Klamath River Hydroelectric Project

Interim Measures Implementation Committee:

Interim Measure 11

Development of a Priority List of Projects:

Phase 2 Final Report

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1 Introduction

The Klamath Hydroelectric Settlement Agreement (KHSA; as amended on November 30, 2016) includes Interim Measure 11 (Interim Water Quality Improvements), which is intended to address water quality improvements in the Klamath River during the Interim Period[1] leading up to potential dam removal by the designated Dam Removal Entity[2] (DRE). Regarding Interim Measure (IM) 11, the KHSA states "The emphasis of this measure shall be nutrient reduction projects in the watershed to provide water quality improvements in the mainstem Klamath River, while also addressing water quality, algal and public health issues in Project reservoirs and dissolved oxygen in J.C. Boyle Reservoir." Interim Measure 11 calls for PacifiCorp to fund such projects in consultation with the Interim Measures Implementation Committee[3] (IMIC).

The original KHSA (executed on February 18, 2010) envisioned implementation of IM 11 and the Priority List of Projects (PLP) to occur during the Interim Period. With the passage of time since the original KHSA and subsequent amendments to the KHSA (dated November 30, 2016), the goal of the PLP is further clarified to provide long-term water quality improvement projects for the Klamath River. These long-term projects would commence with the DRE's acceptance of the FERC surrender order and could extend beyond the Interim Period.

One of the IM 11 activities during the 2016-2017 period includes the *Development of a Priority List of Projects*. The purpose of this effort is to develop a PLP to be implemented after the DRE's acceptance of a surrender order from the Federal Energy Regulatory Commission (FERC; per the KHSA). Following the DRE's acceptance of the FERC surrender order, PacifiCorp shall provide funding of up to $5.4 million for implementation of projects (as directed by the PLP), and an additional amount of up to $560,000 per year to cover project operation and maintenance expenses related to those projects.[4] The PLP is being informed by, among other things, the information gained from the specific studies conducted to-date under IM 11 and expert input from IMIC members. The KHSA further stipulates that prior to implementation of projects, the PLP will be approved by the Oregon Department of Environmental Quality (ODEQ), the North Coast Regional Water Quality Control Board (Regional Water Board), and the State Water Resources Control Board (State Water Board).

The development and implementation of the PLP is being accomplished in four phases:

- Phase 1: Define the PLP selection process. Identify project categories that are candidates for the PLP and rank the project categories for further detailed assessment in Phase 2. Phase 1 activities were completed in April 2017, and results of Phase 1 activities are described in CH2M (2017).
- Phase 2: Identify and determine the specific PLP. Determine the approach to allocation of funding amounts for the PLP. Define the conceptual governance structure and process anticipated to be necessary to implement the PLP. Per IM 11, obtain final approval of the PLP from ODEQ, the Regional Water Board, and the State Water Board. This report describes the results of Phase 2 activities.
- Phase 3: Fully develop the governance process, select a Fiscal Agent, and begin development of a process to allow for project implementation. Phase 3 activities are expected to begin in 2018 pending approval of the final PLP in Phase 2.

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[1] The KHSA defines the Interim Period as the period between the Effective Date and Decommissioning. The Effective Date is the date that the KHSA was originally executed (February 18, 2010). Decommissioning is PacifiCorp's physical removal from a facility of any equipment and personal property that PacifiCorp determines has salvage value, and physical disconnection of the facility from PacifiCorp's transmission grid.

[2] The DRE is the Klamath River Renewal Corporation (KRRC), which will be the entity responsible for Facilities Removal under the KHSA.

[3] The IMIC is comprised of representatives from PacifiCorp, other parties to the KHSA (as amended on November 30, 2016), and representatives from the State Water Board and Regional Water Board (though not signatories to the KHSA) through Appendix B, Section 3.2 of the KHSA. The purpose of the IMIC is to collaborate with PacifiCorp on ecological and other issues related to the implementation of the Non-Interim Conservation Plan Interim Measures set forth in Appendix D of the amended KHSA.

[4] These amounts are subject to adjustment for inflation as set forth in Section 6.1.5 of the KHSA.

- Phase 4: Implement governance process and develop project selection process for the PLP. Per the KHSA, funding and implementation of these projects will occur following the DRE's acceptance of the FERC surrender order.

As noted above, Phase 1 activities are described in CH2M (2017), while Phase 2 activities are described in this report. Therefore, the Phase 1 report (CH2M 2017) and this Phase 2 report are companion documents. This Phase 2 report is written assuming that the reader is familiar with the contents of the Phase 1 report (CH2M 2017).

As documented in following sections of this Phase 2 report, PacifiCorp coordinated and facilitated a process with the IMIC, that: (1) obtained additional information on the top-ranked PLP categories; (2) conducted a Phase-2 specific PLP workshop (in Yreka, California on September 19, 2017); (3) finalized the PLP; (4) defined the conceptual governance process anticipated to implement the PLP; and (5) prepared the PLP package for approval by ODEQ, Regional Water Board, and State Water Board.

2 Approach to Final PLP Determination

2.1 Refinement of the PLP Categories Matrix

Within this report, the term "projects" is used as a general term applicable to various water quality improvement projects, technologies, or activities that have been (or are being) considered for implementation in the Klamath Basin. The term "project categories" is used to refer to groupings or types of projects. As determined in Phase 1, the candidates for the PLP are comprised of project categories, since in most cases specific projects are not yet of known scope or location (CH2M 2017). Twelve candidate project categories were assessed and evaluated in Phase 1, and four top-ranked project categories were ultimately selected from which the final PLP could be developed during Phase 2 (CH2M 2017, and as described further below). The four top-ranked project categories, in no particular order, include: Natural Wetlands Restoration; Diffuse Source Treatment Wetlands (DSTWs); Riparian Fencing and Grazing Management; and Irrigation Efficiency and Water Management. The IMIC concluded that each of the top-ranked project categories can provide water quality improvements to the Klamath Basin, and as such considers each top-ranked project category equally important. The IMIC also concluded that PLP implementation should prioritize projects in the Klamath Basin area upstream of Upper Klamath Lake. This decision was made because the Klamath Basin's nutrient loadings originate from, and are highest, in this area (Oliver et al. 2014; Walker et al. 2012, 2014). As a result, the IMIC assumed that PLP activities in that area will yield greatest proportional nutrient reductions.

To facilitate the assessment, evaluation, and determination of the PLP categories during Phase 1, PacifiCorp compiled a matrix of the 12 candidate project categories (CH2M 2017). The matrix provided a basis for the IMIC to assess and score the various candidate project categories and to ultimately select the four top-ranked project categories to be used in development of the final PLP in Phase 2.

During Phase 2, additional information was gathered on the four top-ranked project categories to allow more precise differentiation between the top-ranked project categories and to guide final PLP development. The additional specific information developed and assessed in Phase 2 included:

- Nutrient-removal efficiency information or metrics to allow additional comparisons of effectiveness of project categories
- Targeting of priority projects by geographical area or location
- More information on who-is-doing-what in the upper basin to consider where project categories may cumulatively benefit ongoing water quality work
- Refined costing information to better inform allocation of funds between project categories

The refined attached matrix of the four top-ranked project categories is contained in Appendix A.

2.2 PLP Workshop and Follow-Up Discussions

During Phase 2, PacifiCorp facilitated a workshop with IMIC participants to discuss and select the final specific PLP. The PLP Phase 2 workshop was held in Yreka, California on January 19, 2017 with workshop participants representing ODEQ, the Regional Water Board, the State Water Board, Karuk Tribe, The Klamath Tribes, Yurok Tribe, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), Oregon Department of Fish and Wildlife (ODFW), and PacifiCorp. The specific PLP was determined using both the Phase 1 results (CH2M 2017) and the additional data and information gathered as part of Phase 2 (Section 2.1; Appendix A). During the workshop, participants reviewed the additional information on top-ranked project categories. Participants then determined the final PLP and discussed the approach to recommended allocation of funding of $5.4 million for implementation of projects as stipulated in the KHSA.

At the workshop, and in follow-up meetings, participants discussed the process and governance needs anticipated to be necessary to implement the PLP. The process and governance considerations included discussions of: (1) final authorization and contracting of priority projects; (2) funding amounts for different priority projects; (3) use of a Fiscal Agent for contracting of work and payment of funds; and (4) responsibilities for oversight of project implementation, progress, and outcomes.

2.3 Development of PLP Package for Final Approval

The contents of this report have been developed by the IMIC in collaboration with PacifiCorp and reflect the result of a consensus-based decision-making process. As the reader will see, this report presents documentation on the PLP development process (including the rationale) and presents the final PLP. At the workshop, and in subsequent meetings, participants from ODEQ, the Regional Water Board, and the State Water Board discussed their expectations for materials needed to support their final approval of the PLP (as required per IM 11). This report provides the materials necessary for consideration by the ODEQ, the Regional Water Board, and the State Water Board in issuing final approval of the PLP to PacifiCorp.

3 Recommended Priority and Funding of PLP Categories

3.1 Priority of PLP Categories

Based on discussion among participants at the Phase 2 PLP workshop (held on September 19, 2017 in Yreka), it was decided that the four final PLP categories would not be ranked or prioritized relative to each other. In other words, each category would be treated with equal importance and priority relative to subsequent implementation and funding. The rationale for this decision was basically two-fold.

First, participants at the Phase 2 PLP workshop reviewed the original rankings of PLP categories made during the Phase 1 PLP workshop (held on February 22, 2017 in Yreka) and verified that the four final PLP categories were essentially equally-ranked in level-of-importance relative to the technical objectives of the PLP. As described in CH2M (2017), the Phase 1 PLP workshop participants assessed and scored 12 candidate project categories relative to 11 clearly-stated objectives. These objectives included:

- Four performance objectives addressing estimated magnitude of benefits, sustainability of project benefits, certainty of success, and potential negative environmental impacts
- Five operability objectives addressing estimated timeliness to achieve function, ease of implementation, ease of permitting, ease of operation and maintenance, and associated safety risk

- Two economics (or cost) objectives addressing estimated capital costs relative to performance, and operations and maintenance (O&M) costs relative to performance

The scores generated by Phase 1 PLP workshop participants were averaged to generate a rank order of the candidate project categories (CH2M 2017). The scores and resultant rank order indicated that the four final PLP categories comprised a definite top-ranked grouping of project categories in comparison to the other eight candidate categories (Table 1). In addition, the four project categories were consistently ranked relatively highly by all Phase 1 PLP workshop participants (CH2M 2017).

Based on review and discussion of the Phase 1 results at the Phase 2 PLP workshop, the workshop participants decided that the additional information in the refined matrix (Appendix A) combined with their further understanding of the top-ranked project categories did not warrant any changes or adjustments to the original scoring of the four top-ranked PLP categories. Furthermore, given that less than one point separated all four project categories within this grouping (Table 1), the categories were considered comparable in terms of relative ranking for PLP consideration.

Table 1. Verified Scores and Rankings of Project Categories

Project Categories	Average Score	High Score Across Participants[1]	Low Score Across Participants[2]	Rank by Average Score
Diffuse Source Treatment Wetlands (DSTWs)	4.9	5	4	1
Riparian Fencing and Grazing Management	4.8	5	4	2
Irrigation Efficiency and Water Management Projects	4.3	5	3	3
Natural Wetlands Restoration	4.0	5	2	4
All other 8 categories assess in Phase 1	1.1 to 2.2	2 to 4	1	5 to 12

1: Highest total score for that project category amongst the individual organizations that scored the project.

2: Lowest total score for that project category amongst the individual organizations that scored the project.

Second, participants at the Phase 2 PLP workshop determined that the four PLP categories could work together across the landscape to cumulatively achieve water quality benefits (Figure 1). The cumulative reductions can be thought of as geographically distributed or serial, where features from the various project categories each contribute to improvements in water quality. For example:

- A set of geographically-distributed actions (i.e., across the gradient from upland to confluence) could include: DSTWs implemented in upland areas or along smaller drainages higher in watersheds; riparian management at various locations along stream and river corridors further downslope; and natural wetland restoration at downstream confluence or delta locations.
- A set of actions in series (i.e., linked actions in the same general area), such as: irrigation efficiency and water management to reduce agricultural tailwater runoff; followed by a DSTW and/or riparian exclusion area to treat the residual tailwater runoff discharging to a drainage; and then a restored natural wetland to provide additional filtering of the flow where it meets a lake or river.

On the basis of this conceptual model, Phase 2 PLP workshop participants agreed that the four final PLP categories should each be equally emphasized and implemented in aggregated programmatic-like manner to the extent possible.

3.2 Recommended Funding of PLP Categories

Based on the decision at the Phase 2 PLP workshop to treat the final four PLP categories with equal priority, it was further decided that the four PLP categories would be treated equally relative to allocation of funding. As such, it was recommended that each of the four PLP categories would be initially allocated an equal percentage-share of the $5.4 million for implementation of projects (Table 2). These shares of the overall fund are funding targets only because the volume of funding necessary under each of the categories is unclear and flexibility in allocation between categories may be necessary. In addition, the Phase 2 PLP workshop recommended that an equal percentage-share of the overall fund be held as a “Flex Fund”, which could be applied to any (or all) of the four project categories as the need arises. This combination of funding targets and a Flex Fund allows flexibility for allocation of funds between categories should more or less money be needed in a particular category to achieve the highest water quality benefits.

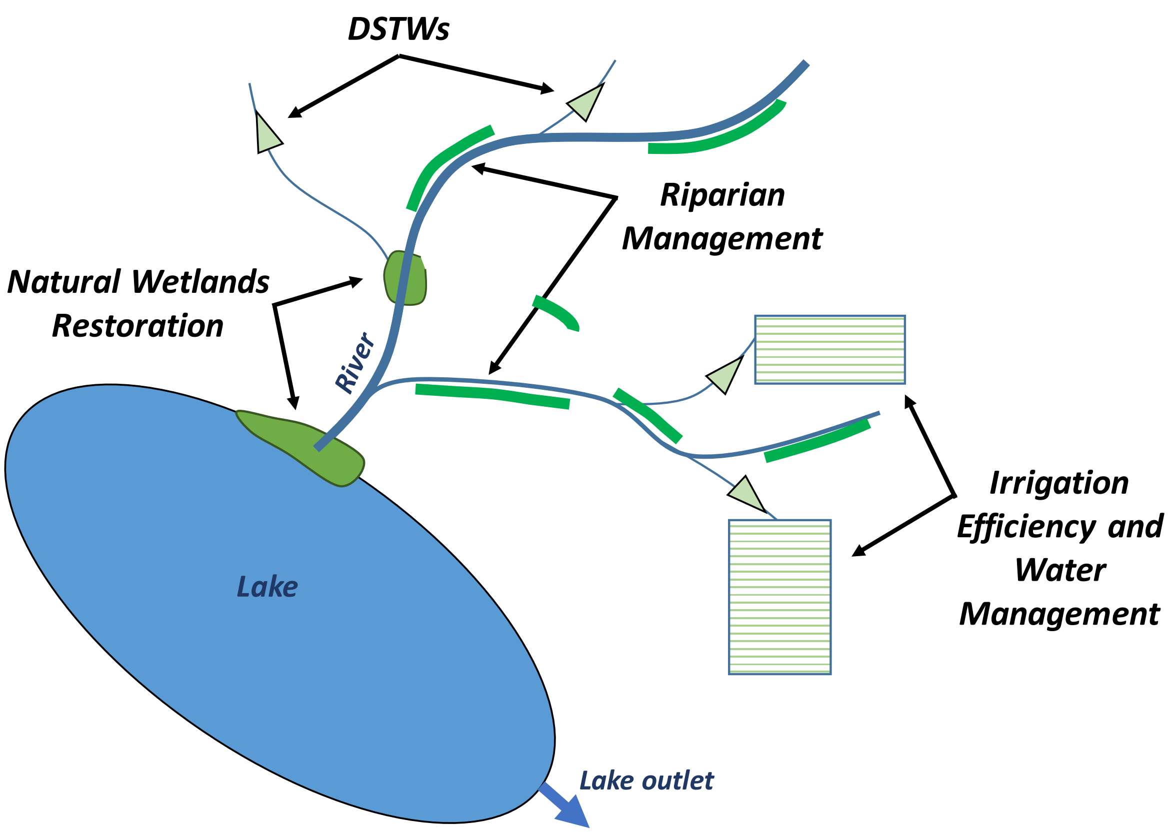

Figure 1. Implementation of all four PLP categories will provide actions distributed across the landscape.

Table 2. Recommended Funding of Project Categories

Project Category	Funding Target
Natural Wetlands Restoration	20 %
Diffuse Source Treatment Wetlands	20 %
Riparian Fencing and Grazing Management	20 %
Irrigation Efficiency and Water Management Projects	20 %
Flex Fund	20 %

4 Final PLP Categories

The four project categories chosen as the final PLP during Phase 2 include: Natural Wetlands Restoration; Diffuse Source Treatment Wetlands (DSTWs); Riparian Fencing and Grazing Management; and Irrigation Efficiency and Water Management. The following sections provide detailed descriptions of the features and attributes of each project category.

4.1 Natural Wetlands Restoration

In general, "natural wetlands" as referred to in this report are the freshwater wetlands and marshes that occur naturally in the Upper Klamath Basin (Figure 2). Akins (1970) refers to three types of naturally-occurring wetlands in the Upper Klamath Basin: (1) "fresh meadows-wetland type" in river valley flats, such as occupied by the Klamath and Sycan marshes; (2) "shallow-fresh marsh type" in regularly-flooded river valley flats, such as occurs in much of Lower Klamath Lake and the shallow margins of Upper Klamath Lake; and (3) "deep-fresh marsh type" that includes the standing water areas of Tule Lake, Lower Klamath Lake, and the bays of Upper Klamath Lake.

Figure 2. Example of Upper Klamath basin natural shallow-fresh marsh-type wetlands. (Source: Oregon Wild).

Wetland restoration refers to the reestablishment and rehabilitation of wetland processes and functions. Wetlands serve many important functions in the landscape, including (but not limited to) flood control, groundwater recharge, nutrient sequestration and transformation, and habitat for numerous species of fish and wildlife. In the Klamath Basin, approximately 80 percent of natural wetlands have been lost to various land uses and development, and increasing the extent of wetlands in the Klamath Basin is a recommended strategy for improving water quality (Stillwater et al. 2013; CH2M Hill 2012). For example, the Independent Multidisciplinary Science Team (IMST) indicated that wetlands surrounding Upper Klamath Lake and Agency Lake have declined from an historic level of 51,150 acres of wetlands to a current level of 17,370 acres as a result of dike construction and marsh drainage (IMST 2003). The IMST (2003) indicated that historic wetlands surrounding Upper Klamath Lake were important filters that modified the form, amounts, and timing of nutrients delivered into the lake from the surrounding watershed, and the loss of these wetlands is a major reason for more nutrients entering the lake. Indeed, wetlands have the potential to effectively remove a wide range of point and non-point source pollutants from incoming water (Kadlec and Wallace 2009; CH2M Hill 2012; Stillwater et al. 2013), including: nutrients such as nitrogen and phosphorus; total suspended solids; bacteria and pathogens; metals; and trace organic compounds such as pesticides and herbicides.

For purposes of PLP development and implementation, the key goal of the natural wetlands restoration category is to improve water quality in Upper Klamath Lake, Agency Lake, Keno reservoir, Klamath Straits Drain, and ultimately the Klamath River. This would be accomplished by allowing wetland ecosystem processes to remove nutrients from surface waters (Wong et al. 2011; CH2M Hill 2012; Stillwater et al. 2013; Sullivan et al. 2014). One particularly effective wetland restoration technique is to reconnect delta areas with Upper Klamath Lake, Agency Lake, Keno reservoir, and Klamath Straits Drain. These reconnections would restore wetland areas and improve water quality by reducing the amount of externally generated phosphorus and nitrogen to reach Upper Klamath Lake, Agency Lake, Keno reservoir, Klamath Straits Drain, and ultimately the Klamath River. Wetlands restoration could also provide habitat for the endangered shortnose and Lost River suckers if located in Upper Klamath Lake.

There are several examples of natural wetlands rehabilitation projects in the Upper Klamath Basin aimed at improving water resources, wildlife habitat, and water quality (Stillwater et al. 2013). Examples include: Sycan Marsh, Williamson River Delta, Upper Klamath Marsh National Wildlife Refuge, Wood River Wetlands, Upper Klamath Lake National Wildlife Refuge, Barnes and Agency Lake ranches, Circle 5 Ranch, Ridgeway Project, Lower Klamath Lake National Wildlife Refuge, Tule Lake National Wildlife Refuge, and Miller Island Wildlife Refuge (Stillwater et al. 2013).

A prominent example of wetland restoration is the 7,500-acre Williamson River Delta project (Delta), which straddles the last 4 miles of the Williamson River before it discharges into Upper Klamath Lake. This Delta was once a vast expanse of natural shallow- and deep-freshwater marsh habitat that formed where the Williamson River entered Upper Klamath Lake (Figure 3). In the mid-20th Century, the Delta was separated from the river and lake by levees, drained, and converted to agricultural production. The Nature Conservancy (TNC) initiated the restoration by breaching levees on the perimeter of the Delta west of the Williamson River (known as Tulana) in 2007 and on the perimeter of the Delta east of the river (known as Goose Bay) in 2008 (Wong and Hendrixson 2011). Approximately 5,500 acres were re-flooded, restoring the wetlands as an open and passively managed system.

Figure 3. Williamson River Delta (Source: The Nature Conservancy)

Wetlands remove nutrients from surface waters through natural wetland ecosystem processes (Aldous et al. 2005; Wong et al. 2011; Wong and Hendrixson 2011). The capacity of natural wetlands to reduce nutrient loads can be uncertain (Fisher and Acreman 2004). Whether wetlands are a source or sink for nutrients depends on hydrologic and geomorphic conditions, seasonal patterns of uptake and release, and ecosystem succession (Mitsch and Gosselink 2000; Kadlec and Wallace 2009). However, properly-designed wetlands should be expected to provide a net reduction in nutrient export to the lakes and river. Constructed treatment wetlands have been shown to be effective at removing a range of pollutants from incoming waters, including total suspended solids, phosphorus, nitrogen, metals, organic compounds, and bacteria and pathogens (Kadlec and Wallace 2009; CH2M Hill 2012; Stillwater et al. 2013; Sullivan et al. 2014).

The Nature Conservancy has conducted post-restoration water quality monitoring in the Delta to determine the extent to which the restored wetlands provide a source or sink of nutrients, and to assess the effects of the restoration on surface water chemistry in the wetlands and adjacent lakes. Sampling in the Delta by Wong et al. (2011) revealed that the wetlands released phosphorus upon flooding. Initially, actual phosphorus concentrations in the wetlands were up to six times greater than at adjacent Upper Klamath Lake and Agency Lake sampling sites. However, after three additional years (2008, 2009, and 2010) of post-restoration effectiveness water quality monitoring in the Delta, Wong and Hendrixson (2011) concluded that the increase in phosphorus concentrations that occurred with the initial flood restoration of the Delta had substantially diminished. For example, phosphorus concentrations at wetlands sampling sites ranged up to about 0.7 milligrams of phosphorus per liter (mg P/L) in 2007 and 2008, and ranged up to about 0.4 mg P/L in 2009 and 2010. The data in Wong and Hendrixson (2011) also show that phosphorus concentrations at wetlands sampling sites in 2009 and 2010 were more like adjacent lake sampling sites than in 2007 and 2008, indicating that that the wetlands were continuing to transition toward a nutrient condition more in equilibrium with the surrounding lake. Wong and Hendrixson (2011) concluded that quantifying an accurate post-restoration nutrient load from the wetlands as a whole can be difficult because of the hydrologic connectivity and spatial complexity of the wetlands. Their conclusion underscores the importance of carefully-designed and robust monitoring for future projects in this PLP category.

A prominent example of wetland management has occurred at the Lower Klamath National Wildlife Refuge (NWR). Mayer (2005) conducted a study to evaluate water use and the impacts of refuge wetland management on nitrogen and phosphorus concentrations and loads as water enters and leaves different wetland habitats on the refuge. Mayer (2005) determined that outflow nutrient concentrations of nitrogen and phosphorus generally increased relative to inflow concentrations, but nutrient loads were reduced. From

55 to 77 percent of the mass of nitrogen, and 19 to 51 percent of the mass of phosphorus entering the refuge wetlands was retained. Seasonal wetlands retained less phosphorus than permanent wetlands, possibly because of the annual drying cycle, and predominance of annual vegetation. For all refuge wetlands, dissolved inorganic nitrogen was retained more efficiently than particulate nitrogen, and particulate phosphorus was retained more efficiently than dissolved or soluble phosphorus. Mayer (2005) concluded that the ultimate effect of refuge wetland management was to decrease net nitrogen and phosphorus loads but increase the proportion of bioavailable phosphorus in the refuge outflow.

Wetland management and restoration activities to improve water quality have also recently occurred at Sycan Marsh (Wong and Bienz 2011). The flow regime and vegetation within Sycan Marsh and along its inlet streams were affected by irrigation system development and agricultural use beginning in the early 20th Century (Wong and Bienz 2011). In 1980, 1999, and 2001, TNC acquired tracts totaling 30,539 acres at Sycan Marsh to establish a preserve to enhance the ecological health of the marsh. In 2005, TNC initiated a strategic interagency watershed restoration program in the marsh and surrounding watershed to enhance the marsh's natural hydrologic patterns and processes (Wong and Bienz 2011). Water quality monitoring at Sycan Marsh has shown both an increase in nutrient loading shortly after restoration actions (Aldous 2009) and a subsequent longer-term reduction in nutrient loading (Wong and Beinz 2011).

Starting in 1995, The U.S. Bureau of Land Management (BLM) implemented a management plan for the 3,200-acre Wood River Wetland area that included cessation of grazing and implementation of seasonal flooding and water management aimed at improving water quality, increasing water availability, and providing wildlife and fish habitat (Carpenter et al. 2009). Results of a study in 2003-2005 indicated that nitrogen and phosphorus levels, primarily as dissolved organic nitrogen, ammonium, soluble phosphorus, and dissolved organic carbon were high in wetland surface waters but nitrate levels were moderate to low in wetland surface waters. Surface-water concentrations of ammonium and soluble phosphorus increased in spring and summer to very high values by the end of summer because of evaporative concentration. Experiments indicated that some of these nutrients were coming from wetland sediments, or upwelling groundwater.

Carpenter et al. (2009) developed a water budget for the Wood River Wetland over 2 water years (2004 and 2005). This work indicated that outflows exceeded inflows by about 22 percent over the 2-year period. Since 2006, BLM has implemented a carefully managed water regime within the Wood River Wetland to optimize vegetation establishment, water storage and discharge, quality of water discharged, and accumulation of new organic soil (A. Hamilton, BLM, pers. comm.). In addition, artesian wells with high nutrient concentrations in the area were decommissioned in 2008. During 2007-2011, BLM conducted nutrient and water quality sampling at several sites in the Wood River Wetland, and the results indicate a trend of declining nutrient discharge concentration over this 5-year sampling period (A. Hamilton, BLM, pers. comm.). Substantial reductions in phosphorus concentrations, particularly compared to previous 2003-2005 values, suggest that the newer water management regime has helped to ameliorate the effects of evaporative concentration, which led to high nutrient concentrations (Carpenter et al. 2009) under prior conditions. During 2008-2011, BLM showed consistent year-to-year net retention of nutrients in the Wood River Wetland (A. Hamilton, BLM, pers. comm.).

These examples show that although wetlands have the potential to sequester and reduce nutrients and other pollutants, removal efficiency from wetland restoration can be highly variable depending on multiple factors, such as restoration design, underlying soils, and hydrological conditions (CH2M Hill 2012; Stillwater et al. 2013). This variability is important context for future selection, implementation, and monitoring of activities pursued in this PLP category.

Recently, Land et al. (2016) conducted a systematic review of research literature to assess how effective created or restored freshwater wetlands are for nutrient removal. Four wetland types were included in the review:

1. Riparian wetland, which are wetlands at the interface between land and a river or stream

2. Free water surface wetland having visible water flowing usually between 0.1 and 2 meters deep, with submerged, floating, or emergent wetland plants
3. Horizontal subsurface flow wetlands that are typically designed with a permeable filter material ("soil") planted with emergent wetland plants
4. Vertical flow wetlands, which are similarly constructed to horizontal subsurface flow wetlands, but water is applied on the surface of the filtering material, and percolates vertically downward

All the included wetlands were primarily created or restored specifically for nutrient removal, although a small number of them were multi-purpose wetlands. Of these types, the riparian and free water surface wetlands would likely best represent the larger fringe wetlands assumed in this PLP category.

The result of this review was that nutrient removal is remarkably similar for the four types of wetlands; the summary effects all differ significantly from zero and the averages are relatively close to each other with confidence levels showing a high degree of overlap (Land et al. 2016). Median removal efficiency for total nitrogen was approximately 37 percent, with a 95 percent confidence interval of 29–44 percent. Median removal efficiency for total phosphorus was approximately 46 percent with a 95 percent confidence interval of 37–55 percent. The removal rate of both total nitrogen and total phosphorus is highly dependent on the loading rate. Higher rates of removal are generally attained in individual wetlands in more optimal locations and that were specifically designed to achieve nutrient removal.

4.2 Diffuse Source Treatment Wetlands

Diffuse Source Treatment Wetlands (DSTWs) are small (1 to 10s of acres) wetlands usually located along creeks and canals and in low-lying areas in fields (Figure 4). Scattered throughout a watershed, these small wetlands have been shown to remove nutrients from irrigation ditches and stream networks (Stillwater et al. 2013; Bottcher and Kolden 2014; Creager 2015; Scott 2016). Diffuse Source Treatment Wetlands are designed to accommodate an estimated amount of stormwater or agricultural tail-water runoff from the landscape or, provide a particular hydraulic residence time given predicted runoff from adjacent agricultural land uses. Specific design elements such as natural low points in pastures and agricultural fields or areas directly adjacent to small drainage ditches allow DSTWs to function at relatively small scales (Bottcher and Kolden 2014; Scott 2016). Unlike larger-scale natural wetland restoration projects (Section 4.1), DSTWs typically occupy a smaller footprint of land and result in less permanent loss of land for other potential uses (Stillwater et al. 2013).

A network of DSTWs would decrease external loading of phosphorus and nitrogen to Upper Klamath and Agency lakes, or any other waterbody downstream of the DSTW, and may help decrease nuisance algal blooms in these waterbodies (Stillwater et al. 2013; Bottcher and Kolden 2014; Creager 2015; Scott 2016). The goals for DSTWs are generally the same as for other types of wetlands (Section 4.1), but the functionality occurs in relatively smaller pockets and has the advantage of providing onsite treatment and creating wildlife habitat. For DSTWs, the Wood River and Sprague River watersheds are identified as priority locations because of their relatively high contribution to Upper Klamath Lake's external nutrient loads and a perceived capacity for additional wetland rehabilitation (Stillwater et al. 2013; Bottcher and Kolden 2014; Creager 2015; Scott 2016).

Stillwater et al. (2013) used a generalized geographic information system (GIS) analysis to estimate that DSTWs, typically sized at 5-6 acres each, could theoretically represent a maximum potential cumulative area of 600 acres in the Wood River Valley. Stillwater et al. (2013) estimate that the majority of DSTW acreage (540 acres) would be mid-field systems scattered throughout the valley, with the remainder (60 acres) consisting of creek/canal-side DSTWs. For the valley as a whole, 31,500 acres or 98 percent of the existing land use would remain unchanged under this theoretical DSTW scenario (Stillwater et al. 2013).

Figure 4. This small wetland located in an agricultural field represents the look of a DSTW.

Stillwater et al. (2013) estimated that this maximum potential cumulative area of 600 acres of DSTWs would provide about a 5-20 percent cumulative annual reduction of phosphorus and 5-15 percent cumulative annual reduction of nitrogen for the Wood River Valley, depending on the relative amounts of flow-through and terminal DSTWs (see Figure 3.11 in Stillwater et al. 2013). The corresponding cumulative flow reduction from the adjacent waterways would be just over 3 percent, based on estimated evapotranspiration losses (see calculations in Appendix B in Stillwater et al. 2013).

As discussed in the previous section on Natural Wetlands Restoration, nutrient removal is quite similar across wetland types (Kadlec and Wallace 2009; Creager 2015; Land et al. 2016). Removal rates are highly dependent on the loading rate and wetland area. Higher rates of removal occur in wetlands in more optimal locations and that are specifically designed for nutrient removal.

There are two general types of DSTWs: (1) flow-through DSTWs; and (2) terminal DSTWs (Figure 5). Flow-through DSTWs rely on continuous flow for water treatment (Stillwater et al. 2013). Flow-through DSTWs have a designated outflow and can be located along waterways and in naturally low-lying depressions in pastures and agricultural fields. By installing overflow weirs in appropriate locations, flow from rivers, creeks, canals, and fields can be diverted into adjacent low-lying areas, treated, and returned to a waterway. As with larger treatment wetlands, the required wetland area is linked to the amount of time water spends in the wetland. This is called hydraulic residence time and is typically on the order of 2–5 days for these wetlands. The required area for individual flow-through DSTWs is determined using the relationship between wetland area, inlet flow volume, hydraulic residence time, and average water depth.

Terminal DSTWs are located in naturally low-lying depressions in pastures and agricultural fields and do not have a designated outflow (Stillwater et al. 2013). These wetlands are designed to mimic the natural variability in water depth and areal extent of wetlands dependent on runoff. For this type of application, DSTWs can be conceived of as vegetated detention or infiltration basins, with sizes and specific designs based on estimated runoff. The required wetland area is determined using annual rainfall, irrigation practices (if appropriate), parcel area, a runoff coefficient for the land cover, and annual evapotranspiration. The resulting wetland area tends to be on the order of 1 to 2 percent of the parcel area.

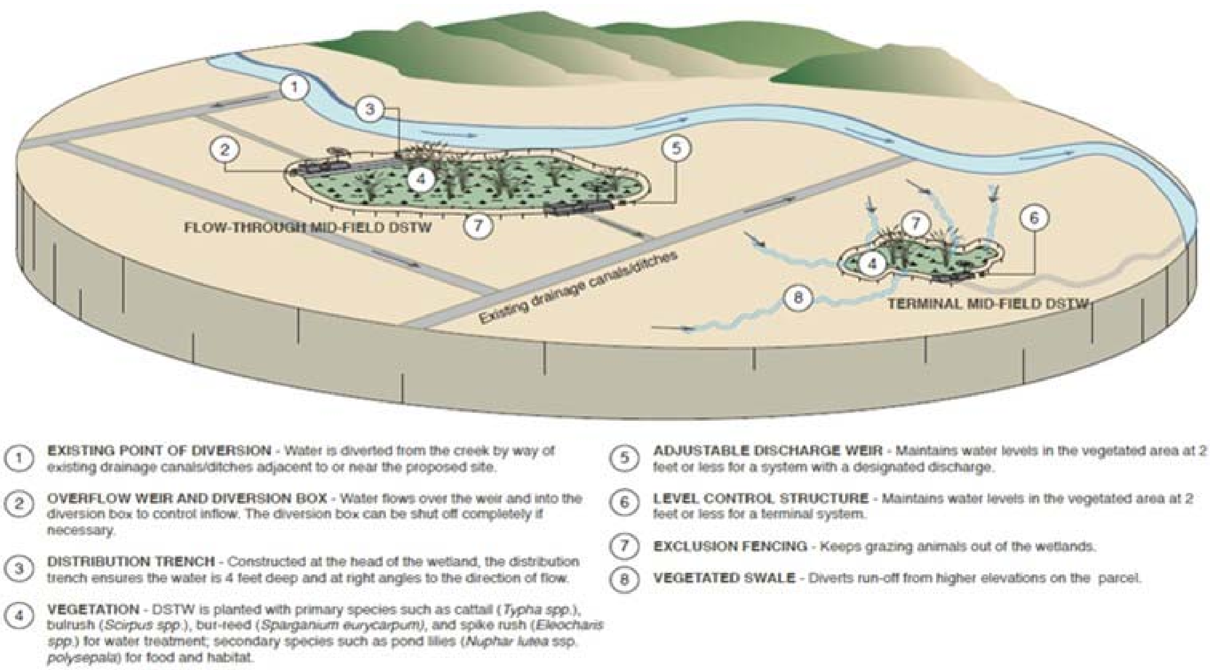

Figure 5. Conceptual diagram of flow-through and terminal DSTWs (Source: Stillwater et al. 2013).

4.3 Riparian Fencing and Grazing Management

Riparian areas are generally defined as ecosystems that occur around watercourses and water bodies (Dickard et al. 2015; George et al. 2011; Wyman et al. 2006). They occupy the transitional area between aquatic (water-based) systems and terrestrial (land-based) systems, and usually have characteristics of both. Common examples are areas adjacent to streams, rivers, and lakes (Figure 6).

The three main characteristics that define riparian area ecosystems are hydrology, soils, and vegetation (Dickard et al. 2015; George et al. 2011; Wyman et al. 2006). Protecting soil and streambanks from excess erosion is an important function of riparian plants. Thus, properly functioning riparian areas absorb the water, nutrients, and energy from runoff events, which substantially aids stream channel stability and helps maintain water quality and habitat diversity and integrity (Dickard et al. 2015; Swanson et al. 2015; Tufekcioglu et al. 2013; Van Horn et al. 2012).

Riparian plant communities are more productive and generally have higher quality forage than upland plant communities (Dickard et al. 2015; George et al. 2011; Wyman et al. 2006). In the Upper Klamath Basin, riparian areas represent a small portion of the landscape but are important sources of wildlife habitat and livestock forage (Stillwater et al. 2013; Upper Klamath Basin Comprehensive Agreement 2014). Riparian areas also provide important ecological functions such as flood control, groundwater storage, enhancements to water quality, and erosion control.

Figure 6. Example of well-established streamside riparian area.

In the Upper Klamath Basin, an important objective is to manage and restore riparian corridors along streams that flow into Upper Klamath Lake to reduce sediment loads (and sediment-bound nutrients) in the streams (Stillwater et al. 2013; Upper Klamath Basin Comprehensive Agreement 2014). The naturally eutrophic condition of Upper Klamath Lake is attributed to the natural sediment geology and soils of the Upper Klamath Basin (Walker 2001). Volcanic ash and pumice deposited throughout the Upper Klamath Basin from the eruption of Mount Mazama (which formed Crater Lake) some 6,800 years ago are rich in phosphorus (ODEQ 2002). In addition, progressive anthropogenic development and uses of the basin has led to further cultural eutrophication of Upper Klamath Lake (Eilers et al. 2001). Walker et al. (2015) closely correlated increases in sediment load with total phosphorus in the Upper Klamath Basin. As a result of these conditions, external phosphorus loading from the basin upstream of Upper Klamath Lake is a key driver of water quality throughout the system (ODEQ 2002, 2010). Reducing the sediment load from the basin associated with land use (i.e., sediment loads higher than background) is a priority identified in both the Upper Klamath Lake and Klamath River Total Maximum Daily Loads (TMDLs)[5] (ODEQ 2002, 2010) and Upper Klamath Basin Comprehensive Agreement (2014).

Riparian Fencing and Grazing Management actions can be very effective at managing sediment loads in surface runoff (George et al. 2011; Sarr 2002; Swanson et al. 2015; Wyman et al. 2006). Wenger (1999) states that "…riparian buffers should be viewed as an essential component of a comprehensive, performance-based approach to sediment reduction." Based on a review of scientific literature, riparian fencing and grazing management were the central focus of the Upper Klamath Basin Comprehensive Agreement (2014) and the Upper Klamath Basin Watershed Action Plan (Action Plan). The Action Plan is currently under development and will identify actions for water quality and fish habitat enhancements, one of which will be riparian fencing and grazing management. The Action Plan will identify locations for specific riparian fencing and grazing management actions in the Sprague River, Williamson River, and Wood River watersheds in the basin upstream of Upper Klamath Lake. The Action Plan is being developed by a team consisting of representatives from The Klamath Tribes, TNC, ODEQ, USFWS, Trout Unlimited, Klamath Watershed Partnership, and the

[5] A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act (CWA) describing a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. The ODEQ issued TMDLs and associated Water Quality Management Plans (WQMPs) for Upper Klamath Lake in 2002 and for the Klamath River in 2010.

Regional Water Board. The Action Plan could be used to inform project-specific activities under this PLP category.

Effective grazing management practices can prevent grazing-related impacts to streambanks, soil, and plants (George et al. 2011; Sarr 2002; Swanson et al. 2015; Wyman et al. 2006). Rotation or variation in timing of grazing prevents stress in the same season year after year so plants can successfully complete all phases of their annual life cycle. By actively managing livestock, grazing intensity can also ensure adequate leaf area for growth or regrowth before, during, or after grazing.

Fencing, when properly located, well-constructed, and maintained, can be an effective tool for management of riparian areas by: (1) excluding livestock from riparian areas; or (2) controlling the timing and duration of access to riparian grazing within existing pastures (Figure 7). The use of fencing to limit the access of livestock to waterways could eliminate or reduce possible grazing-related damage to streambanks and deposition of manure on the bank or directly in the water (Sarr 2002; Swanson et al. 2015; Wyman et al. 2006).

The width of the area of riparian vegetation is often called a buffer zone because it buffers the water from the potential effects from adjacent non-riparian land activities (Buffler et al. 2005; Diebel et al. 2008; Wenger 1999). As it relates to grazing activities, the buffer zone not only protects vegetation from being browsed by animals, it can also provide for collection of sediments from adjacent pastures before they run off into the waterway. While the specific distance that should separate adjacent non-riparian land activities from the water is still subject to debate, the size of a buffer should ultimately depend on several factors including land management objectives, landowner interest, soil type, slope steepness, and condition of the adjacent pasture.

Figure 7. Example of fencing to exclude riparian area from an adjacent grazing area along the Sprague River.

Wenger (1999) and Buffler et al. (2005) provide extensive literature reviews that demonstrate the ability of a riparian areas to remove total suspended solids, phosphorus, and nitrogen from runoff is a function of the riparian width. Diebel et al. (2008) found that targeted conservation or protection of riparian areas could be used to retain and remove substantial percentages of nutrients from runoff. Diebel et al. (2008) simulated phosphorus loading at field and watershed scales along with typical stream phosphorus concentration variability under scenarios where riparian conservation efforts are aggregated within certain fields and watersheds that had the highest phosphorus loading potential. They showed that this aggregated and targeted approach efficiently improves water quality. For example, with riparian conservation on only 10 percent of a simulated landscape, 26 percent of the total phosphorus load is retained. These results indicate that riparian conservation efforts can be more efficient if they account for the uneven spatial distribution of higher phosphorus sources and the cumulative aspects of aggregated management actions.

The Sprague River, Williamson River, and Wood River valleys are identified as priority locations for riparian protection and grazing management because of current land use practices and a perceived capacity for additional riparian rehabilitation (Stillwater et al. 2013; Upper Klamath Basin Comprehensive Agreement 2014). It is likely that other areas in the Upper Klamath River basin, such as the Lost River and Upper Klamath River, also have similar opportunities for riparian protection and grazing management actions. Generally, riparian fencing and grazing management should be focused in valley-bottom areas where grazing is concentrated. These areas primarily include the Sprague River main stem, Williamson River downstream of Kirk Reef, and Sevenmile Creek, but also includes areas such as restored wetlands and springs in the Wood River valley.

4.4 Irrigation Efficiency and Water Management

Irrigated agriculture is a significant socioeconomic activity in the Upper Klamath Basin (Reclamation 2012, 2016). Irrigated agricultural areas within subbasins of the Upper Klamath Basin include the Sprague River, Williamson River, Upper Klamath Lake, Lost River, Upper Klamath East, and Butte Creek. The U.S. Bureau of Reclamation (Reclamation) Klamath Project Area includes 188,000 of the 502,000 acres of private irrigated land in the basin upstream of Iron Gate dam (Reclamation 2012, 2016). This includes lands leased from the various wildlife refuges that are supplied with water by Reclamation.

The overall objective of Irrigation Efficiency and Water Management is to manage irrigation and associated return flows along streams and canals that flow into Upper Klamath Lake or the Klamath River to reduce sediment loads, sediment-bound nutrients, and irrigation tailwater[6] discharges to streams and rivers in the Upper Klamath Basin. Walker et al. (2015) closely correlated increases in sediment load with total phosphorus in the Upper Klamath Basin. External phosphorus loading from the basin upstream of Upper Klamath Lake is known to be a key driver of water quality throughout the system (ODEQ 2002, 2010). Reducing the sediment load from the basin associated with land use (i.e., sediment loads above background) is a priority identified in both the Upper Klamath Lake and Klamath River TMDLs (ODEQ 2002, 2010) and Upper Klamath Basin Comprehensive Agreement (2014).

Because of this naturally high loading rate, minimizing return flow associated with irrigation, and therefore the nutrients associated with that return flow, is one method of improving water quality because any method that captures sediment or retains soil on agricultural lands will reduce phosphorus loads. For example, converting flood or furrow irrigation to drip, sprinkler, or gated pipe irrigation conserves water and keeps more phosphorus in the field (Ciotti 2005; Ciotti et al. 2010). Likewise, fields that are leveled to a gentle slope irrigate more uniformly and do not suffer as much irrigation-induced erosion as fields with greater slope.

Irrigation Efficiency and Water Management projects include: the reduction of irrigation return flow by using wetlands, ponds, and pump-back systems; upgrading irrigation systems to increase the efficiency of irrigated water applications to reduce runoff and irrigation-induced erosion; purchasing or leasing of water rights for instream return; and lining or piping delivery systems to reduce water loss and sediment delivery to rivers and streams (Figure 8). Examples of specific projects include: canal lining; water storage improvements; water conveyance and pumping improvements; on-farm delivery and best practices; on-farm individual storage ponds/tanks; or land idling. These irrigation efficiency and water management efforts would contribute to

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[6] Tailwater is excess run-off from irrigated agricultural fields. When tailwater flows into neighboring waterways, it can increase sediment and nutrient loading.

improved water quality in adjacent canals and streams by preventing excessive soil leaching and runoff into local water sources. Water conservation practices that reduce tailwater runoff from irrigated fields can provide extensive improvements in water quality (Shock and Welch 2011; Reclamation 2016). While tailwater reduction can be achieved by re-routing, recycling, and ponding tailwater adjusting irrigation management, scheduling, and monitoring for runoff is perhaps the most cost-effective method of controlling tailwater. Maximum tailwater reductions are likely achieved when irrigation is effectively managed and resulting tailwater is re-routed, recycled, or ponded.

Figure 8. Irrigation efficiency and water management projects include water conveyance and piping improvements.

Improved irrigation practices to manage soil water include more precise irrigation water application rates and timing (tied to monitored soil moisture deficit) to reduce agricultural water use and thereby conserve water. Techniques to improve irrigation efficiency include installing more efficient irrigation systems. For example, sprinkler and drip irrigation systems are more efficient than furrow irrigation (Figure 9). By using polyacrylamide or straw mulch, the sediment that normally would be washed away in runoff, instead settles to the bottom of the furrow or ditch, preventing excess phosphorus loss (Iida and Shock 2008). Sedimentation basins with pump-back systems pump water to the top of the field or to the next field, thereby collecting and reusing runoff (Shock and Welch 2011). Vegetation filter strips can be implemented as barriers to slow and filter runoff water containing sediment. As water runs through the filter strip, the sediment settles and is trapped in the strip (Shock et al. 2013).

Figure 9. Irrigation efficiency and water management projects include advanced sprinkler irrigation delivery systems.

Reclamation is in the midst of a planning effort to identify and assess options to improve water quality and sustain or enhance water use in the Klamath Project study area. Reclamation assessments indicate that if all potential conservation practices are implemented on all irrigated lands, on-farm water use could be reduced (and hence potential runoff) by up to 25 percent in the Upper Klamath Basin, with an associated reduction in nutrient and sediment loadings to adjacent waterways (Reclamation 2012, 2016). Water resource options could involve new facilities or modified operations. Examples include land-based water treatment (e.g., wetlands, agriculture, sedimentation, etc.), irrigation operations (e.g., water reuse, crop cycling, etc.), or seasonal storage (e.g., supplemental supply, surge ponds, etc.). Advanced control and monitoring of water delivery and use are also important measures for enhancing irrigation water use efficiency (Figure 10).

Figure 10. Irrigation efficiency and water management projects include advanced control and monitoring of water delivery.

Piping and irrigation strategies help to reduce irrigation water contact with soils and other nutrient containing organic material (Ciotti 2005; Ciotti et al. 2010). Piping irrigation delivery systems also eliminates the ability of livestock to access and disturb sediment on the ditch banks and in the ditches, reduces the need for herbicides and chemicals commonly used on crops, and excludes the need for mechanical removal and disturbance of nutrient rich sediments. Through irrigation efficiency projects, the potential for tailwater return will be greatly reduced. This reduction will in turn help reduce or eliminate the suspected nutrient loading stemming from these discharges. The environmental benefits relate directly to reduced nutrient and temperature loading through reduction of irrigation return flows. The environmental benefits also relate indirectly through reduced water demand, which could potentially allow for more water in the streams and less need to divert water from Upper Klamath Lake.

5 PLP Conceptual Governance

This section describes the conceptual structure for governance and oversight of PLP implementation as discussed during Phase 2 with the IMIC. Further details and decisions on the governance and oversight of PLP implementation will occur in upcoming Phase 3 of the PLP process.

5.1 Governance Structure

The primary objective of the PLP governance structure is to provide an adaptive management capability to ensure science-centered management of PLP projects, which will be implemented over a period of years. At its core, the PLP governance structure should include a Steering Committee and a Fiscal Agent (Figure 11). The Steering Committee is ultimately responsible for successful implementation of the PLP actions to improve water quality in the Klamath River as envisioned in the KHSA per IM 11. The Fiscal Agent is responsible for the day-to-day financial and administrative management of the PLP funds.

5.1.1 Steering Committee

Like the IMIC, the Steering Committee could be made up of members from each of the following organizations or other organizations with management roles in the Upper Klamath Basin: ODEQ, State Water Board, Regional Water Board, Karuk Tribe, The Klamath Tribes, Yurok Tribe, USFWS, CDFW, ODFW, Reclamation, and Oregon Water Resources Department (OWRD). Each entity should provide a primary member and assign an alternate. Alternate members should be kept current on the process by the primary members, but only participate in meetings or decisions when the primary members are unavailable. The Fiscal Agent's representative should participate in the Steering Committee meetings, but not in an operational decision-making role. PacifiCorp's only involvement in the governance is the one-time action of providing funds to the Fiscal Agent.

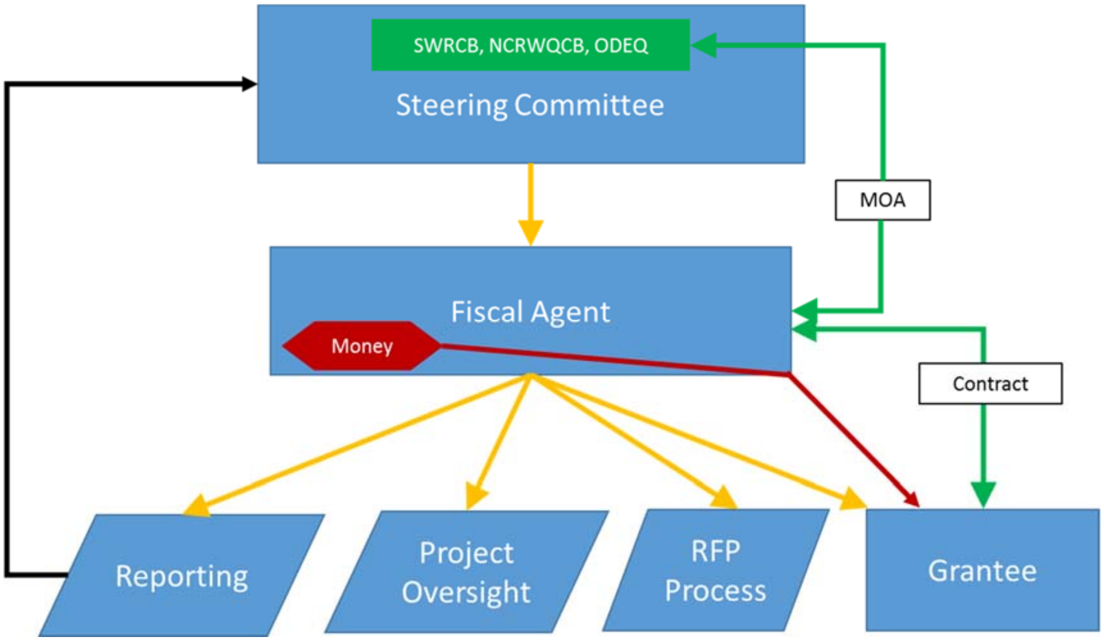

Figure 11. Conceptual governance organization.

The Steering Committee is tasked with oversight of the PLP implementation process. This includes selection of a Fiscal Agent (if this has not already been completed as is discussed below), review and approval of solicitations, project selection, oversight of the Fiscal Agent, and completion of any necessary reporting. The Steering Committee should include (at a minimum) a designated Committee Chair, Secretary, and Treasurer. The remaining members of the Steering Committee would be considered Members-at-Large. None of the committee would be compensated from IM 11 funds, but rather participation would be supported by the organizations for which individuals are already employed. To avoid potential conflicts of interest, Steering Committee organizations would not be allowed to seek PLP-related project funding.

The responsibilities for each of the positions should include (at a minimum):

- Committee Chair – Responsible for facilitating routine meetings, overseeing an efficient project selection process, representing the Steering Committee at other functions, and providing updates to non-member stakeholders.
- Secretary – Responsible for keeping Steering Committee records (including meeting minutes, website, etc.), scheduling routine meetings, and coordinating all other communications and logistical needs.
- Treasurer – Responsible for oversight of the Fiscal Agent, approval of Fiscal Agent expenditures, annual financial reporting, and any Steering Committee-specific operational costs (assuming funds are available to cover such costs).
- Members-at-Large – Responsible for participating in meetings and related decision-making, providing input on project selection, communication within their organizations and communities, and other tasks or ad hoc committees as determined by the Steering Committee.

According to IM 11, within 60 days of the KRRC's acceptance of the FERC surrender order, PacifiCorp is to develop the PLP in consultation with the IMIC. The IMIC is now working on the PLP and the final list will likely be completed well before the surrender order is issued. The acceptance of the surrender order is the logical point at which to convene the Steering Committee because this is also the timeframe during which PacifiCorp would provide funding under IM 11 to implement the PLP.

The duration of the entire PLP implementation process cannot be accurately predicted. Depending on how projects are selected and funds allocated and spent, the process could last a couple of years or a decade. Details of the method for selecting a Chair, Secretary, and Treasurer and the terms for those positions will be developed in Phase 3 of the PLP process in consultation with the IMIC. Conceptually, it's recommended that the Chair, Secretary, and Treasurer be elected from a slate of volunteer candidates from the Steering Committee at the first Steering Committee meeting. Terms for these positions should be a minimum of 2 years with the opportunity to repeat; a period shorter than 2 years would seem to reduce the effectiveness of the overall group because a substantial amount of time is required to learn the various job duties. As terms expire, a new Chair, Secretary, and Treasurer should be elected from a slate of candidates by the Steering Committee with one vote per Steering Committee member per position.

The Steering Committee should make decisions based on a simple consensus when possible. In cases when consensus cannot be reached and an immediate decision is necessary, a vote should be taken on that topic with the simple majority vote making the decision. The Steering Committee may decide to conduct all business using a formal motion/second/discussion/vote process to provide structure and clarity to the process.

5.1.2 Fiscal Agent

The role of the Fiscal Agent is to administer the funds, provided by PacifiCorp as per IM 11, and to implement the PLP at the direction of the Steering Committee. Per IM 11, these funds would be transferred following the KRRC acceptance of the FERC surrender order. The Fiscal Agent would be responsible for fiscal oversight of the IM 11 fund, managing the Request for Proposals (RFP) process, communicating with applicants, signing contracts with and then managing individual grantees efforts, and reporting to the Steering Committee on overall funded project status and progress.

The IMIC started a process to identify potentially suitable Fiscal Agents. This process was put on hold in Fall 2016 when the IMIC decided that a Fiscal Agent could not be accurately identified or selected until the type(s) of projects to be funded under the PLP and IM 11 had been identified. Because project categories have now been identified and specific on-the-ground projects are not part of the PLP, this process will be re-started in Phase 3 of the PLP with a review of the possible Fiscal Agent candidates, updates to the Fiscal Agent screening questions, collection of candidate-specific answers, and recommendation of a final Fiscal Agent.

As envisioned here, the Steering Committee is not an incorporated legal organization. In conversations with the National Fish and Wildlife Foundation, an organization that often serves as a Fiscal Agent, it was recommended that a Memorandum of Agreement (MOA) be developed between the Fiscal Agent and ODEQ, the State Water Board, and the Regional Water Board to clarify legal and fiduciary responsibilities to the Fiscal Agent (Figure 11). This recommendation was made for two reasons:

1. An MOA could describe the overall process, roles and responsibilities, administrative fees, and other items as necessary to implement the PLP process and manage the implementation fund. This provides clarity to everyone involved in the process.
2. These were the decision-making agencies identified in IM 11 and it seemed reasonable that they have some responsibility for oversight of the effort.

However, the Regional Water Board and State Water Board have both indicated a desire to simply participate in the Steering Committee and not have a management role. As of the October 18, 2017 IMIC meeting, the State Water Board, Regional Water Board, and ODEQ were going to coordinate with their legal departments on what could be required and possible outcomes. An alternative to an MOA would be to have PacifiCorp deposit the money into an implementation fund with specific stipulations directing the Fiscal Agent on how that money was to be spent. Investigations into these different avenues are ongoing and will be clarified in Phase 3.

5.2 Project Selection Process

The Steering Committee should follow a defined process for selecting projects to receive IM 11 PLP funds. This process serves two main purposes: (1) it provides an open and transparent proposal-bid opportunity to any potential entity with interest and qualifications to implement projects from the PLP; and (2) it provides a defensible, structured decision-making framework by which projects can be selected for funding.

Request for Proposals. The Steering Committee and the Fiscal Agent will need to work collaboratively to develop the final RFP that will allow them to select implementable projects from the PLP (a draft RFP will be developed in Phase 3). The RFP should include an overview of the PLP program; details relating to PLP goals, objectives, and priorities; applicant eligibility; geographic focus for proposed projects; funding availability; discussion of evaluation criteria; an overview of contractual requirements; timelines for submittals and decision-making; and detailed instructions on how to apply.

Communications. Communications between applicants and the Steering Committee during the entire RFP process should occur only through the Fiscal Agent. The Steering Committee should not directly communicate with any applicants. This ensures all applicants receive the same information and there are no back-channel communications that could be construed as benefiting certain applicants.

Pre-proposals. If numerous submittals for funds are expected, a pre-proposal process is recommended. Pre-proposals are relatively short documents (about 2 pages) where applicants present the project location, an abstract of proposed work, effects/outcomes of the project, and a preliminary project budget. The Steering Committee then uses pre-proposals to make decisions about which proposals should be invited to submit a full proposal and which projects can be declined. Pre-proposals allow the Steering Committee to provide feedback to the applicants (if desired) regarding suggested changes in project focus or reasons for being declined. Using a pre-proposal process requires an extra evaluation step and a Steering Committee meeting to discuss the pre-proposals; however, the pre-proposals are relatively short and easy to review. Because the Steering Committee has reviewed the pre-proposals, full proposal review is somewhat more efficient. Overall, this process saves time for both the Steering Committee and the applicants.

Full Proposals. Full proposals contain a detailed scope of work, discussion of water quality benefits of the proposed project, detailed and up-to-date budget, implementation schedule, description of the project team's qualifications, and other information following the guidelines in the RFP. The full proposal must provide a detailed discussion of the project and the benefits it would have on water quality in the Klamath River. This information is critical so that the Steering Committee can make the most informed decisions about where funds should be allocated based on the benefits of individual proposed projects. Score sheets should be developed for use in proposal evaluation to help standardize and document decisions.

Award Decisions. The decision to fund or not fund a specific proposal would be made by the Steering Committee and clearly communicated to the applicants by the Fiscal Agent. The Fiscal Agent would be responsible for confirming the available funds are consistent with the proposed funded projects.

5.3 Project Administration

Once projects are awarded the Fiscal Agent can proceed with contracting with the successful applicants. After contracting is complete and a notice to proceed has been provided, the Fiscal Agent is responsible for the contractual project management and communication with the grantees. All invoices and progress reports are submitted to the Fiscal Agent by the grantee for consideration and payment. The grantees would be responsible for detailed progress reporting to the Fiscal Agent. The Fiscal Agent is in turn responsible for reporting to the Steering Committee on the status of funded projects. The reporting goal should be to inform the Steering Committee about progress, milestones, and any substantial issues that arise that change project focus, cost, or schedule. Reporting specifics will need to be defined by the Steering Committee, but could include project updates for Steering Committee meetings, an annual summary report, quarterly fiscal reports, monthly invoice approval forms, or some combination of these. The Fiscal Agent would compile grantee invoices into a monthly invoice approval form that would be submitted to the Treasurer for review and approval. This limits the Treasurer's workload to one action item per month, yet allows the Treasurer some control over the funds and the opportunity to bring issues to the attention of the Steering Committee should action at that level be necessary.

Because a fixed amount of funding is available through IM 11, when that funding is exhausted (meaning completely spent, not just contracted), the Steering Committee would disband and the agreement with the Fiscal Agent would expire. Should additional funds be obtained from another source that would further the group's mission, and the committee so desires, then the program could continue to operate.

6 Next Steps

6.1 Final PLP Submittal for Approval

This Phase 2 PLP report will be provided to ODEQ, the State Water Board, and Regional Water Board as the PLP package that these agencies will use to approve the PLP as stipulated under IM 11 in the KHSA.

6.2 Phase 3 of PLP Process

Following approval by ODEQ, the State Water Board, and Regional Water Board of the PLP (as described in section 6.1 above), Phase 3 of the PLP will be initiated. Specific Phase 3 work will be developed in consultation with the IMIC, but could include activities to: fully develop the governance process; select a Fiscal Agent; draft an RFP; and begin development of a process to allow for project implementation. Phase 3 activities are anticipated to begin in 2018.

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Appendix A:
Refined Matrix of PLP Categories

Refined Matrix of PLP Categories

Matrix Contents and Definitions

To facilitate IMIC's development of the PLP, PacifiCorp compiled a matrix of information relating to the PLP categories as described in the preceding report. An original version of the matrix was included in the Phase 1 report (CH2M 2017), and included information on 12 candidate project categories. The attached matrix is a refined and updated version of the matrix for the four final PLP categories. This refined matrix is written assuming that the reader is familiar with the contents of the Phase 1 report, including the original version of the matrix (CH2M 2017). This refined matrix includes the following information:

- **Name of Technique or Project.** The short name used to define each PLP category.
- **Location.** The physical spot on the ground where actions of the particular PLP category would be placed (if known). Locations could be site-specific (e.g., at Link River dam) or more broadly implemented (e.g., in the Wood River basin).
- **Goals, Objectives, Assumed Capability.** Summary of the goals, objectives, and assumed capability of each PLP category. The goals and objectives indicate what category is intended to achieve in terms of water quality benefits. The assumed capability addresses anticipated effectiveness of the category in achieving the intended water quality benefits.
- **Design Features and Elements.** Summary of the anticipated conceptual layout, facilities, and operation of the PLP category.
- **Potential Adverse Impacts and Uncertainties.** Summary of the potential adverse environmental impacts, if any, that might be associated with construction and operation of the PLP category. Summary of the uncertainties of the PLP category regarding its potential implementation and effectiveness.
- **Estimated Cost of Project.** Estimated costs of the particular PLP category are itemized for design, construction, operation and maintenance (O&M), if data is available. Where sufficient cost information is available, an 'Annualized Cost Metric' (ACM) is estimated. The ACM is calculated as the sum of all estimated costs for the PLP category (including for design, construction, operation and maintenance, if available) divided by the estimated duration of the project in years.[7] The ACM provides an approximate cost per-year metric that can be used for cost comparisons across project categories. For calculation simplicity, the ACM values reported in the matrix were not adjusted for inflation.
- **Duration.** The estimated lifetime or longevity of the PLP category reported in months or years, if available. Otherwise, duration is qualitatively referred to as 'short-term', 'intermediate term', or 'long-term'. For use in this matrix, long-term is a duration of 20 years or more (and including potentially permanent).
- **Collaboration, Synergy, or Conflict.** If pertinent to the PLP category, information is provided on relevant practitioners in the area to allow consideration of possible collaboration, synergies, or conflicts. When there is the potential for additive benefits between two project categories, they are

[7] In some cases, the total costs and project life-spans used in the ACM calculation are based on a number of years that differs from the estimated duration of the project category. For example, the costs for the Riparian Fencing and Grazing Management project category are estimated over 10 years (rather than 20 years as the long-term duration assumes). The main reason for difference is to maintain consistency with the source of cost information which is sometimes different than the duration used in the matrix. Extension of costs for life-spans beyond those in the source material did not seem appropriate.

said to have synergistic benefits. For example, diffuse source treatment wetlands (DSTWs) would have potential synergies with natural wetlands restoration, because DSTWs could provide research opportunities for assessing effectiveness of restored natural wetlands. When the benefit of one project category is not possible if another project category is undertaken, then the two would be said to conflict. An example of a conflict could be where two wetland projects, say a DSTW and a restored natural wetland are targeted at the same physical location.

- **Information Sources.** Key reference sources that describe or support the summary statements in the matrix for a given project category.

Matrix of Final PLP Categories

The final PLP categories include:

- Natural Wetlands Restoration
- Diffuse Source Treatment Wetlands
- Riparian Fencing and Grazing Management
- Irrigation Efficiency and Water Management

Selection of PLP categories is described in the Phase 1 report (CH2M 2017) and in Sections 2 and 3 of this document. The matrix of detailed information associated with the final four PLP categories is provided on the following pages.

Natural Wetlands Restoration	
Locations	Priority locations for natural wetlands restoration are assumed to include larger (10s to 1,000s of acres) fringe wetlands areas on the margins of Upper Klamath Lake, Agency Lake, Keno reservoir, and Klamath Straits Drain. The Upper Klamath Basin Watershed Action Plan (Action Plan) is currently under development that will identify actions for water quality and fish habitat enhancements, including natural wetlands restoration. The Action Plan will identify locations for specific wetlands restoration on Upper Klamath Lake and the Sprague and Williamson watersheds in the basin above the lake. The Action Plan will also include a Lost River chapter that would cover locations in the Bureau of Reclamation's (Reclamation) Klamath Project in that watershed. Trout Unlimited (TU) is managing a Natural Resources Conservation Service (NRCS) Regional Conservation Partnership Program (RCPP) grant for projects in the Upper Klamath Basin that restore water quality and flow. Currently, TU is working to enroll private landowners to participate in wetland reserve easements. As of September 2017, two landowners with several hundred acres each plan to enroll. Both parcels are on Upper Klamath Lake and would be restored to wetlands. The Reclamation is conducting planning to identify and assess options to improve water quality and sustain or enhance water use in the Klamath Project study area. Water resource options could include constructed or restoration wetlands that can contribute to the Total Maximum Daily Load (TMDL) goals established for the Klamath River and Lost River systems (ODEQ 2012). The TMDL cites measures to reduce the loading of organic material and nutrients in the water flowing into the Klamath River from Reclamation's Klamath Project study area. Reclamation is going forward with construction of a 225-acre treatment wetland near Stateline that would help store and treat Rangeline Drain water from the west and return it to Klamath Straights Drain to the east. Potential treatment wetland sites in the Keno reservoir reach of the Klamath River and the downstream end of the Klamath Straights Drain were identified in prior studies (Mahugh et al. 2009; Lyon et al. 2009). These sites could accommodate potential treatment wetlands on larger parcels of 100s to 1,000s of acres.
Goals, Objectives, Assumed Capability	The key goal of wetlands restoration is to facilitate improvement in water quality in Upper Klamath Lake, Agency Lake, Keno reservoir, Klamath Straits Drain, and ultimately the Klamath River by nutrient removal from surface waters through wetland ecosystem processes (Wong et al. 2011; CH2M Hill 2012; Stillwater et al. 2013; Sullivan et al. 2014). The primary means of envisioned wetland restoration is to: (1) reconnect delta areas with Upper Klamath Lake, Agency Lake, Keno reservoir, and Klamath Straits Drain; and (2) rehabilitate and enhance other existing natural wetlands areas. These reconnections would restore wetland areas and improve water quality by reducing the external loadings of phosphorus and nitrogen to Upper Klamath Lake, Agency Lake, Keno reservoir, and Klamath Straits Drain. Wetlands restoration also could provide habitat for the endangered shortnose and Lost River suckers if located in Upper Klamath Lake. The Nature Conservancy (TNC) implemented the foremost example of this reconnection approach to wetland restoration (beginning in 1996) in the Williamson River Delta (Delta). This Delta was once a vast expanse of floodplain and lake-fringe wetland habitat that formed where the Williamson River entered Upper Klamath Lake. In the mid-20th Century, the Delta was separated from the river and lake by levees and converted to agricultural production. Agricultural practices on the Delta included pumping water from the property into the lake to drain the fields before planting. This

Natural Wetlands Restoration	
	pumped water contributed about 21-25 tons of phosphorus per year to Upper Klamath Lake (Snyder and Morace 1997), which contributed to the lake's severe enrichment issues, including extensive algae blooms. These actions also eliminated important marsh habitat historically used by the endangered Lost River and shortnose suckers. In the initial stage of TNC's Williamson River Delta wetland restoration, there was concern that breaching levees and reconnecting former agricultural fields could release a large amount of stored phosphorus into Upper Klamath Lake, further degrading water quality. Conservation benefits from restoration, particularly an increase in habitat for suckers, were expected to offset the initial export of phosphorus, so the decision was made to breach the levees and monitor the results. Levees were breached on the west side of the Delta in 2007, inundating approximately 3,500 acres, and on the east side of the Delta in 2008, inundating approximately 2,000 acres (Aldous et al. 2005, 2007). Subsequent monitoring indicated that far less phosphorus was released into the lakes and wetlands following restoration than modeling and experiments had predicted (Wong et al. 2010; Stevens and Tullos 2011; Hayden and Hendrixson 2013). Ultimately, a well-designed wetland restoration should be expected to provide a net reduction in nutrient export to the lakes and river. Constructed treatment wetlands have been shown to be effective at removing a range of pollutants from incoming waters, including total suspended solids, phosphorus, nitrogen, metals, organic compounds, and bacteria and pathogens (CH2M Hill 2012; Stillwater et al. 2013; Sullivan et al. 2014).
Design Features and Elements	Wetland projects can be small-scale (1 acre to 10s of acres), large-scale (100s to 1,000s of acres) or in-between, depending on resource management needs and site constraints. Projects can be located anywhere degraded naturally-occurring wetlands already exist. This could be in downstream portions of a watershed to capture pollutants before they leave the system and are discharged into a receiving waterbody, or they can be scattered throughout a watershed to provide on-site treatment and habitat. For wetland restoration that involves reconnecting former agricultural fields, it is possible that restoration could release stored phosphorus into the adjoining lake or reservoir, resulting in temporary degrading of water quality. However, TNC's Williamson River Delta wetland restoration monitoring has indicated that such releases had far less phosphorus than modeling and experiments had predicted (Wong et al. 2010; Stevens and Tullos 2011; Hayden and Hendrixson 2013). Over time, the capacity of wetlands to reduce nutrient loads to downstream water bodies can be uncertain (Fisher and Acreman 2004). Whether wetlands serve as a source or sink for nutrients depends on several different factors including hydrologic and geomorphic conditions, seasonal patterns of uptake and release, and ecosystem succession (Mitsch and Gosselink 2000). It is well-established that interception and removal of nutrients and particulates (including algae) can be accomplished using constructed wetlands (Kadlec and Wallace 2009). Properly-designed treatment wetlands have been shown to be highly effective at removing a range of pollutants from incoming waters, including total suspended solids, phosphorus, nitrogen, metals, organic compounds, and bacteria and pathogens (CH2M Hill 2012; Stillwater et al. 2013; Sullivan et al. 2014). For example, the removal of nutrients and particulates require that the average residence time of water in the wetland – referred to as hydraulic residence time or hydraulic retention time – is of sufficient duration (on the order of several days) for wetland-related mechanisms and

Natural Wetlands Restoration	
	processes to occur. Normally, hydraulic retention time of about 2 days is needed to remove approximately 80 to 90 percent of total suspended solids typically found in lake and river waters (Kadlec and Wallace 2009). CH2M Hill (2012) includes a summary of nitrogen and phosphorus removal data in wetlands receiving flow from river diversions and other large wetland systems. This summary indicates removal efficiencies of 20 to 75 percent for total phosphorus, 40 to 65 percent for total nitrogen, and 50 to 90 percent for nitrate-nitrogen. Recently, Land et al. (2016) conducted a systematic review of research literature to assess how effective are created or restored freshwater wetlands for nutrient removal. After screening on relevance and critical appraisal, 93 articles including 203 wetlands were used for data extraction. Four wetland types were included: including riparian wetland, which are wetlands at the interface between land and a river or stream; free water surface wetland having visible water flowing usually between 0.1 and 2 m deep, with submersed, floating or emergent wetland plants; horizontal subsurface flow wetlands that are typically designed with a permeable filter material ("soil") planted with emergent wetland plants; and vertical flow wetlands, which are similarly constructed to horizontal subsurface flow wetlands, but water is applied on the surface of the filtering material, and percolates vertically downward. All the included wetlands were primarily created or restored for nutrient removal, although a small number of them were multi-purpose wetlands. Of these types, the riparian and free water surface wetlands would likely best represent the larger fringe wetlands assumed in this category. Land et al. (2016) found that nutrient removal is remarkably similar for the four types of wetlands; the summary effects all differ significantly from zero and the averages are relatively close to each other with confidence levels showing a strong overlap. Removal efficiency for total nitrogen includes a median of 37 percent, with a 95 percent confidence interval of 29–44 percent. Removal efficiency for total phosphorus includes a median total phosphorus removal efficiency was 46 percent with a 95 percent confidence interval of 37–55 percent. The removal rate of both total nitrogen and total phosphorus is highly dependent on the loading rate. Significant relationships were also found for annual average air temperature and wetland area. Higher rates of removal are generally provided in individual wetlands in more optimal locations and that were specifically designed to achieve nutrient removal. General design criteria for wetland rehabilitation (Kadlec and Wallace 2009; CH2M Hill 2012) typically address the following features or attributes: • Water inundation or saturation for some portion of the growing season • Topography and configuration that support a slow-moving, tortuous flow path for water • Varied depth to support a variety of vegetation types and habitats • Inlet and outlet structures, if hydrology is to be managed
Potential Adverse Impacts & Uncertainties	Potential adverse impacts: Potential for invasive species (aquatic/terrestrial) management problems and bioaccumulation potential (e.g., mercury); initial release of stored phosphorus into the adjoining waterbody from wetland restoration projects that involve levee breaching. Uncertainties: Location and property for wetlands restoration; sponsors and funding sources; magnitude and reliability of effectiveness; extent of routine maintenance and

Natural Wetlands Restoration	
	how maintenance relates to function over time (i.e., does an unmaintained wetland decrease in efficiency over time?).
Estimated Cost of Project	Pilot Study: $150,000 to $275,000 (5 to 10-acre plot along Keno Reservoir; pg. 63 of Stillwater et al. 2013) Construction: For restoration of wetlands in the Upper Klamath Basin, Stillwater et al. (2013) estimated construction costs of $17,000,000 for 1,600 acres, or about $10,600 per acre (pg. 19 of Stillwater et al. 2013, pg. 13 of Appendix A of Stillwater et al. 2013) O&M (timeframe): Stillwater et al. (2013) estimated O&M costs of $21,000,000 over 50 years for 1,600 acres, or about $13,250 per acre over 50 years (pg. 19 of Stillwater et al. 2013; pg. 13 of Appendix A of Stillwater et al. 2013) ACM: $765,500 In considering the above cost estimates, it is noteworthy that costs for wetland creation and restoration projects can be highly variable, depending on project size, complexity, and site-specific conditions. In terms of project complexity, wetland creation and restoration projects can range widely from a simple passive levee breach or reconnection system to a more-engineered wetland system involving basin construction, grading, planting, and water control structures. Costs for wetland creation and restoration projects reported above by Stillwater et al. (2013) and additional sources below (Zentner et al. 2003; King and Bohlen 1995) do not include estimated costs for land acquisition. Zentner et al. (2003) reported costs for wetland creation and restoration projects in Northern California. Costs are construction costs only, reported on a per-acre basis in 2002 dollars. Zentner et al. (2003) divided wetland projects into three types: (1) salt marsh restoration through breeching of diked baylands; (2) creation or restoration of perennial freshwater marshes, which are inundated all or most of the year, and dominated by open water, cattails (*Typha* spp.), and tules (*Scirpus* spp.); and (3) creation or restoration of seasonal wetlands, which are inundated seasonally (typically 3 to 6 months) and dominated by common wetland plants such as rushes (*Eleocharis* spp., *Juncus* spp.) and sedges (*Carex* spp.). For relatively simple dike breeching projects (i.e., breeching only without other construction actions), Zentner et al. (2003) reported project costs of $6,000 to $14,000 per acre (about $7,900 to $18,500 per acre in inflation-adjusted 2017 dollars). For more complex dike breeching projects (i.e., breeching with additional grading and planting actions), Zentner et al. (2003) reported project costs of $59,000 to $140,000 per acre (about $77,900 to $185,000 per acre in inflation-adjusted 2017 dollars). For perennial marsh restoration projects, Zentner et al. (2003) reported project costs of $21,400 to $33,300 per acre (about $27,700 to $43,500 per acre in inflation-adjusted 2017 dollars). For seasonal marsh/wet meadow restoration projects, Zentner et al. (2003) reported project costs of $12,000 to $42,000 per acre (about $15,800 to $55,400 per acre in inflation-adjusted 2017 dollars). King and Bohlen (1995) examined cost estimates for approximately 1,000 historical wetland creation, restoration, and enhancement projects carried out in 44 states over 25 years from 1970 to 1995. King and Bohlen (1995) report that, for wetland creation and restoration projects other than those that involved converted agricultural land, average project costs ranged from just under $20,000 to over $75,000 per acre (about $32,000 to $120,000 per acre in inflation-adjusted 2017 dollars). Conversions of

<table>
<tr><th colspan="2">Natural Wetlands Restoration</th></tr>
<tr><td></td><td>agricultural land to wetland proved substantially less costly, usually around $1,000 per acre (around $1,600 per acre in 2017 dollars).

Per acre costs of wetland creation and restoration projects decline with project size (King and Bohlen 1995). Small projects (under 0.5 acre) accounted for a disproportionate share of very high-cost projects. This is because of relatively high fixed costs associated with these projects and the standardizing of costs at the level of 1 acre (e.g., a 0.25-acre project costing $15,000 implies costs of $60,000 per acre).

Per acre project costs were only weakly related to the type of wetland being constructed (King and Bohlen 1995). Site specific and project specific factors had a much larger effect on per-acre project costs. Construction costs, as opposed to pre-construction or post-construction costs, usually were the largest component of overall project costs (King and Bohlen 1995). However, monitoring and follow-up costs were highly variable, and led to unusually high project costs in some cases.

East Contra Costa County Habitat Conservancy (ECCCHC 2012) reports on costs incurred for seasonal and riparian wetlands constructed in the Bay Area in California, including construction costs, administrative costs, and related design and permitting costs, but not land acquisition. Costs reported for the East Contra Costa County Habitat Conservation Plan (HCP) mitigation program included seasonal wetlands at $180,000 per acre and riparian restoration at $85,000 per acre. Costs reported for the Santa Clara Valley HCP mitigation program included restoration of seasonal wetlands at $125,000 per acre, permanent wetlands/ponds at $97,500 per acre, and riparian restoration at $85,000 per acre. Costs varied between $10,000 to $550,000 per acre depending on location, level of engineering, and scale of projects.</td></tr>
<tr><td>Duration</td><td>Long term</td></tr>
<tr><td>Collaboration, Synergy, or Conflict</td><td>Potential synergies with other wetland restoration actions (e.g., DSTWs, Riparian Fencing) because resulting nutrient removal would be additive.

Regarding potential collaboration, the TNC Williamson River Delta project has many collaborators, but in particular the USFWS, which views the large lake fringe wetlands as key to their sucker recovery strategy.</td></tr>
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</table>

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Diffuse Source (Decentralized) Treatment Wetlands (DSTWs)	
Locations	For DSTWs, the Wood River and Sprague River watersheds are identified as priority locations because of current land use practices and a perceived capacity for additional wetland rehabilitation. DSTWs are small (about 10 acres or less each) flow-through or terminal wetlands located along creeks and canals or in low-lying areas in fields within the Wood River and Sprague River valleys. The Upper Klamath Basin Watershed Action Plan is currently under development that will identify actions for water quality and fish habitat enhancements, including DSTWs. The Action Plan will identify locations for specific DSTW actions in the Sprague and Williamson watersheds. The Natural Resources Conservation Service (NRCS) is currently working on a National Water Quality Initiative (NWQI) study in the upper Lost River watershed. The study includes an assessment of water quality improvement needs. Irrigation efficiency and conservation will be a primary focus. DSTWs also are being explored and certainly have potential. The NWQI study report will come out early 2018 and will identify specific water quality improvement needs and locations. The Klamath Basin Rangeland Trust (KBRT; now Trout Unlimited), U.S. Fish and Wildlife Service (USFWS), and the Klamath Tribes have partnered to develop a DSTW pilot program focused in the Wood River Valley upstream of Upper Klamath Lake. The Wood River Valley was chosen for the project location because flows from the valley contribute 30 percent of the total phosphorus to Upper Klamath Lake while the valley area is only 5 percent of the total drainage area into the lake (Walker et al. 2012). The construction and monitoring of DSTWs across the Wood River Valley landscape will provide important empirical information to be used in future treatment wetland designs.

Goals, Objectives, Assumed Capability	A network of DSTWs would decrease external loading of phosphorus and nitrogen to Upper Klamath and Agency lakes and may help decrease nuisance algal blooms in these waterbodies. The goals for DSTWs are generally the same as for other types of wetlands, but the functionality occurs in relatively smaller pockets and has the advantage of onsite treatment and habitat. Constructed treatment wetlands have been shown to be effective at removing a range of pollutants from incoming waters, including total suspended solids, phosphorus, nitrogen, metals, organic compounds, and bacteria and pathogens (Mitsch and Gosselink 2000; Kadlec and Wallace 2009). These systems can also provide high quality wildlife habitat. Land et al. (2016) conducted a systematic review of research literature to assess how effective are created or restored freshwater wetlands for nutrient removal. After screening on relevance and critical appraisal, 93 articles including 203 wetlands were used for data extraction. Four wetland types were included: including riparian wetland, which are wetlands at the interface between land and a river or stream; free water surface wetland having visible water flowing usually between 0.1 and 2 m deep, with submersed, floating or emergent wetland plants; horizontal subsurface flow wetlands that are typically designed with a permeable filter material ("soil") planted with emergent wetland plants; and vertical flow wetlands, which are similarly constructed to horizontal subsurface flow wetlands, but water is applied on the surface of the filtering material, and percolates vertically downward. All the included wetlands were primarily created or restored for nutrient removal, although a small number of them were multi-purpose wetlands. Of these types, the horizontal subsurface flow wetlands and vertical flow wetlands would likely best represent DSTWs. Land et al. (2016) found that nutrient removal is remarkably similar for the four types of wetlands; the summary effects all differ significantly from zero and the averages are relatively close to each other with confidence levels showing a strong overlap. Removal efficiency for total nitrogen includes a median of 37 percent, with a 95 percent confidence interval of 29–44 percent. Removal efficiency for total phosphorus includes a median total phosphorus removal efficiency was 46 percent with a 95 percent confidence interval of 37–55 percent. The removal rate of both total nitrogen and total phosphorus is highly dependent on the loading rate. Significant relationships were also found for annual average air temperature and wetland area. Higher rates of removal are generally provided in individual wetlands in more optimal locations and that were specifically designed to achieve nutrient removal. Stillwater et al. (2013) used a generalized geographic information system (GIS) analysis to estimate that DSTWs, typically sized at 5-6 acres each, could theoretically represent a maximum potential cumulative area of 600 acres in the Wood River Valley. Stillwater et al. (2013) estimate that the majority of DSTW acreage (540 acres) would be mid-field systems scattered throughout the valley, with the remainder (60 acres) consisting of creek/canal-side DSTWs. For the valley as a whole, 31,500 acres or 98 percent of the existing land use would remain the same under this theoretical DSTW area scenario (Stillwater et al. 2013). Stillwater et al. (2013) estimates that this maximum potential cumulative area of 600 acres of DSTWs would provide about a 5-20 percent cumulative annual reduction of phosphorus and 5-15 percent cumulative annual reduction of nitrogen for the Wood River Valley, depending on the relative amounts of flow-through and terminal DSTWs (see Figure 3.11 in Stillwater et al. 2013). The corresponding cumulative flow reduction from the adjacent waterways would be just over 3 percent, based on estimated evapotranspiration losses (see calculations in Appendix B in Stillwater et al. 2013).

Diffuse Source (Decentralized) Treatment Wetlands (DSTWs)	
Design Features and Elements	Wetland-located water treatment can occur throughout a watershed, rather than at the bottom or just prior to discharge into a large receiving water body. Design and implementation of networks of small-scale DSTWs can achieve the benefits of wetland ecosystem functioning in multiple locations throughout a watershed. DSTWs are designed to accommodate an estimated amount of stormwater runoff from the landscape or a particular hydraulic residence time given adjacent agricultural canal flow. Specific design elements allow DSTWs to function at smaller scales such as natural low points in pastures and agricultural fields or areas directly adjacent to small drainage ditches. Unlike larger-scale habitat and treatment wetlands, DSTWs can be located on a fraction of an existing parcel and result in less permanent loss of land.
Potential Adverse Impacts & Uncertainties	Potential adverse impacts: Potential for unintended consequences (i.e., invasive species, mosquitos, nutrient export, creation of sate or federally jurisdictional wetlands). Uncertainties: To generate the necessary nutrient reduction, many DSTWs would be necessary. It would seem uncertain at this time if willing sponsors and landowners are available. Other uncertainties are associated with the number of required features and reliability of effectiveness.
Estimated Cost of Project	Pilot Study: $230,000 to $270,000 (pg. 50 of Stillwater et al. 2013) Construction: $663,000 per 50 units (pg. 15 of Appendix A of Stillwater et al. 2013) O&M (timeframe): $130,000 a year for 10 years for 50 units (pg. 15 of Appendix A of Stillwater et al. 2013) ACM: $223,300 The ECCCHC (2012) reports on costs incurred for seasonal and riparian wetlands constructed in the Bay Area in California, including construction costs, administrative costs, and related design and permitting costs, but not land acquisition. Costs reported for the East Contra Costa County HCP mitigation program included seasonal wetlands at $180,000 per acre and riparian restoration at $85,000 per acre. Costs reported for the Santa Clara Valley HCP mitigation program included restoration of seasonal wetlands at $125,000 per acre and riparian restoration at $85,000 per acre. Costs varied between $10,000 to $550,000 per acre depending on location, level of engineering, and scale of projects.
Duration	Long term
Collaboration, Synergy, or Conflict	USFWS, Trout Unlimited, The Klamath Tribes, and Stillwater Sciences are collaborating on several pilot DSTWs. Oregon Department of Environmental Quality and the Regional Water Board are planning to discuss with NRCS their interest in encouraging DSTWs as an approved practice. Diffuse Source Treatment Wetlands would have potential synergies with other wetland restoration-related project categories (e.g., Natural Wetlands as described above) because resulting watershed-level nutrient removal using wetlands systems would be additive.

Diffuse Source (Decentralized) Treatment Wetlands (DSTWs)	
Information Sources	East Contra Costa County Habitat Conservancy (ECCCHC). 2012. Review and Adjustment of the HCP/NCCP Mitigation Fees Recommendation. May 10, 2012. Kadlec, R.H. and S. Wallace. 2009. Treatment Wetlands. 2nd edition. CRC Press. Boca Raton, FL. Land, M., W. Granéli, A. Grimvall, C. Hoffmann, W. Mitsch, K. Tonderski, and J. Verhoeven. 2016. How effective are created or restored freshwater wetlands for nitrogen and phosphorus removal? A systematic review. Environmental Evidence 5:9. 26 p. Mitsch, W. and J. Gosselink. 2000. Wetlands. Third Edition. John Wiley & Sons, Inc., New York. Stillwater Sciences, Jones & Trimiew Design, Atkins, Tetra Tech, Riverbend Sciences, Aquatic Ecosystem Sciences, and NSI/Biohabitats. 2013. Water Quality Improvement Techniques for the Upper Klamath Basin: A Technical Workshop and Project Conceptual Designs. Prepared for California State Coastal Conservancy, Oakland, California. Walker, W.W., J. D. Walker, and J. Kann. 2012. Evaluation of Water and Nutrient Balances for the Upper Klamath Lake Basin in Water Years 1992-2010. Technical Report to the Klamath Tribes Natural Resources Department, Chiloquin, OR. 50 pp +Appendices.

Riparian Fencing and Grazing Management	
Location	The Sprague River, Williamson River, and Wood River valleys are identified as priority locations because of current land use practices and a perceived capacity for additional riparian rehabilitation. Generally, riparian fencing and grazing management should be focused in valley-bottom areas where grazing is typically concentrated. This primarily includes the Sprague River main stem, Williamson River downstream of Kirk Reef, and Sevenmile Creek, but also includes areas such as restored wetlands and springs in the Wood River valley. The Upper Klamath Basin Watershed Action Plan is currently under development that will identify actions for water quality and fish habitat enhancements, including riparian fencing and grazing management. The Action Plan will identify locations for specific riparian fencing and grazing management actions in the Sprague, Williamson, and Wood River watersheds in the basin above the lake.
Goals, Objectives, Assumed Capability	The overall objective is to manage and restore riparian corridors along streams that flow into Upper Klamath Lake to reduce sediment loads (and sediment-bound nutrients) in the streams. Because of relatively high phosphorus content of soils in the Upper Klamath Basin and the fact that both the Upper Klamath Lake Drainage and Klamath River TMDLs point to external phosphorus loading from the basin above Upper Klamath Lake as a driver of water quality throughout the system, minimizing sediment load associated with land use (i.e., sediment loads above background) is a priority. Walker et al. (2015) closely correlated sediment load and total phosphorus in the Upper Klamath Basin. A number of studies indicate that Riparian Fencing and Grazing Management can be very effective at managing sediment loads in surface runoff. For instance, Wenger (1999; page 20) states that "…riparian buffers should be viewed as an essential component of a comprehensive, performance-based approach to sediment reduction." Additionally, riparian fencing and grazing management were the central focus of the Upper Klamath Basin Comprehensive Agreement (April 18, 2014; see in Information Sources below) which was created from review of scientific literature. Diebel et al. (2008) found that riparian management targeting areas of nutrient input could use riparian buffers to retain and remove substantial percentages of sediment and nutrients from runoff. Wenger (1999) and Buffler et al. (2005) provide extensive literature reviews that demonstrate that the ability of a riparian buffers to remove total suspended solids, phosphorus, and nitrogen from runoff as a function of the buffer's width. These riparian systems can also provide high quality wildlife habitat.
Design Features and Elements	For planning and assessment purposes, features and elements can be approximated based on Riparian Program specifics in the Upper Klamath Basin Comprehensive Agreement (April 18, 2014; see in Information Sources below). These specifics indicate that Riparian Fencing and Grazing Management would be implemented through agreements entered with willing landowners. Minimum width of protected riparian areas will be approximately the lesser of about 50 feet or a reasonably consistent contour of 2 feet above the elevation of the adjacent stream water surface, constrained by an absolute minimum of about 30 feet. The maximum needed width of protected riparian areas will be about 100 to 130 feet (this includes area in fields adjacent to the riparian area such that the combined width of the two areas is 100 to 130 feet, unless the landowner agrees to a greater width). Within these limits, a baseline width of 75 to 90 feet can be used as a starting point for delineation for planning and assessment purposes.

Riparian Fencing and Grazing Management	
	Wenger (1999) and Buffler et al. (2005) provide extensive literature reviews with specific information about sediment and nutrient removal. Wenger (1999) reports average total suspended solids reductions of 81 percent for a 15-ft buffer and 91 percent for a 30-ft buffer. Peterjohn and Correll (1984) found that a 160-ft riparian buffer in an agricultural catchment in the Mid-Atlantic Coastal Plain trapped 94 percent of suspended sediment that entered, with 90 percent trapped in the first 60 ft. Wenger (1999) and Buffler et al. (2005) report that a riparian buffer strip of 30-60 ft will, in most cases, retain the major part of the nutrients carried by surface runoff. In the short term, riparian buffers retain much of total phosphorus that enters, and retention increases with riparian buffer width. Wenger (1999) reports that after 26 ft, grassed buffers retained 66 percent of phosphate in surface runoff, while after 52 ft, 95 percent was retained. The long-term effectiveness of riparian buffers in retaining available phosphate is questionable. Whereas nitrate can be denitrified and released into the atmosphere, phosphorus is either taken up by vegetation, adsorbed onto soil or organic matter, precipitated with metals, or released into the stream or groundwater (Wenger 1999). It is possible for a buffer to become saturated with phosphorus when all soil binding sites are filled; in this situation, any additional phosphorus inputs will then be offset by export of soluble phosphate (Wenger 1999). Soils become saturated at different rates, depending on factors such as cation exchange capacity and redox potential. Harvesting vegetation may be the only reasonable management technique that permanently removes phosphorus from the system. However, such harvesting can destabilize the riparian area and lead to erosion, and should be restricted to areas well away from the stream bank (Wenger 1999). Welsch (1991) recommends 15 ft, although data provided in Welsch (1991) indicates that 25-50 ft would provide a greater margin of safety. The Nutrient Tracking Tool (NTT) model is being developed by the NRCS for use in the Upper Klamath Basin. While the calibration studies have not yet been completed, the NTT model can provide a reasonable estimate of nutrient reduction benefits from a wide range of riparian fencing and grazing management practices. The NRCS NTT team can be contacted for more information at (541) 883-6932.
Potential Adverse Impacts & Uncertainties	Potential adverse impacts: Potential for unintended consequences (i.e., stream channel substrate and shape changes; creation of state or federally jurisdictional wetlands), and loss or reductions in use of agricultural lands. Uncertainties: To generate the necessary nutrient reduction, many miles of riparian protection and enhancement would be necessary. It would seem uncertain at this time if sufficient willing sponsors and landowners are available. Other uncertainties are associated with the magnitude and reliability of effectiveness.
Estimated Cost of Project	Construction and O&M: (timeframe): $35,606,000 over 10 years (total estimated implementation costs for Sprague, Williamson, and Wood River subbasins, including main stems and tributaries) ACM: $3,560,600 The above costs are based on Barry et al. (2010), who estimated implementation costs in the above subbasins over a 10-year period for riparian corridor management agreements; 318 miles of fencing construction and off stream watering; 548 miles of maintenance of existing fences and managing of riparian corridor plants.

Riparian Fencing and Grazing Management	
	Trout Unlimited's costing guidelines, which contain adjustments to account for culverts and other project contingencies, include: • $3.50 per lineal ft for fencing • Add $5,000 per mile for additional work (culverts, tree removal, etc.) • Add $10,000 for off-stream watering system (no well drilling) • Add $12,000 for any well drilling for stock water wells
Duration	Long term
Collaboration, Synergy, or Conflict	Protection and restoration of riparian buffers is functionally the same as wetland restoration and enhancement. In other words, as related to nutrient removal, riparian buffers are in the same functional category as Natural Wetlands Restoration and in many cases DSTWs. Regarding potential collaboration, TU and USFWS currently are implementing this type of project in the Upper Klamath Basin. In the future, the Klamath Tribes are planning to undertake similar projects in collaboration with USFWS, Klamath Watershed Partnership (KWP), and TU as part of a program of implementation originally described in the Comprehensive Agreement, but likely implemented in conjunction with the Upper Klamath Basin Watershed Action Plan, which is under development by the Klamath Tribes, TNC, USFWS, TU, ODEQ, Klamath Watershed Partnership (KWP), and the Regional Water Board (M. Skinner, pers. comm.). The NRCS National Water Quality Initiative is also considering activities in this project category.
Information Sources	Barry, M., L. Dunsmoor, S. Peterson, D. Watson, and S. Mattenberger. 2010. Projected Restoration Actions and Associated Costs Under the Klamath Basin Restoration Agreement for the Upper Klamath River Basin Above Keno, Oregon. Jointly prepared by U. S. Fish and Wildlife Service, Klamath Tribes, Klamath Basin Rangeland Trust, and Ranch and Range Consulting. July 30, 2010. Buffler, S., C. Johnson, J. Nicholson, and N. Mesner. 2005. Synthesis of Design Guidelines and Experimental Data for Water Quality Function in Agricultural Landscapes in the Intermountain West. USDA Forest Service/UNL Faculty Publications. Paper 13. http://digitalcommons.unl.edu/usdafsfacpub/13 Diebel, M., J. Maxted, P. Nowak, M. Vander Zanden. 2008. Landscape planning for agricultural nonpoint source pollution reduction. I: A geographical allocation framework. Environmental Management 42:789-802. Kallestad, J. and M. Swanson. 2009. Riparian Buffers for Western Washington Agriculture. Tilth Producers Farm Walk Series. Washington State University, Pullman WA. August 3, 2009. Michie, R. 2010. Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon. Prepared by Oregon Department of Environmental Quality, Watershed Management Section, Portland, OR. March 2010. Peterjohn, W. T. and D. L. Correll. 1984. Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. Ecology 65(5): 1466-1475. The Freshwater Trust (TFT). 2015. Recommendations for Process Improvements: Phosphorus Crediting in the Klamath Basin. Submitted to PacifiCorp by The Freshwater Trust. March 2015.

Riparian Fencing and Grazing Management	
	Upper Klamath Basin Comprehensive Agreement. April 18, 2014. http://klamathtribes.org/wp-content/uploads/2014/08/2014-4-18-UPPER-KLAMATH-BASIN-COMPREHENSIVE-AGREEMENT.pdf Walker, J., J. Kann, W. Walker. 2015. Spatial and temporal nutrient loading dynamics in the Sprague River Basin, Oregon. Prepared for The Klamath Tribes Natural Resources Department. Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent and vegetation. Office of Public Service and Outreach, Institute of Ecology, University of Georgia. Welsch, D. J. 1991. Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources. Radnor, PA: USDA Forest Service.

<table>
<tr><th colspan="2">Agricultural Irrigation Efficiency and Water Management</th></tr>
<tr><td>Location</td><td>Irrigated agricultural areas within the Upper Klamath Basin subbasins include the Sprague River, Williamson River, Upper Klamath Lake, Lost River, Upper Klamath East, and Butte Creek. Specific areas or locations that are logical to be targeted for these projects include:

Klamath Project and Lost River, Horsefly, and Langell Valley Irrigation Districts
Klamath Irrigation District
Tule Lake Irrigation District
North Ditch off the North Fork Sprague
Upper end of Middle Sprague
Lake Ewuana/Keno Reservoir – mainstem Klamath River

Reclamation’s Klamath Project Area includes 188,000 of the 502,000 acres of private irrigated land in the basin upstream of Iron Gate dam. This includes lands leased from the various wildlife refuges that are supplied with water by Reclamation. The majority of the private irrigated land in the basin, about 314,000 acres, is located outside Reclamation’s Klamath Project Area. Natural Resources Conservation Service (2006) subbasin assessments indicated an opportunity to conserve water and improve water quality on 130,000 acres of irrigated lands within Reclamation’s Klamath Project Area. Outside Reclamation’s Klamath Project Area there is an opportunity for water conservation on approximately 220,000 irrigated acres.

Reclamation is conducting planning to identify and assess options to improve water quality and sustain or enhance water use in the Klamath Project study area. Water resource options could involve new facilities or modified operations. Examples include land-based water treatment (wetlands, agriculture, sedimentation), irrigation operations (water reuse, crop cycling), or seasonal storage (supplemental supply, surge ponds). Identified higher priority actions and locations could be carried into a demonstration project planning stage with potential funding support by Reclamation or other resources.</td></tr>
<tr><td>Goals, Objectives, Assumed Capability</td><td>The overall objective is to manage irrigation and associated return flows along streams that flow into Upper Klamath Lake or the Klamath River to reduce sediment loads (and sediment-bound nutrients) and irrigation tailwater discharges to the streams and rivers in the Upper Klamath Basin. Given the relatively high phosphorus content of soils in the Upper Klamath Basin and the fact that both the Upper Klamath Lake Drainage and Klamath River TMDLs point to external phosphorus loading from the basin above Upper Klamath Lake as a driver of water quality throughout the system, minimizing return flow associated with irrigation is a potential priority. Any method that captures sediment or retains soil on agricultural lands would reduce phosphorus loads. For example, converting from flood or furrow irrigation to drip, sprinkler, or gated pipe irrigation conserves water and keeps more phosphorus in the field. Likewise, fields that are leveled to a gentle slope irrigate more uniformly and do not suffer as much irrigation-induced erosion as fields with greater slope.

Reclamation assessments indicate that if all potential conservation practices are implemented on all irrigated lands, on-farm water use efficiency could reduce water use (and hence potential runoff) by up to 25 percent in the Upper Klamath Basin, with a concomitant reduction in nutrient and sediment loadings to adjacent waterways (Reclamation 2012, 2016). An additional potential two to five percent reduction in water use could be achieved by increasing management in upland range and forestland areas.</td></tr>
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<tr><th colspan="2">Agricultural Irrigation Efficiency and Water Management</th></tr>
<tr><td>Design Features and Elements</td><td>Irrigation Efficiency and Water Management Projects include the reduction of irrigation return flow by using wetlands/ponds and pump-back systems; upgrading irrigation systems to reduce irrigation-induced erosion, sedimentation to streams, and increase the efficiency of irrigated water applications to reduce runoff; and lining or piping delivery systems to reducing water loss and sediment delivery to rivers and streams. Examples of specific projects include canal lining, water storage improvements, water conveyance and pumping improvements, on-farm delivery and best practices, on-farm individual storage ponds/tanks, or land idling.

These irrigation efficiency and water management efforts would contribute to improved water quality in adjacent canals and streams by preventing excessive soil leaching and runoff into local water sources. Water conservation practices that reduce tailwater runoff from irrigated fields can provide extensive improvements in water quality (Shock and Welch 2011; Reclamation 2016).

Improved irrigation practices to manage soil water include more precise irrigation timing and managed deficit irrigation strategies to reduce agricultural water use and conserve water, but they require excellent control of the timing and amounts of the applied water. Techniques to improve irrigation efficiency also include installing more efficient irrigation systems. Sprinkler and drip irrigation systems are more efficient than furrow irrigation. By using polyacrylamide or straw mulch, the sediment that normally would be washed away in runoff, instead settles to the bottom of the furrow or ditch, preventing excess phosphorus loss (Iida and Shock 2008). Sedimentation basins with pump-back systems pump water to the top of the field or to the next field thereby collecting and reusing runoff (Shock and Welch 2011). Vegetation filter strips can be implemented as barriers to slow and filter runoff water containing sediment. As water runs through the filter strip, the sediment settles and is trapped in the strip (Shock et al. 2013).

Data and information is not currently available on the specific nutrient removal or reduction efficiencies by potential Irrigation Efficiency and Water Management Projects. In the Lost River Valley, there are current efforts to monitor the main points of diversion and some of the large tail water return locations (M. Hiatt, ODEQ, pers. comm.). This is ahead of large scale piping efforts that are potentially moving forward in this area.

Piping and irrigation strategies help to reduce irrigation water contact with soils and other nutrient containing organic material (Ciotti 2005; Ciotti et al. 2010). Through irrigation efficiency projects, the potential for tail water return will be greatly reduced. This reduction will in turn help reduce or eliminate the suspected loading stemming from these discharges. The environmental benefits relate directly to reduced nutrient and temperature loading through reduction of irrigation return flows and indirectly through reduced water demand which could potentially allow for more water in the streams and less need to divert water from Upper Klamath Lake.</td></tr>
<tr><td>Potential Adverse Impacts & Uncertainties</td><td>Potential adverse impacts: Potential for some tradeoff effects including, for example, improved water use efficiency from agricultural lands resulting from piping supply systems, while generally considered a positive effect, could result in less groundwater recharge and therefore reductions in local surface water runoff or groundwater discharge to streams.

Uncertainties: It is uncertain at this time as to how much and when Irrigation Efficiency and Water Management Projects would occur in the basin, depending on landowner incentives and funding availability to undertake the projects. Other uncertainties are</td></tr>
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Agricultural Irrigation Efficiency and Water Management	
	associated with the magnitude and reliability of effectiveness that result from these projects in affecting the necessary nutrient reduction.
Estimated Cost of Project	Construction: $200,000,000 O&M (timeframe): $27,000,000 over 20 years ACM: $37,000,000 The above costs are based on NRCS (2004), who estimated costs of implementing improved irrigation and water conservation practices in the Upper Klamath Basin. The estimated costs are evaluated as applied on 350,000 acres of private farm and range lands in the basin over an assumed period of 20 years. These estimated costs pertain specifically to implementation costs, and therefore do not account for potential resulting economic benefits of these actions to other resources, such as enhanced water availability and benefits to fish and wildlife habitat. It should be noted that costs for each project are highly depended on flow rates, installation difficulty, and other site-specific concerns (e.g., road crossings, creek crossings, elevation changes, etc.). Two other pertinent cost information includes: • In consultation with Reclamation and reviewing current and past piping projects funded through their WaterSmart program, the cost for 7,200 ft of pipe is $397,232.50 or $55.17 per foot. This is inclusive of labor and equipment cost. • Current estimates from TU for the North Ditch off the North Fork Sprague River is approximately $1,000,000 per mile or $189.39 per foot.
Duration	Long term
Collaboration, Synergy, or Conflict	Irrigation Efficiency and Water Management Projects will address some of the same non-point sources of sediment and nutrient loads (and therefore provide synergy with) as natural wetland restoration, DSTWs, and riparian buffers. Reduced runoff could reduce the nutrient loading that these other treatment systems are intended to manage, further increasing the overall reduction as many of these different projects come on line. However, it is possible that reduced runoff from agricultural uses could reduce the water supply to wetlands and DSTWs that the vegetation in these systems depend on to capture sediments and reduce nutrient loading. Regarding potential collaboration, potential agency partners include ODEQ, North Coast Regional Water Quality Control Board, Reclamation, and NRCS. In addition to the water conservation benefits that are of significant interest to Reclamation and NRCS, the water quality agencies see this as a potentially important strategy for reducing discharge of phosphorus related to agricultural activities. Trout Unlimited is currently exploring options for some piping projects in the Sprague River area.
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