic matter would reduce June-October total phosphorus loads in Keno Reservoir by ~8%), 2) potential for creation of useful products (e.g., pharmaceuticals, human/animal dietary supplements, or fertilizer)(Simon et al. 2013) if it is cost-effective to do so, and 3) in contrast to a chemical treatment like alum, algal harvesting does not produce potentially toxic byproducts.

Carlson and Hughes (2016) coordinated a series of conference calls with the IMIC (see section 9.5.1 above) to discuss key questions about algal harvesting and summarized the resulting discussions. Participants generally agreed that removing 25% of the algae at Link Dam was likely the approximate upper limit of feasibility. The Sullivan et al. (2013) model scenarios predict that a 25% reduction in algae and organic matter would increase average June 15-October 31 dissolved oxygen conditions in Keno Reservoir by approximately 0.8 mg/L. This increase would notably improve water quality, but is far short of meeting dissolved oxygen criteria. In summary, algae removal has the potential to make some limited improvement in Keno Reservoir dissolved oxygen, but cannot by itself resolve the oxygen depletion problem.

Pilot tests are necessary to assess the potential harvested amounts and per-unit costs for algal harvesting systems (CH2M 2017). Previous efforts (Stillwater et al. 2012, 2013) already tried to get this information from the literature and there is not much information available. In-lake pilot tests are absolutely critical. Ideally, several different technologies should be tested. The New Algae Company developed a conceptual design for a demonstration algae removal project near Link Dam (CH2M 2017). The Interim Measures Implementation Committee (IMIC) considered funding the New Algae Company demonstration project in 2017 through KHSA Interim Measure 11, but decided that the cost of the demonstration project was too high (approximately $600,000[10]) relative the program's available budget (CH2M 2017). Costs for the demonstration project could be reduced somewhat by reducing the length of harvest screens deployed, but unfortunately that would not result in major cost savings because the onshore equipment cannot be shrunk (CH2M 2017). Conversely, capital costs for a larger permanent system would not cost substantially more than the demonstration project.

A major obstacle to implementing algal biomass removal is the lack of an identified funding source to pay for ongoing operating costs. If algal biomass removal were ever to implemented at a large scale, it would likely have to be part of a multi-benefit integrated economic development

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[10] The 4-month demonstration project was estimated to cost approximately $600,000 which included $100,000 labor costs for 4-months of continuous 24 hours per day operation with the remaining costs split between materials, fabrication, and installation (Jerry Anderson and Doug Jackson of New Algae Company, personal communication, August 1, 2016). Disposal and water quality monitoring were not included in the $600,000 cost estimate, so would need to be added.

project rather than solely for water quality improvement purposes. It would hopefully be possible to produce high-value products (e.g., pharmaceuticals or human/animal dietary supplements) which can be sold for a profit during portions of the year, but during periods when cyanobacterial toxins are present, algal biomass would need to be diverted to lower value uses (but which hopefully would still generate some revenue to at least partially offset costs) such as a composted soil amendment. Composting under proper conditions would likely degrade the toxins (Carlson and Hughes 2016). In comments on a draft of this NPS Plan, the Klamath Soil and Water Conservation District expressed interest in the possibility of participating in experiments to test the effects of an algal soil amendment on agricultural lands. If experiments demonstrated improved soil health, moisture holding capacity, and productivity, it could increase interest by farmers and ranchers in using the material.

Environmental permitting requirements for an algal harvesting system would be high, even for a temporary demonstration project (CH2M 2017). These requirements (e.g., screen size, approach velocity, and season of use) to reduce impacts to Endangered Species Act (ESA) protected species and other fish would likely to reduce the efficiency of the design, which will in turn decrease effectiveness and increase costs per unit of algal biomass removed (CH2M 2017). The ESA permitting process would be easier for a federal agency than a private company, but still difficult (CH2M 2017). Given that it is a popular outdoor recreational area, there could also be public resistance to industrial development around Link River.

In summary, relative to other project types which could achieve similar water quality benefits, the capital costs for algal biomass removal are quite low (i.e., likely something like $1-2 million). However, environmental permits would be difficult to obtain and would compromise system effectiveness. In addition, there would likely be a need for ongoing funds to subsidize operating costs. The Consortium would like to keep algal biomass removal as an option for future consideration, to be re-evaluated if a funding source for ongoing operations becomes available and a federal agency becomes willing to lead the project.

Due to permitting requirements, the Consortium envisions the pilot tests as a two-year project with the first year laying the groundwork for a pilot test that would be conducted in the second year. That groundwork should include recruiting algal harvesters to participate, creating a study design, and obtaining necessary permits.

Long-Term Task OTH-2: Develop detailed design and engineering for system to remove algal biomass at outlet of UKL and obtain necessary permits

If the pilot projects and conceptual designs indicate that algae harvesting would be feasible and cost-effective and a potential source of funding for ongoing operations has been identified, then a full-scale system should be designed and engineered and permits acquired.

Long-Term Task OTH-3: Construct/operate full-scale system to remove algal biomass at outlet of UKL

If the pilot projects are successful, funding has been identified, the full-scale algal harvesting system is designed, and permits have been acquired, then the system should be constructed and put into operation.

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13 ACRONYMS AND ABBREVIATIONS LIST

AGR	Agriculture
Al	Aluminum
BDAs	Beaver Dam Analogues
BLM	United States Bureau of Land Management
BMPs	Best Management Practices
CCC	California Coastal Conservancy
CDFW	California Department of Fish and Wildlife
CDFG	California Department of Fish and Game
Consortium	Klamath Tribal Water Quality Consortium
CWA	Clean Water Act
DO	Dissolved Oxygen
DSTWs	Diffuse Source Treatment Wetlands
FAE	financial assistance eligibility
FERC	Federal Energy Regulatory Commission
FFOD	Findings of Fact and Order of Determination
FOR	Forestry
GIS	geographic information system
HU	Hydrologic Unit
HUC	USGS hydrologic unit code
HVTEPA	Hoopa Valley Tribal Environmental Protection Agency
HHA	Hydromodification and Habitat Alteration
IM	Interim Measures
IMST	Independent Multidisciplinary Science Team
KBMP	Klamath Basin Monitoring Program
KBRA	Klamath Basin Restoration Agreement
KHP	Klamath Hydroelectric Project
KHSA	Klamath Hydroelectric Settlement Agreement
KBREC	Klamath Basin Research & Extension Center
KSWCD	Klamath Soil and Water Conservation District
KTAP	Klamath Tracking and Accounting Program
KTWQC	Klamath Tribal Water Quality Consortium
KWP	Klamath Watershed Partnership
LID	Lower Impact Development
LKL	Lower Klamath Lake
LRLAWQAC	Lost River Local Agricultural Water Quality Advisory Committee
m	meters
MEI	Mobley Engineering Inc.
mi	miles
NCRWQCB	North Coast Regional Water Quality Control Board
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service

NPS	Nonpoint Source
NPS Plan	Nonpoint Source Assessment and Management Program Plan
NRC	Natural Research Council
NRCS	Natural Resources Conservation Service
NWFP	Northwest Forest Plan
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
OEHHA	Office of Environmental Health Hazard Assessment
OTH	Other
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
PCSRF	Pacific Coastal Salmon Recovery Fund
QVIR	Quartz Valley Indian Reservation
RCPP	Regional Conservation Partnership Program
REPA	Resighini Rancheria Environmental Protection Authority
RIT	Recovery Implementation Team
RM	River Mile
SIF	Specified Instream Flows
SIP	Special Investment Partnership
SVRCD	Shasta Valley Resource Conservation District
SWRCB	State Water Resources Control Board
TAS	treatment as a state
TMDLs	Total Maximum Daily Loads
Ti	Titanium
TU	Trout Unlimited
U.S. BLM	United States Bureau of Land Management
U.S. DOI	United States Department of Interior
UKBCA	Upper Klamath Basin Comprehensive Agreement
UKCAN	Upper Klamath Conservation Action Network
UKL	Upper Klamath Lake
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USFS	U.S. Forest Service
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
WDR	Waste Discharge Requirements
WRP	Wetlands Reserve Program
WUP	Water Use Program
YTEP	Yurok Tribe Environmental Program

Table A10. Oregon Department of Environmental Quality (ODEQ) list of waterbodies in the Upper Klamath Basin designated as impaired under section 303(d) of the Clean Water Act. Key to abbreviations: R. = River, Cr. = Creek, S.F. = South Fork, N.F. = North Fork, UKL = Upper Klamath Lake.

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Lost	Klamath R.	250 to 251	Fecal Coliform	Summer	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Lost	Klamath R.	250 to 251	Fecal Coliform	FallWinterSpring	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Lost	Klamath R.	250 to 251	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Lost	Klamath R.	250 to 251	Nutrients	Undefined		Aesthetics	3
Lost	Klamath R.	250 to 251	pH	FallWinterSpring	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	Attaining
Lost	Klamath R.	250 to 251	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Lost	Klamath R.	250 to 251	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Criteria change or use clarification
Lost	Klamath Strait	0 to 9.8	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
Lost	Klamath Strait	0 to 9.8	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	5
Lost	Klamath Strait	0 to 9.8	Arsenic	Year Around	Table 40 Human Health Criteria for Toxic Pollutants	Aquatic life; Human health	5
Lost	Klamath Strait	0 to 9.8	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Lost	Klamath Strait	0 to 9.8	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	5
Lost	Klamath Strait	0 to 9.8	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l		5
Lost	Klamath Strait	0 to 9.8	Dissolved Oxygen	Year Around	Spawning: Not less than 11.0 mg/L or 95% of saturation	Salmonid fish spawning	Criteria change or use clarification
Lost	Klamath Strait	0 to 9.8	E. Coli	Summer	E. Coli [3]		5
Lost	Klamath Strait	0 to 9.8	E. Coli	Summer	30-day log mean of 126 E. coli	Water contact recreation	2

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
					organisms per 100 ml; no single sample > 406 organisms per 100 ml		
Lost	Klamath Strait	0 to 9.8	E. Coli	FallWinterSpring	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
Lost	Klamath Strait	0 to 9.8	Fecal Coliform	Summer	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Criteria change or use clarification
Lost	Klamath Strait	0 to 9.8	Fecal Coliform	FallWinterSpring	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Criteria change or use clarification
Lost	Klamath Strait	0 to 9.8	Iron	Year Around	Table 20 Toxic Substances	Aquatic life; Human health	3
Lost	Klamath Strait	0 to 9.8	Manganese	Year Around	Table 20 Toxic Substances	Human health	3B
Lost	Klamath Strait	0 to 9.8	pH	Summer	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	2
Lost	Klamath Strait	0 to 9.8	pH	FallWinterSpring	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	2
Lost	Klamath Strait	0 to 9.8	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
Lost	Klamath Strait	0 to 9.8	Temperature	Summer	Previous narrative criteria: No measurable increase…	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	Criteria change or use clarification
Lost	Lost R. Diversion Canal	0 to 237.8	Dissolved Oxygen	Year Around	Cool water: Not less than 6.5 mg/l		5
Lost; Upper Klamath	Klamath R.	231.5 to 253	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	5
Lost; Upper Klamath	Klamath R.	231.5 to 253	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	5
Lost; Upper Klamath	Klamath R.	231.1 to 251	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	5
Lost; Upper Klamath	Klamath R.	231 to 250	Fecal Coliform	Summer	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Lost; Upper Klamath	Klamath R.	231 to 250	Fecal Coliform	FallWinterSpring	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Lost; Upper	Klamath R.	231 to	Flow	Undefined	Creation of foul tastes, odors, or	Resident fish and aquatic life; Salmonid fish rearing;	4B

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Klamath		250	Modification		toxins.[1]	Salmonid fish spawning	
Lost; Upper Klamath	Klamath R.	231 to 250	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Lost; Upper Klamath	Klamath R.	231 to 250	Nutrients	Undefined		Aesthetics	3
Lost; Upper Klamath	Klamath R.	231 to 250	pH	FallWinterSpring	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	Attaining
Lost; Upper Klamath	Klamath R.	231.5 to 253	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	5
Lost; Upper Klamath	Klamath R.	231 to 250	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Lost; Upper Klamath	Klamath R.	231 to 250	Temperature	Summer	Previous narrative criteria: No measurable increase…	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	Criteria change or use clarification
Lost; Upper Klamath	Klamath R.	231 to 250	Toxics	Undefined	Table 20 Toxic Substances	Anadromous fish passage; Drinking water; Resident fish and aquatic life	3
Lost; Upper Klamath	Klamath R. / Ewauna, Lake	232.7 to 253.7	Ammonia	Year Around	Table 20 Toxic Substances		5
Lost; Upper Klamath	Klamath R. / Ewauna, Lake	232.7 to 253.7	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	5
Lost; Upper Klamath	Klamath R. / Ewauna, Lake	232.7 to 253.7	pH	Summer	pH 6.0 to 8.5		5
Lost; Upper Klamath	Klamath R. / Ewauna, Lake	232.7 to 253.7	pH	FallWinterSpring	pH 6.0 to 8.5		5
Lost; Upper Klamath	Klamath R. / Ewauna, Lake	232.7 to 253.7	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
Sprague	Boulder Cr.	0 to 4.8	Temperature	Summer	Bull Trout: 10.0 C	Salmonid fish rearing; Salmonid fish spawning	4A
Sprague	Brownsworth Cr.	3.2 to 8.8	Temperature	Summer	Bull Trout: 10.0 C	Salmonid fish rearing; Salmonid fish spawning	4A
Sprague	Brownsworth Cr.	0 to 3.2	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Buckboard Cr.	0 to 5	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Calahan Cr.	0 to 7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Camp Cr.	0 to 3.1	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	3B
Sprague	Copperfield Cr.	0 to 3.2	Sedimentation	Summer	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Corral Cr.	0 to 2.8	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
Sprague	Coyote Cr.	0 to 10.4	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Sprague	Deming Cr.	6.7 to 12.5	Temperature	Summer	Bull Trout: 10.0 C	Salmonid fish rearing; Salmonid fish spawning	4A
Sprague	Deming Cr.	0 to 6.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Fishhole Cr.	0 to 25.6	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	Fishhole Cr.	0 to 25.6	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	Fishhole Cr.	0 to 25.6	Biological Criteria	Year Around	Biocriteria [5]	Aquatic life	3B
Sprague	Fishhole Cr.	0 to 25.6	Chloride	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	Fishhole Cr.	0 to 25.6	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	Fishhole Cr.	0 to 25.6	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	3
Sprague	Fishhole Cr.	0 to 25.6	E. Coli	Summer	E. Coli [3]	Water contact recreation	3
Sprague	Fishhole Cr.	0 to 25.6	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Fishhole Cr.	0 to 25.6	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Fishhole Cr.	0 to 25.6	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	Fishhole Cr.	0 to 25.6	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3
Sprague	Fishhole Cr.	0 to 25.6	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Fishhole Cr.	0 to 25.6	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Fivemile Cr.	0 to 19.3	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Fivemile Cr.	0 to 19.3	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Fivemile Cr.	0 to 19.3	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Fivemile Cr.	0 to 19.3	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Leonard Cr.	0 to 3.1	Temperature	Summer	Bull Trout: 10.0 C	Salmonid fish rearing; Salmonid fish spawning	4A
Sprague	Long Cr.	0 to 15.6	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Long Cr.	0 to 15.6	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Long Cr.	0 to 15.6	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Sprague	Meryl Cr.	0 to 15	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Meryl Cr.	0 to 15	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Meryl Cr.	0 to 15	Temperature	Undefined	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	3
Sprague	N.F. Sprague R.	0 to 18	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	N.F. Sprague R.	18 to 33.5	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	3B
Sprague	N.F. Sprague R.	0 to 33.5	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	N.F. Sprague R.	0 to 33.5	Chloride	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	N.F. Sprague R.	0 to 33.5	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	N.F. Sprague R.	0 to 33.5	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	N.F. Sprague R.	0 to 8	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	2
Sprague	N.F. Sprague R.	8 to 11.3	Dissolved Oxygen	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cold-water aquatic life	3
Sprague	N.F. Sprague R.	0 to 33.5	Dissolved Oxygen	January 1 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning	3
Sprague	N.F. Sprague R.	0 to 33.5	E. Coli	Summer	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
Sprague	N.F. Sprague R.	0 to 33.5	E. Coli	FallWinterSpring	E. Coli [3]	Water contact recreation	3
Sprague	N.F. Sprague R.	0 to 33.5	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	N.F. Sprague R.	0 to 33.5	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	N.F. Sprague R.	0 to 33.5	Iron	Year Around	Table 20 Toxic Substances	Aquatic life; Human health	3
Sprague	N.F. Sprague R.	0 to 33.5	Manganese	Year Around	Table 20 Toxic Substances	Human health	3
Sprague	N.F. Sprague R.	0 to 33.5	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	2
Sprague	N.F. Sprague R.	0 to 33.5	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	N.F. Sprague R.	0 to 33.5	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
Sprague	N.F. Sprague R.	0 to 33.5	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Sprague	N.F. Sprague R.	28.3 to 33.5	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
Sprague	N.F. Sprague R.	0 to 33.5	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Paradise Cr.	0 to 8.6	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Pothole Cr.	0 to 6.1	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	S.F. Sprague R.	0 to 31.3	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	S.F. Sprague R.	0 to 31.3	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	S.F. Sprague R.	0 to 27.7	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths [6]	Aesthetics; Fishing; Water contact recreation	3
Sprague	S.F. Sprague R.	0 to 31.3	Chloride	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	S.F. Sprague R.	0 to 31.3	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	S.F. Sprague R.	0 to 31.3	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	S.F. Sprague R.	0 to 14.3	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	3
Sprague	S.F. Sprague R.	0 to 31.2	Dissolved Oxygen	January 1 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning	3
Sprague	S.F. Sprague R.	0 to 31.3	E. Coli	FallWinterSpring	E. Coli [3]	Water contact recreation	3
Sprague	S.F. Sprague R.	0 to 31.3	E. Coli	Summer	E. Coli [3]	Water contact recreation	5
Sprague	S.F. Sprague R.	0 to 27.7	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	S.F. Sprague R.	0 to 27.7	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	S.F. Sprague R.	0 to 31.3	Iron	Year Around	Table 20 Toxic Substances	Aquatic life; Human health	3
Sprague	S.F. Sprague R.	0 to 31.3	Manganese	Year Around	Table 20 Toxic Substances	Human health	3
Sprague	S.F. Sprague R.	0 to 27.7	Nutrients	Undefined		Aesthetics	3
Sprague	S.F. Sprague R.	0 to 31.3	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	S.F. Sprague R.	0 to 31.3	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	S.F. Sprague R.	0 to 31.2	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
Sprague	S.F. Sprague R.	0 to 27.7	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	S.F. Sprague R.	27.7 to	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
		31.2					
Sprague	S.F. Sprague R.	0 to 27.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Sprague R.	0 to 79.2	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	Sprague R.	0 to 79.2	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	Sprague R.	0 to 79.2	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths [6]	Aesthetics; Fishing; Water contact recreation	3
Sprague	Sprague R.	0 to 79.2	Chloride	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	Sprague R.	0 to 79.2	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	Sprague R.	0 to 79.2	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	Sprague R.	45.7 to 79.2	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	2
Sprague	Sprague R.	0 to 45.7	Dissolved Oxygen	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cold-water aquatic life	4A
Sprague	Sprague R.	0 to 79.2	Dissolved Oxygen	Summer	Cold water: Not less than 8.0 mg/l or 90% of saturation	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Sprague R.	0 to 79.2	Dissolved Oxygen	January 1 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning	3
Sprague	Sprague R.	0 to 79.2	E. Coli	Summer	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
Sprague	Sprague R.	0 to 79.2	E. Coli	FallWinterSpring	E. Coli [3]	Water contact recreation	3
Sprague	Sprague R.	0 to 79.2	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Sprague R.	0 to 79.2	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Sprague R.	0 to 79.2	Iron	Year Around	Table 20 Toxic Substances	Aquatic life; Human health	3
Sprague	Sprague R.	0 to 79.2	Manganese	Year Around	Table 20 Toxic Substances	Human health	3
Sprague	Sprague R.	0 to 79.2	Nutrients	Undefined		Aesthetics	3
Sprague	Sprague R.	0 to 79.2	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	Sprague R.	0 to 79.2	pH	Summer	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	4A
Sprague	Sprague R.	0 to 79.2	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Sprague	Sprague R.	0 to 79.2	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Sprague R.	0 to 79.2	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Sycan R.	0 to 71.4	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	Sycan R.	0 to 71.4	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
Sprague	Sycan R.	0 to 64.1	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths [6]	Aesthetics; Fishing; Water contact recreation	3
Sprague	Sycan R.	0 to 71.4	Chloride	Year Around	Table 20 Toxic Substances	Aquatic life	3
Sprague	Sycan R.	0 to 71.4	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	Sycan R.	0 to 71.4	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Sprague	Sycan R.	0 to 64.1	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	2
Sprague	Sycan R.	0 to 71.4	Dissolved Oxygen	January 1 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning	3
Sprague	Sycan R.	0 to 71.4	E. Coli	Summer	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
Sprague	Sycan R.	0 to 71.4	E. Coli	FallWinterSpring	E. Coli [3]	Water contact recreation	3
Sprague	Sycan R.	0 to 64.1	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Sycan R.	0 to 64.1	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Sprague	Sycan R.	0 to 71.4	Iron	Year Around	Table 20 Toxic Substances	Aquatic life; Human health	3
Sprague	Sycan R.	0 to 71.4	Manganese	Year Around	Table 20 Toxic Substances	Human health	3
Sprague	Sycan R.	0 to 64.1	Nutrients	Undefined		Aesthetics	3
Sprague	Sycan R.	0 to 71.4	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	2
Sprague	Sycan R.	0 to 71.4	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	Sycan R.	0 to 71.4	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
Sprague	Sycan R.	0 to 64.1	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Sprague	Sycan R.	0 to 64.1	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Sprague	Trout Cr.	0 to 1.4	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	3

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Sprague	Trout Cr.	0 to 1.4	Dissolved Oxygen	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cold-water aquatic life	3
Sprague	Trout Cr.	0 to 1.4	E. Coli	Summer	E. Coli [3]	Water contact recreation	3
Sprague	Trout Cr.	0 to 1.4	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Sprague	Trout Cr.	0 to 1.4	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3
Sprague	Trout Cr.	0 to 1.4	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Upper Klamath	Beaver Cr.	0 to 5.5	Temperature	Year Around (Non-spawning)	Redband or Lahontan cutthroat trout: 20.0 degrees Celsius 7-day-average maximum	Redband or Lahontan cutthroat trout	5
Upper Klamath	Clover Cr.	0 to 8.4	Biological Criteria	Year Around	Biocriteria [5]	Resident fish and aquatic life	3
Upper Klamath	Clover Cr.	0 to 8.4	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Upper Klamath	Clover Cr.	0 to 8.4	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	303(d)
Upper Klamath	Clover Cr.	0 to 8.4	Temperature	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Upper Klamath	Corral Cr.	0 to 2.4	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	3B
Upper Klamath	Grizzly Cr.	0 to 3	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Hoxie Cr.	0.8 to 4.4	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Jenny Cr.	0 to 17.8	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Upper Klamath	Jenny Cr.	0 to 18.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
Upper Klamath	Jenny Cr.	0 to 17.8	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Johnson Cr.	0 to 9.4	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Keene Cr.	0 to 7.2	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Keene Cr.	7.5 to 9.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Keene Cr. / Hyatt Reservoir	11.3896 to 13.8	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths [6]	Aesthetics; Drinking water; Fishing; Livestock watering; Water contact recreation; Water supply	5
Upper Klamath	Keene Cr. / Hyatt Reservoir	11.3896 to 13.8	Nutrients	Undefined		Aesthetics	3
Upper Klamath	Klamath R.	207 to 231.5	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
Upper Klamath	Klamath R.	207 to 231	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	Attaining

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Upper Klamath	Klamath R.	207 to 231.1	Dissolved Oxygen	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cold-water aquatic life	5
Upper Klamath	Klamath R.	207 to 231.1	Dissolved Oxygen	January 1 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning	5
Upper Klamath	Klamath R.	207 to 231	Fecal Coliform	Summer	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Upper Klamath	Klamath R.	207 to 231	Fecal Coliform	FallWinterSpring	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Upper Klamath	Klamath R.	207 to 231	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Upper Klamath	Klamath R.	207 to 231	Nutrients	Undefined		Aesthetics	3
Upper Klamath	Klamath R.	207 to 231	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Anadromous fish passage; Water contact recreation; Salmonid fish spawning; Salmonid fish rearing	Attaining
Upper Klamath	Klamath R.	207 to 231	pH	FallWinterSpring	pH 6.5 to 9.0	Salmonid fish rearing; Salmonid fish spawning; Resident fish and aquatic life; Anadromous fish passage; Water contact recreation	Attaining
Upper Klamath	Klamath R.	207 to 231.5	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	2
Upper Klamath	Klamath R.	207 to 231	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Upper Klamath	Klamath R.	207 to 231.1	Temperature	Year Around (Non-spawning)	Redband or Lahontan cutthroat trout: 20.0 degrees Celsius 7-day-average maximum	Redband or Lahontan cutthroat trout	5
Upper Klamath	Klamath R. / Unnamed Lake (J.C. Boyle Reservoir)	224.7 to 228.1	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Upper Klamath	Klamath R. / Unnamed Lake (J.C. Boyle Reservoir)	224.7 to 228.1	Nutrients	Undefined		Aesthetics	3
Upper Klamath	Klamath R. / Unnamed Lake (J.C. Boyle Reservoir)	224.7 to 228.1	pH	Summer	pH 6.0 to 8.5	Resident fish and aquatic life; Water contact recreation	3

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Upper Klamath	Lincoln Cr.	0 to 2.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	3B
Upper Klamath	Long Prairie Cr.	0 to 11.9	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Upper Klamath	Mill Cr.	0 to 3.9	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Miners Cr.	0 to 4.3	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	303(d)
Upper Klamath	Miners Cr.	0 to 4.3	Temperature	Year Around (Non-spawning)	Redband or Lahontan cutthroat trout: 20.0 degrees Celsius 7-day-average maximum	Redband or Lahontan cutthroat trout	2
Upper Klamath	S.F. Keene Cr.	0 to 3.1	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	303(d)
Upper Klamath	Spencer Cr.	0 to 18.9	Biological Criteria	Year Around	Biocriteria [5]	Resident fish and aquatic life	303(d)
Upper Klamath	Spencer Cr.	0 to 18.9	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Upper Klamath	Spencer Cr.	0 to 18.9	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Upper Klamath	Spencer Cr.	0 to 18.9	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	303(d)
Upper Klamath	Spencer Cr.	0 to 18.9	Temperature	Year Around (Non-spawning)	Redband or Lahontan cutthroat trout: 20.0 degrees Celsius 7-day-average maximum	Redband or Lahontan cutthroat trout	5
UKL	Annie Cr.	0 to 16.3	Biological Criteria	Year Around	Biocriteria [5]	Aquatic life	5
UKL	Annie Cr.	0 to 6.1	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Annie Cr.	0 to 6.1	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Annie Cr.	0 to 6.1	Temperature	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Cherry Cr.	0 to 9.7	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Cherry Cr.	0 to 9.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
UKL	Crooked Cr.	0 to 9	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
UKL	Crooked Cr.	0 to 9	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3
UKL	Fourmile Cr.	0 to 10.2	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
UKL	Fourmile Cr.	1 to 10.2	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
UKL	Fourmile Cr.	0 to 1	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
UKL	Klamath R. / Agency Lake	275 to 282	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths [6]	Aesthetics; Drinking water; Fishing; Livestock watering; Water contact recreation; Water supply	4A
UKL	Klamath R. / Agency Lake	275 to 282	Chlorophyll a	Summer	Thermally stratified lake: 0.01 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	4A
UKL	Klamath R. / Agency Lake	275 to 282	Dissolved Oxygen	Summer	Cool water: Not less than 6.5 mg/l	Resident fish and aquatic life; Salmonid fish rearing	4A
UKL	Klamath R. / Agency Lake	275 to 282	Nutrients	Undefined		Aesthetics	3
UKL	Klamath R. / Agency Lake	275 to 282	pH	Summer	pH 6.5 to 8.5	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	4A
UKL	Klamath R. / Agency Lake	275 to 282	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Klamath R. / UKL	254.9 to 278.5	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths [6]	Aesthetics; Drinking water; Fishing; Livestock watering; Water contact recreation; Water supply	4A
UKL	Klamath R. / UKL	254.9 to 278.5	Chlorophyll a	Summer	Thermally stratified lake: 0.01 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	4A
UKL	Klamath R. / UKL	254.9 to 278.5	Dissolved Oxygen	Summer	Cool water: Not less than 6.5 mg/l	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4A
UKL	Klamath R. / UKL	254.9 to 278.5	Nutrients	Undefined		Aesthetics	3
UKL	Klamath R. / UKL	254.9 to 278.5	pH	Summer	pH 6.5 to 8.5	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	4A
UKL	Klamath R. / UKL	254.9 to 278.5	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Klamath R. / UKL	254.9 to 278.5	Temperature	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Rock Cr.	0 to 5.7	Biological Criteria	Year Around	Biocriteria: Waters of the state must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.	Aquatic life	2
UKL	Rock Cr.	0 to 5.7	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Rock Cr.	0 to 5.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
UKL	Sevenmile Canal	0 to 10.5	Dissolved Oxygen	Year Around	Cool water: Not less than 6.5 mg/l		5
UKL	Sevenmile Cr.	4.2 to 12.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
UKL	Sevenmile Ditch	0 to 1.8	Dissolved Oxygen	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Sevenmile Ditch	0 to 1.8	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Sevenmile Ditch	0 to 1.8	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Sevenmile Ditch	0 to 1.8	Nutrients	Undefined		Aesthetics	3
UKL	Sevenmile Ditch	0 to 1.8	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Sevenmile Ditch	0 to 1.8	Temperature	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Sun Cr.	0 to 13.6	Temperature	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Threemile Cr.	0 to 7.6	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Threemile Cr.	0 to 7.6	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
UKL	Wood R.	0 to 17.9	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	3
UKL	Wood R.	0 to 17.9	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
UKL	Wood R.	0 to 17.8	Chlorophyll a	Summer	Thermally stratified lake: 0.01 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	Attaining
UKL	Wood R.	0 to 15	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	3
UKL	Wood R.	15 to 17.8	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	3
UKL	Wood R.	0 to 17.8	Dissolved Oxygen	August 15 - June 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning; Bull trout spawning and juvenile rearing	3
UKL	Wood R.	0 to 17.8	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Wood R.	0 to 17.8	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
UKL	Wood R.	0 to 17.8	Nutrients	Undefined		Aesthetics	3B
UKL	Wood R.	0 to 17.8	pH	Undefined	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning;	Attaining

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
						Water contact recreation	
UKL	Wood R.	0 to 17.9	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
UKL	Wood R.	0 to 17.9	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
UKL	Wood R.	0 to 17.8	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3
UKL	Wood R.	0 to 17.8	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
UKL	Wood R.	0 to 17.8	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
UKL; Lost	Unnamed	0 to 3.9	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	3
UKL; Lost	Unnamed	0 to 3.9	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	3
UKL; Lost	Unnamed	0 to 3.9	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
UKL; Lost	Unnamed	0 to 3.9	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
UKL; Lost	Unnamed	0 to 3.9	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	3
UKL; Lost	Unnamed	0 to 3.9	E. Coli	Summer	E. Coli [3]	Water contact recreation	3
UKL; Lost	Unnamed	0 to 3.9	E. Coli	FallWinterSpring	E. Coli [3]	Water contact recreation	3
UKL; Lost	Unnamed	0 to 3.9	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
UKL; Lost	Unnamed	0 to 3.9	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
UKL; Lost	Unnamed	0 to 3.9	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	Arsenic	Year Around	Table 40 Human Health Criteria for Toxic Pollutants	Aquatic life; Human health	5
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	E. Coli	Summer	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	E. Coli	FallWinterSpring	30-day log mean of 126 E. coli organisms per 100 ml; no single	Water contact recreation	2

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
					sample > 406 organisms per 100 ml		
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	2
UKL; Lost; Upper Klamath	Klamath R.	207 to 285.3	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
UKL; Upper Klamath; Lost	Klamath R. / UKL	253 to 275	pH	FallWinterSpring	pH 6.5 to 9.0		5
Williamson	Cottonwood Cr.	0 to 11.9	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	3B
Williamson	Jackson Cr.	0 to 10.4	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
Williamson	Miller Cr.	0 to 12.7	Biological Criteria	Year Around	Biocriteria [5]	Aquatic life	5
Williamson	Miller Cr.	0 to 12.7	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
Williamson	Sand Cr.	0 to 18	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	Attaining
Williamson	Tipsoo Cr.	0 to 3	Biological Criteria	Year Around	Biocriteria [5]	Aquatic life	5
Williamson	Williamson R.	12.5 to 94.6	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Williamson	Williamson R.	12.5 to 94.6	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Williamson	Williamson R.	9.4 to 39.2	Dissolved Oxygen	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cold-water aquatic life	3
Williamson	Williamson R.	39.2 to 94.6	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	3
Williamson	Williamson R.	12.5 to 94.6	E. Coli	Summer	E. Coli [3]	Water contact recreation	3
Williamson	Williamson R.	12.5 to 94.6	E. Coli	FallWinterSpring	E. Coli [3]	Water contact recreation	3
Williamson	Williamson R.	35.6 to 94.6	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Williamson	Williamson R.	12.5 to 35.6	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Williamson	Williamson R.	35.6 to 94.6	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Williamson	Williamson R.	12.5 to 35.6	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Williamson	Williamson R.	35.6 to 94.6	Nutrients	Undefined		Aesthetics	3

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Williamson	Williamson R.	12.5 to 35.6	Nutrients	Undefined		Aesthetics	3
Williamson	Williamson R.	12.5 to 94.6	pH	FallWinterSpring	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Williamson	Williamson R.	12.5 to 94.6	pH	Summer	pH 6.5 to 9.0	Resident fish and aquatic life; Water contact recreation	3
Williamson	Williamson R.	0 to 94.6	Sedimentation	Year Around	Bottom Deposits [2]		5
Williamson	Williamson R.	12.5 to 35.6	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Williamson	Williamson R.	35.6 to 94.6	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Williamson	Williamson R.	35.6 to 94.6	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Williamson	Williamson R.	12.5 to 35.6	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A
Williamson; UKL	Williamson R.	0 to 94.6	Alkalinity	Year Around	Table 20 Toxic Substances	Aquatic life	2
Williamson; UKL	Williamson R.	0 to 94.6	Ammonia	Year Around	Table 20 Toxic Substances	Aquatic life	2
Williamson; UKL	Williamson R.	0 to 94.6	Chloride	Year Around	Table 20 Toxic Substances	Aquatic life	3
Williamson; UKL	Williamson R.	0 to 12.5	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	2
Williamson; UKL	Williamson R.	0 to 12.5	Chlorophyll a	FallWinterSpring	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	3
Williamson; UKL	Williamson R.	0 to 9.4	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	2
Williamson; UKL	Williamson R.	0 to 94.6	Dissolved Oxygen	January 1 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Resident trout spawning	5
Williamson; UKL	Williamson R.	0 to 12.5	E. Coli	Summer	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
Williamson; UKL	Williamson R.	0 to 12.5	E. Coli	FallWinterSpring	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	Water contact recreation	2
Williamson; UKL	Williamson R.	0 to 12.5	Fecal Coliform	Summer	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining
Williamson; UKL	Williamson R.	0 to 12.5	Fecal Coliform	FallWinterSpring	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	Water contact recreation	Attaining

Watershed (USGS 4th Field Name)	Water Body (Stream/Lake)	River Miles	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Williamson; UKL	Williamson R.	0 to 12.5	Flow Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Williamson; UKL	Williamson R.	0 to 12.5	Habitat Modification	Undefined	Creation of foul tastes, odors, or toxins.[1]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	4B
Williamson; UKL	Williamson R.	0 to 94.6	Iron	Year Around	Table 20 Toxic Substances	Aquatic life; Human health	3
Williamson; UKL	Williamson R.	0 to 94.6	Manganese	Year Around	Table 20 Toxic Substances	Human health	3
Williamson; UKL	Williamson R.	0 to 12.5	pH	FallWinterSpring	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	2
Williamson; UKL	Williamson R.	0 to 12.5	pH	Summer	pH 6.5 to 9.0	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	2
Williamson; UKL	Williamson R.	0 to 94.6	Phosphate Phosphorus	Summer	Total phosphates as phosphorus [4]	Aquatic life	3B
Williamson; UKL	Williamson R.	0 to 12.5	Sedimentation	Undefined	Bottom Deposits [2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Williamson; UKL	Williamson R.	0 to 12.5	Temperature	Summer	Rearing: 17.8 C	Anadromous fish passage; Salmonid fish rearing	4A

[1]The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed.

[2]The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed.

[3]30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml

[4]Total phosphates as phosphorus (P): Benchmark 50 ug/L in streams to control excessive aquatic growths

[5]Biocriteria: Waters of the state must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

[6]The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation or industry may not be allowed.

Table A11. Oregon Department of Environmental Quality (ODEQ) list of impaired lakes and reservoirs in the Upper Klamath Basin.

Water Body (Stream/Lake)	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Keene Creek / Hyatt Reservoir	Aquatic Weeds Or Algae	Undefined	Fungi or algae development[1]	Aesthetics; Drinking water; Fishing; Livestock watering; Water contact recreation; Water supply	5
Keene Creek / Hyatt Reservoir	Nutrients	Undefined		Aesthetics	3
Klamath River / Agency Lake	Dissolved Oxygen	Summer	Cool water: Not less than 6.5 mg/l	Resident fish and aquatic life; Salmonid fish rearing	4
Klamath River / Agency Lake	Chlorophyll a	Summer	Thermally stratified lake: 0.01 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	4
Klamath River / Agency Lake	Sedimentation	Undefined	Bottom deposits[2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Klamath River / Agency Lake	Nutrients	Undefined		Aesthetics	3
Klamath River / Agency Lake	Aquatic Weeds Or Algae	Undefined	Fungi or algae development[1]	Aesthetics; Drinking water; Fishing; Livestock watering; Water contact recreation; Water supply	4
Klamath River / Agency Lake	pH	Summer	pH 6.5 to 8.5	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	4
Klamath River / Ewauna, Lake	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	5
Klamath River / Ewauna, Lake	Ammonia	Year Around	Table 20 Toxic Substances		5
Klamath River / Ewauna, Lake	pH	Summer	pH 6.0 to 8.5		5
Klamath River / Ewauna, Lake	pH	FallWinterSpring	pH 6.0 to 8.5		5
Klamath River / Ewauna, Lake	Phosphate Phosphorus	Summer	Total phosphates as phosphorus (P): Benchmark 50 ug/L in streams to control excessive aquatic growths	Aquatic life	3B
Klamath River / J.C. Boyle Reservoir	pH	Summer	pH 6.0 to 8.5	Resident fish and aquatic life; Water contact recreation	3
Klamath River / J.C. Boyle Reservoir	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Fishing; Aesthetics; Livestock watering; Water contact recreation; Water supply	3
Klamath River / J.C. Boyle Reservoir	Nutrients	Undefined		Aesthetics	3

Water Body (Stream/Lake)	Parameter	Season	Criteria	Beneficial Uses	Integrated Category
Klamath River / Upper Klamath Lake	Chlorophyll a	Summer	Thermally stratified lake: 0.01 mg/l	Aesthetics; Fishing; Livestock watering; Water contact recreation; Water supply	4
Klamath River / Upper Klamath Lake	Sedimentation	Undefined	Bottom deposits[2]	Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Klamath River / Upper Klamath Lake	pH	FallWinterSpring	pH 6.5 to 9.0		5
Klamath River / Upper Klamath Lake	Nutrients	Undefined		Aesthetics	3
Klamath River / Upper Klamath Lake	pH	Summer	pH 6.5 to 8.5	Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning; Water contact recreation	4
Klamath River / Upper Klamath Lake	Dissolved Oxygen	Summer	Cool water: Not less than 6.5 mg/l	Resident fish and aquatic life; Salmonid fish rearing	4
Klamath River / Upper Klamath Lake	Aquatic Weeds Or Algae	Undefined	Fungi or algae development[1]	Aesthetics; Drinking water; Fishing; Livestock watering; Water contact recreation; Water supply	4
Klamath River / Upper Klamath Lake	Temperature	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Obenchain Reservoir	Aquatic Weeds Or Algae	Undefined	Fungi or algae development[1]	Aesthetics; Fishing; Water contact recreation	3
Obenchain Reservoir	Dissolved Oxygen	Undefined		Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing; Salmonid fish spawning	3
Obenchain Reservoir	Nutrients	Undefined		Aesthetics	3

[1]The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation or industry may not be allowed.

[2]The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed.

APPENDIX B: CALIFORNIA LIST OF IMPAIRED WATERBODIES

Table B12. California 303(d) list for the portion of the Klamath River from the Oregon border downstream to Scott River, USEPA approved 2012. Table modified from California Integrated Report online combined 303(d) list http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml.

WATER BODY NAME	POLLUTANT	POLLUTANT CATEGORY	INTEGRATED REPORT CATEGORY	POTENTIAL SOURCES	SOURCE CATEGORY
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Aluminum	Metals/ Metalloids	5	Source Unknown	Source Unknown
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Agriculture	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Agriculture	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Agriculture	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Agriculture	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Habitat Modification	Habitat Modification
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Drainage/Filling Of Wetlands	Habitat Modification
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Drainage/Filling Of Wetlands	Habitat Modification
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Drainage/Filling Of Wetlands	Habitat Modification
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Removal of Riparian Vegetation	Habitat Modification
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Flow Alteration/Regulation/ Modification	Hydromodification
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Logging Road Construction/ Maintenance	Silviculture

WATER BODY NAME	POLLUTANT	POLLUTANT CATEGORY	INTEGRATED REPORT CATEGORY	POTENTIAL SOURCES	SOURCE CATEGORY
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Silviculture	Silviculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Nutrients	Nutrients	5	Silviculture	Silviculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	5	Silviculture	Silviculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Iron Gate Dam to Scott River	Temperature, water	Miscellaneous	5	Silviculture	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Other	Source Unknown
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Agriculture	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Agriculture	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Agriculture	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Grazing-Related Sources	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Irrigated Crop Production	Agriculture
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Road Construction	Construction/ Land Development
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Drainage/Filling Of Wetlands	Habitat Modification
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Drainage/Filling Of Wetlands	Habitat Modification
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Drainage/Filling Of Wetlands	Habitat Modification
Klamath River HU, Middle HA,	Temperature, water	Miscellaneous	4a	Removal of Riparian	Habitat Modification

WATER BODY NAME	POLLUTANT	POLLUTANT CATEGORY	INTEGRATED REPORT CATEGORY	POTENTIAL SOURCES	SOURCE CATEGORY
Oregon to Iron Gate[3]				Vegetation	
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Flow Alteration/Regulation/ Modification	Hydromodification
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Sediment Resuspension (clean sediment)	Sediment
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate[4]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	4a	Silviculture	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Silviculture	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate[1]	Organic Enrichment/Low Dissolved Oxygen	Nutrients	4a	Silviculture	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Logging Road Construction/ Maintenance	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate[3]	Temperature, water	Miscellaneous	4a	Silviculture	Silviculture
Klamath River HU, Middle HA, Oregon to Iron Gate	Nutrients	Nutrients	4a	Nonpoint Source	Unspecified Nonpoint Source

[1]This listing only applies to the portion of the mainstem Klamath River that lies within the Klamath River HU, Middle HA, Iron Gate Dam to Scott River water body.

[2]This listing applies to the mainstem Klamath River in the Klamath River Hydrologic Unit, Middle Klamath River Hydrologic Area, Iron Gate Dam to Scott River reach.

[3]The Klamath River HU, Middle HA, Oregon to Iron Gate Dam includes the following Hydrologic Sub Areas (HSAs): Iron Gate HSA 115.37 and Copco HSA 105.38.

[4]This listing applies to the mainstem Klamath River in the Klamath River Hydrologic Unit, Middle Klamath River Hydrologic Area, Oregon to Iron Gate reach, excluding the riverine reach from the Oregon border downstream to the beginning of Copco 1 Reservoir.

WATER BODY NAME	POLLUTANT	POLLUTANT CATEGORY	INTEGRATED REPORT CATEGORY	POTENTIAL SOURCES	SOURCE CATEGORY
Copco Lake[1]	Mercury	Metals/ Metalloids	5	Source Unknown	Source Unknown
Copco Lake[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Agriculture	Agriculture
Copco Lake[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Grazing-Related Sources	Agriculture
Copco Lake[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Road Construction	Construction/ Land Development
Copco Lake[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Drainage/Filling Of Wetlands	Habitat Modification
Copco Lake[2]	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Silviculture	Silviculture
Iron Gate Reservoir	Mercury	Metals/ Metalloids	5	Source Unknown	Source Unknown
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Agriculture	Agriculture
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Grazing-Related Sources	Agriculture
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Irrigated Crop Production	Agriculture
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Road Construction	Construction/ Land Development
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Drainage/Filling Of Wetlands	Habitat Modification
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Logging Road Construction/ Maintenance	Silviculture
Iron Gate Reservoir	Cyanobacteria hepatotoxic microcystins	Miscellaneous	5	Silviculture	Silviculture
Klamath River HU, Tule Lake and Lower Klamath Lake National Wildlife Refuge	pH (high)	Miscellaneous	4a	Internal Nutrient Cycling (primarily lakes)	Natural Sources
Klamath River HU, Tule Lake and Lower Klamath Lake National Wildlife Refuge	pH (high)	Miscellaneous	4a	Nonpoint Source	Unspecified Nonpoint Source

[1]This listing applies to Copco 1 Reservoir.

[2]This listing applies to the Copco 1 and Copco 2 Reservoirs.