4. PROPOSED ACTION

4.1. Action Area

The Action Area includes "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 C.F.R. § 402.02). Project lands are identified in Figure 4-1.

The Action Area extends from UKL, in south central Oregon, and Gerber Reservoir and Clear Lake Reservoir in the Lost River drainage in southern Oregon and northern California, to approximately 254 miles downstream to the mouth of the Klamath River at the Pacific Ocean, near Klamath, California (Figure 4-2).

Within the Upper Klamath Basin, the Action Area includes Agency Lake, UKL, Keno Impoundment (Lake Ewauna), Lost River including Miller Creek, and all Reclamation-owned facilities including reservoirs, diversion channels and dams, canals, laterals, and drains, including those within Tule Lake and Lower Klamath NWRs, as well as all land, water, and facilities in or providing irrigation or drainage for the service area of the Project.

Direct effects of the PA are those effects that occur as a result of implementation of the PA. Indirect effects are those effects that are caused by or will result from the PA and are later in time but are still reasonably certain to occur (50 C.F.R. § 402.02). This BA considers both direct and indirect effects for the purpose of analyzing potential species impacts.

The direct effects of Project operations extend downstream from UKL to the KSD, which is the most downstream Project feature that enters the Klamath River upstream of Keno Dam, Oregon. There is a potential for direct effects on listed suckers to occur throughout the Action Area above IGD, although measures such as fish screens at the A Canal and Clear Lake Dam, and a fish ladder at the LRD reduce these effects.

Effects on suckers continue beyond the location of the Project (*see* Part 1.2 for a description and map), including the entirety of UKL, Clear Lake Reservoir, Gerber Reservoir, and Lake Ewauna, into a series of hydroelectric dams and reservoirs (Keno, J.C. Boyle, Copco I, Copco II, and IGD) owned and operated by PacifiCorp. Effects on coho salmon occur downstream of the hydroelectric dams owned by PacifiCorp and continue to some extent to the mouth of the Klamath River at the Pacific Ocean (*see* Part 8.3.2, Table 8-3 for the relative influence of Project operations [IGD releases] below IGD). The effects of Project operations (IGD releases in this case) diminish with increasing distance downstream as the Klamath River volume increases with water from the Scott, Shasta, Salmon and Trinity rivers, and numerous other tributaries, seeps, and springs (*see* Part 8.3.2, Table 8-3). Figure 4-3 describes average annual flow volumes (in AF; from WY 2001 to 2017) contributed to the mainstem Klamath River by these tributaries, illustrating the diminishing direct effect. Figure 4-3 does not include average annual Project diversions via the A Canal that may impact the volumes available for release at the LRD. Note that there may be other effects of Project operations on Klamath River conditions (e.g., water quality, water temperature, etc.) and these are addressed in Part 8.

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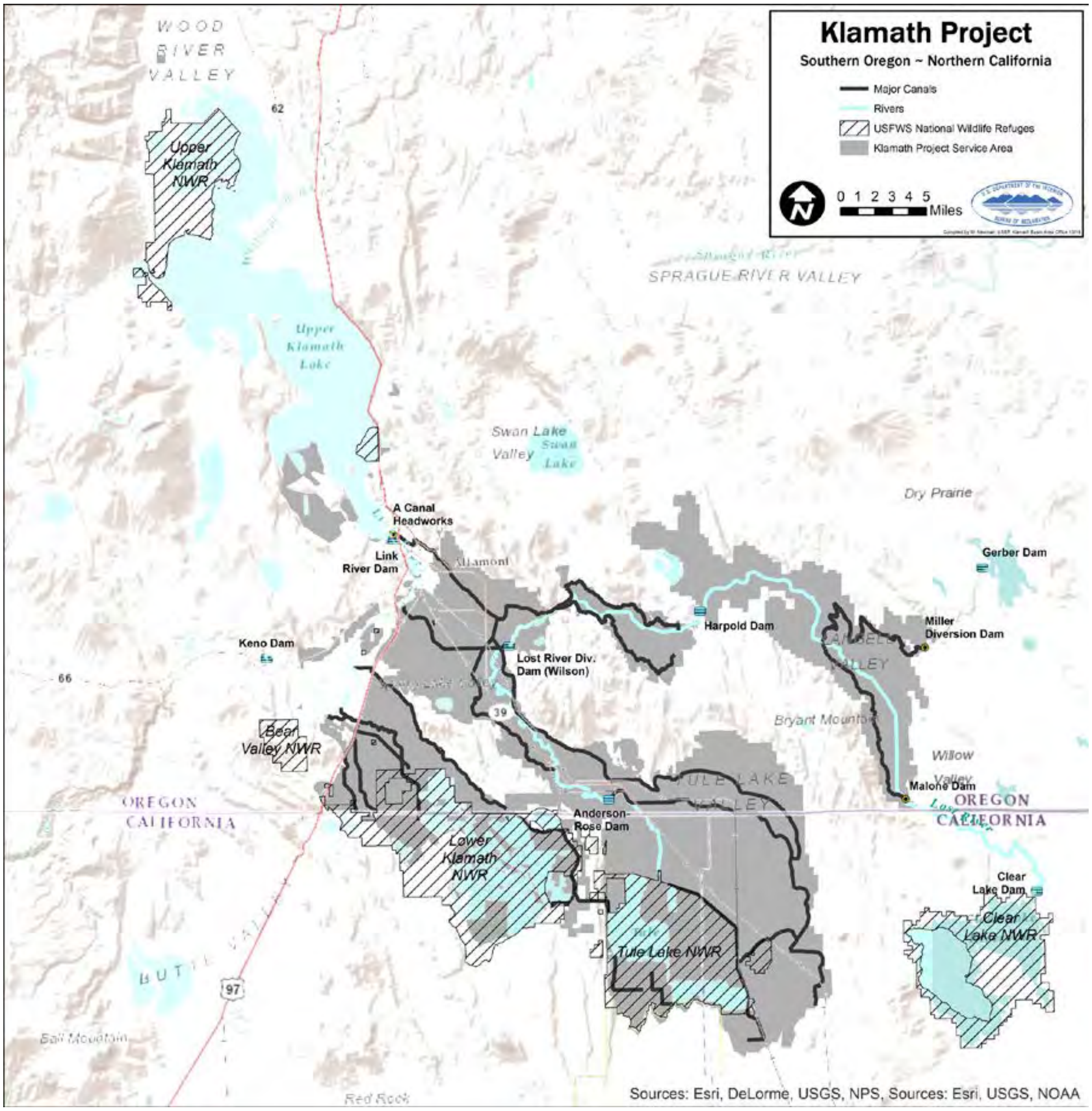

Figure 4-1. Upper Klamath Basin of Oregon and California. Klamath Project lands are shown as shaded area on the map.
Source: Bureau of Reclamation 2018

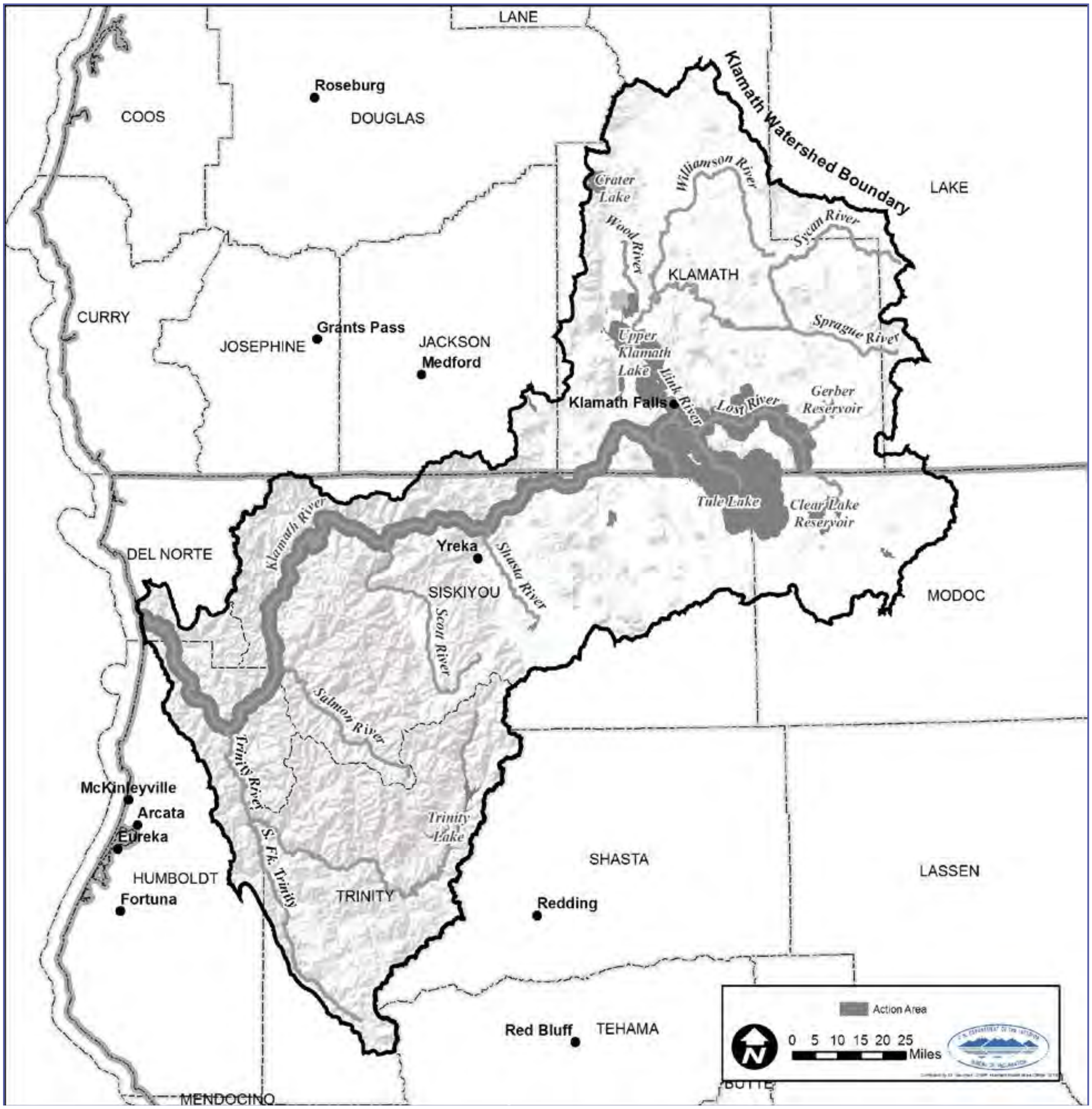

Figure 4-2. Map of the Action Area.
Source: Bureau of Reclamation 2018.

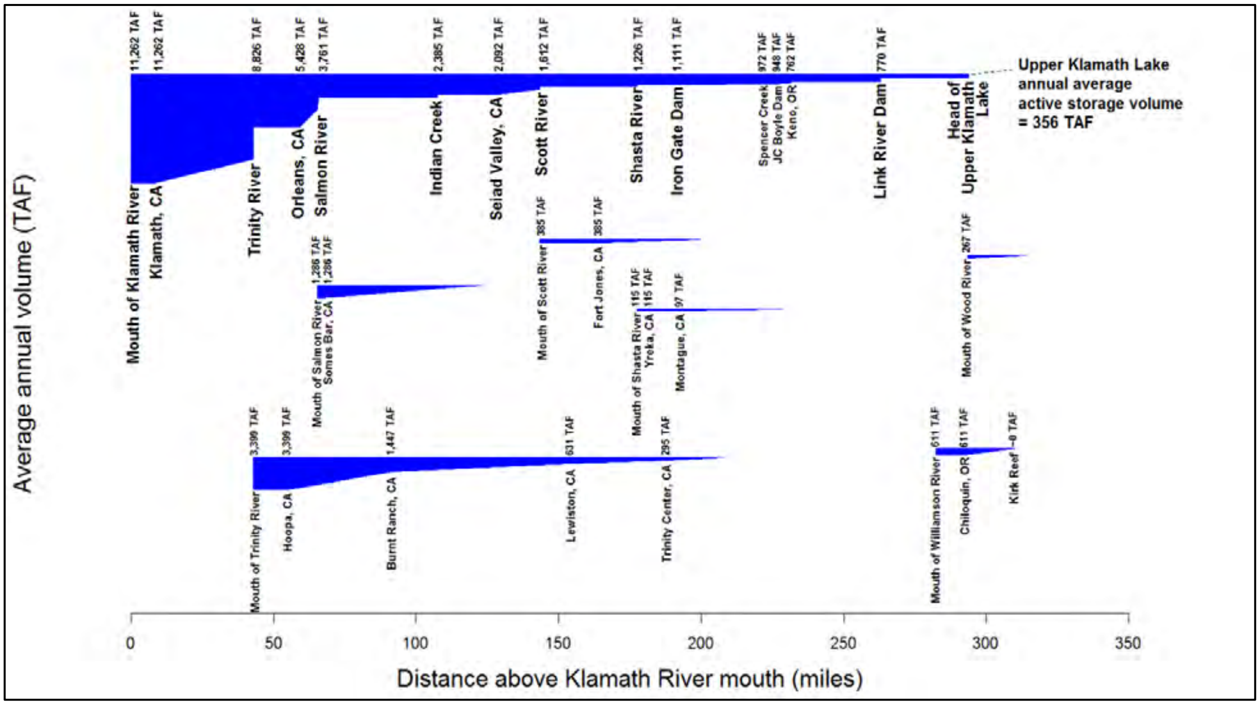

Figure 4-3. Annual volumes (thousand acre-feet [TAF]; water years 2001 to 2017) flowing through the Klamath River at major confluences and landmarks from the Project to mouth of the Klamath River.
Source: Bureau of Reclamation 2017.

There is a separate Action Area specific to the SRKW as there are no effects of flow management that affect SRKW. Rather there is an indirect link to SRKW from Chinook spawning and rearing habitat in the Klamath River, and Chinook are a primary prey for SRKW. This indirect link results in effects that extend out into the Pacific Ocean where SRKW feed on concentrations of adult Chinook salmon (*see* Part 9.1.2. for more detail). This separate Action Area extends, for SRKW only, to that section of the ocean where there is species overlap between Chinook salmon and SRKW. The exact boundaries of this area cannot be defined based upon current information.

4.2. Background

Reclamation has managed minimum UKL elevations (since 1991) and Klamath River flows at IGD (since 2001) in accordance with a series of BiOps from the Services.

For the 2012 BA, Reclamation – in consultation with USFWS and NMFS – used the 1981 through 2011 historical hydrology and revised NRCS forecasts for UKL net inflows as the most complete set of daily data available for development of the PA. To prepare for the current consultation effort, since issuance of the 2013 BiOp, Reclamation has reviewed data updates and refinements, including: new data to expand the POR through 2016 (i.e., 1981 to 2016), a new UKL bathymetric layer, updated UKL net inflow estimates for the POR, and updated daily Project diversion data and return flows for the POR. The 36-year POR includes a broad range of hydrologic conditions that likely represent the range of future conditions within the timeframe covered by the PA. It is important to note that the full effects of climate change during the term of the BA are not fully understood. However, Reclamation believes that the POR includes a climate change signal to some extent, given that trends expected to continue into the future have been observed in the Pacific Northwest over the past several decades (Mote 2003).

4.2.1. Proposed Action Model Development

Reclamation incorporated the 1981 through 2016 dataset into WRIMS to assess the effects of the PA. WRIMS is a generalized water resources modeling system for evaluating operational alternatives of large, complex river basins and is essentially a mass balance model. As described above, historical daily data for this POR was reviewed and updated by comparing values recorded by Reclamation with other data sources, adding data from 2011 through 2016, recalculating computed values, and revising UKL bathymetry using a more current and complete dataset (termed "Reclamation 2017 bathymetry" and described in Reclamation 2017). The final data set used for the analysis was collaboratively developed and reviewed by Reclamation and the Services. Finally, concerns have been raised regarding the accuracy of the UKL bathymetric layer utilized in the KBPM to model this PA; however, it is the best information currently available and it is unclear and to what extent (if any) a revised bathymetric surface will have on the existing area capacity curves. S*ee* Part 6.3.1 for additional discussion about UKL bathymetry.

The working version of WRIMS that was used to simulate operations of the Project is referred to as the KBPM. The KBPM encompasses the areas of the Project served by UKL and the Klamath River and extends from UKL to IGD. KBPM does not model the portion of the Project served by Clear Lake and Gerber reservoirs, although the net effects of conditions on this portion of the Project on the Klamath River are included in the model via the gains (i.e., accretions to the Klamath River) and losses (i.e., Project diversions) within the LRDC. The KBPM also does not model explicit operational details for many facilities within the Project (e.g., Pumping Plant D) and on the Klamath River such as IGD or other reservoirs owned and operated by PacifiCorp; however, reservoir storage on the Klamath River is considered in broad terms to ensure there is sufficient time to fill reservoirs to spillway elevation prior to IGD releases requiring spill. Operation of Project facilities that store and divert water from UKL and the Klamath River was simulated over a range of hydrologic conditions using daily input data to obtain daily, weekly, monthly, and annual results for river flows, UKL elevations, and Project diversions (including deliveries to the LKNWR). Reclamation modeled the effects of the potential management action of operation of Project facilities that store and divert water from UKL and the Klamath River on UKL elevations and Klamath River flows for the period of October 1, 1980 through November 30, 2016. The resulting simulated hydrology represents the water supply available from the Klamath River system (including UKL) at the current level of development.

The KBPM is a planning tool that assisted in the development of the PA and not all the processes built into the model can be implemented during actual operations. In addition, there are many assumptions associated with modeling efforts of this nature, and it is important to be aware of the critical assumptions that are incorporated into the KBPM. Listed below are the critical assumptions that have been identified for the KBPM. This list provides examples of how some of the processes built into the KBPM cannot be, and are not intended to be implemented, during real-time operations.

Critical KBPM assumptions include:

- The upper Klamath River basin will experience WY types within the range observed in the POR.
- UKL inflows will be within the range observed in the POR.
- NRCS inflow forecasts will be within the range and accuracy of historical inflow forecasts.
- UKL bathymetry in the model is reasonably representative of actual UKL bathymetry and therefore accurately represents UKL storage capacity.
- Water deliveries to the Project will be consistent with distribution patterns analyzed for the KBPM.
- Accretions from LRD to IGD will be consistent with accretion timing, magnitude, and volume assumed in the KBPM.
- Accretions from LRD to IGD will be routed through PacifiCorp's hydroelectric reach in a manner that is consistent with the KBPM model results for the POR.
- Facility operational constraints and limitations, and/or associated maintenance activities, will be within the historical range for the POR.
- Implementation of the proposed action will not exactly replicate the modeled results, and actual IGD flows and UKL elevations will differ during real-time operations.

Additionally, the KBPM is a tool and model outcomes are not prescriptive. Similarly, the occurrence of a condition that does not conform to an assumption is not inconsistent with the PA and does not necessarily trigger a duty to re-initiate consultation.

A detailed description of the WRIMS model can be found in Appendix 4.

4.2.2. Water Supply Forecasts

Annual planning relies heavily on seasonal water supply forecasts provided by the NRCS in the form of net inflow forecasts for UKL. The water supply forecasts are developed based on antecedent streamflow conditions, precipitation, snowpack, groundwater, current hydrologic conditions, a climatological index, and historical streamflow patterns (Risley et al. 2005). NRCS updates the forecasts for the season at the start of each month from January to June, with additional unofficial forecasts provided mid-month from March through June. The official (i.e., first of the month) UKL inflow forecasts are used to estimate the seasonal net inflow to UKL through September, which is used to determine the volume of water to be reserved in UKL for the federally-listed suckers, an estimate of water supply for the Project, and an estimate of the March through September Klamath River EWA volume for federally-listed coho salmon (discussed further in Part 4.3.2.2., Operational Approach). It's important to note that the NRCS

UKL inflow forecasts are seasonal volumetric estimates and actual observed inflow volumes and timing can vary substantially from the forecasted inflow, especially over shorter time periods.

Upon request, in 2017, the NRCS used revised inflow data provided by Reclamation to reconstruct forecasts for 1981 to 2016. The results, shown in Table 4-1, appear similar in forecast accuracy to forecasts utilized in development of the 2013 BiOp. Forecast values ranged from 160,419 AF during 1991 to 1,070,129 AF during 1999. These volumes range from 26 to 171 percent of average values for the March through September time period (average March through September inflow for the POR is 620,667 AF). Table 4-1 also shows observed annual inflows from 1981 to 2016. On average, the forecast values were 102 percent of the historical values (98 percent of median). Values for individual years ranged from 63 to 217 percent of observed inflows (as compared to 68 to 223 percent during the 2013 BiOp analysis). A detailed description of the NRCS inflow forecasting procedures is available at https://www.wcc.nrcs.usda.gov/about/forecasting.html.

Table 4-1. Reconstructed Natural Resources Conservation Service March 1st 50 percent exceedance Upper Klamath Lake inflow forecasts for March through September from 1981-2016.

Year	Forecasted UKL Inflow (Acre-Feet)	Forecast Percent of Average (Avg = 620,667 AF)	Observed UKL Inflow (AF)	Observed Percent of Forecast
1981	396,563	64	366,269	92
1982	889,637	143	994,348	112
1983	1,025,671	165	1,223,989	119
1984	878,857	142	1,140,831	130
1985	795,367	128	779,262	98
1986	782,212	126	850,485	109
1987	544,961	88	519,134	95
1988	503,026	81	402,542	80
1989	743,544	120	868,712	117
1990	395,015	64	431,831	109
1991	160,419	26	348,450	217
1992	296,882	48	222,549	75
1993	945,809	152	961,351	102
1994	395,188	64	254,346	64
1995	586,569	95	712,330	121
1996	735,470	118	796,772	108
1997	900,855	145	648,847	72
1998	824,676	133	960,304	116
1999	1,070,129	172	1,027,319	96
2000	867,994	140	723,171	83
2001	407,045	66	338,805	83
2002	693,201	112	438,677	63
2003	425,598	69	474,347	111
2004	730,808	118	459,119	63
2005	456,372	74	454,378	100
2006	963,272	155	917,206	95
2007	530,635	85	526,490	99
2008	692,028	111	623,985	90
2009	514,632	83	507,524	99
2010	509,953	82	422,643	83
2011	625,019	101	808,304	129
2012	392,468	63	566,090	144
2013	519,560	84	415,096	80
2014	241,474	39	339,015	140
2015	315,982	51	293,794	93
2016	587,124	95	506,882	86

4.3. Proposed Action

The PA for water year (WY) 2019 to 2024 consists of three major elements to meet authorized Project purposes, satisfy contractual obligations, and address protections for listed species and certainty for Project irrigators:

1. Store waters of the Upper Klamath Basin and Lost River.

2. Operate the Project, or direct the operation of Project facilities, for the delivery of water for irrigation purposes or NWR needs, or releases for flood control purposes, subject to water availability; while maintaining conditions in UKL and the Klamath River that meet the legal requirements under section 7 of the ESA.

3. Perform O&M activities necessary to maintain Project facilities.

Each of the elements of the PA is described in greater detail in the following sections. The three major elements of the Proposed Action have not changed relative to the 2012 BA.

4.3.1. Element One

Store waters of the Upper Klamath Basin and Lost River.

4.3.1.1. Annual Storage of Water

Reclamation operates three reservoirs for the purpose of storing water for delivery to the Project's service area – UKL and Clear Lake and Gerber reservoirs.

Bathymetric data compiled by Reclamation in 2017 (including nearshore areas such as Upper Klamath NWR, and Tulana and Goose Bays), indicated an "active" storage volume of 562,000 AF between the elevations of 4,136.0 and 4,143.3 feet above sea level (USBR datum), which is the historical range of water surface elevations within which UKL has been operated. *See* Part 6.3 for additional details regarding historical conditions in UKL.

Clear Lake Reservoir has an active storage capacity of 467,850 AF (between 4,521.0 and 4,543.0 feet above sea level, Reclamation datum), of which 139,250 AF is exclusively reserved for flood control purposes (between 4,537.4 and 4,543.0 feet above sea level, USBR datum).

Gerber Reservoir has an active storage capacity of 94,270 AF (between 4,780.0 and 4,835.4 feet above sea level, Reclamation datum). No storage capacity in Gerber Reservoir is exclusively reserved for flood control purposes.

Reclamation proposes to store water in UKL and Clear Lake and Gerber reservoirs year-round with a majority of the storage occurring from October through April. In some years of high net inflows or non-typical inflow patterns (i.e., significant snowfall or other unusual hydrology in late spring/early summer), contributions to the total volume stored can also be significant in May and June. Most water delivery from storage occurs during March through September, although storage releases for irrigation purposes occur year-round. Storing water through the winter raises lake elevations which usually peak between March and May. Flood control releases may occur at any time of year, as public safety, operational, storage, and inflow conditions warrant.

4.3.2. Element Two

> *Operate the Project, or direct the operation of the Project, for the delivery of water for irrigation purposes or NWR needs, subject to water availability, and consistent with flood control purposes, while maintaining conditions in UKL and the Klamath River that are protective of ESA-listed species.*

Consistent with Reclamation Manual Policy "Water-Related Contracts and Charges – General Principles and Requirements" (PEC P05) and as applicable to the Klamath Project, the term "Project water" encompasses surface water, including Project seepage and return flows, that is developed by, pumped or diverted into, and/or stored based on the exercise of water rights that have been appropriated or acquired by the United States or others, or that have been decreed, permitted, certificated, licensed, or otherwise granted to the United States or others, for the Klamath Project. Consistent with state water law and as applicable to the Klamath Project, the term "live flow" encompasses surface water in natural waterways that has not otherwise been released from storage (i.e., "stored water"). Live flow can consist of tributary runoff, spring discharge, return flows, and water from other sources (e.g., municipal or industrial discharges).

Project water, both stored and from live flow, is used to meet irrigation needs within the Project service area. Live flow is diverted from UKL, the Klamath River, and the Lost River for irrigation purposes. Generally, when live flow is insufficient to meet irrigation demands, stored water is released from UKL and Clear Lake and Gerber reservoirs to meet those needs.

Water supply contracts and other agreements between Reclamation and district entities or individuals, coupled with water rights (e.g., as currently determined in the ACFFOD), govern the distribution and use of Project water supplies (*see* Part 1.3.2, regarding Project water rights, and Part 1.3.3, regarding water supply contracts).

Altogether, the Project provides water for irrigation purposes to approximately 230,000 acres of land, including federally-owned lands within Lower Klamath and Tule Lake NWRs (*see* Part 1.3.6, regarding NWRs and associated acreages within the Project). Approximately 200,000 acres are primarily served from UKL and the Klamath River. Approximately 20,000 acres are served from Clear Lake and Gerber reservoirs, although as noted elsewhere, stored water from these reservoirs can be used under certain circumstances to meet irrigation demands in portions of the area served from UKL and the Klamath River.

In addition to the above acreages, live flow from the Lost River is exclusively used for irrigating approximately 10,000 acres, mostly located immediately upstream and downstream of Harpold Dam (i.e., Yonna and Poe valleys). Live flow from the Lost River is also used as a supplemental irrigation source for the area of the Project served from UKL and the Klamath River.

4.3.2.1. Operation and Delivery of Water from UKL and the Klamath River

The portion of the Project served by UKL and the Klamath River consists of approximately 200,000 acres of irrigable land, including areas around UKL, along the Klamath River (from Lake Ewauna to Keno), Lower Klamath Lake, and from Klamath Falls to Tulelake. Most irrigation deliveries occur between April and October, although water is diverted year-round for irrigation use within the Project.

Stored water and live flow in UKL are directly diverted from UKL, via the A Canal and smaller, privately-owned diversions. The A Canal (1,150 cubic feet per second [cfs] capacity) and the connected secondary canals it discharges into (i.e., the B, C, D, E, F, and G canals) serve approximately 71,000 acres within the Project. In addition to the A Canal, there are approximately 8,000 acres around UKL that are irrigated by direct diversions from UKL under water supply contracts with Reclamation.

In addition to direct diversions from UKL, stored water and live flow is released from LRD, for re-diversion from the Klamath River between Klamath Falls and the town of Keno. PacifiCorp currently operates LRD under guidance from Reclamation to achieve certain flows at IGD (*see* Part 1.3.5, regarding Reclamation's relationship with PacifiCorp and its predecessors).

Water released from LRD flows into the Link River, a 1.5-mile waterbody that discharges into Lake Ewauna, which is the start of the Klamath River. The approximately 16-mile section of the Klamath River between the outlet of Link River and Keno Dam is commonly referred to as the Keno Impoundment or Keno Reservoir (referred to as the Keno Impoundment herein).

There are three primary points of diversion along the Keno Impoundment that are used to re-divert stored water and live flow released from UKL via the LRD. Approximately three miles below the outlet of Link River, water is diverted into the LRDC, where it can then be pumped or released for irrigation use. Pumping from the LRDC primarily occurs at the Miller Hill Pumping Plant (105 cfs capacity), which is used to supplement water in the C-4 Lateral for serving lands within KID that otherwise receive water through the A Canal. KID operates and maintains the Miller Hill Pumping Plant. In addition to the Miller Hill Pumping Plant, there are other smaller, privately-owned pumps along the LRDC that serve individual tracts within KID.

Water re-diverted into the LRDC can also be released through Station 48 (650 cfs maximum capacity), where it is then discharged into the Lost River below the Lost River Diversion Dam for re-diversion and irrigation use downstream. TID makes gate changes at Station 48 based on irrigation demands in the J Canal system, which serves approximately 62,000 acres within KID and TID. To the extent that live and return flows in the Lost River at Anderson-Rose Dam and the headworks of the J Canal (810 cfs capacity) are insufficient to meet associated irrigation demands, water is released from Station 48 to augment the available supply.

The other two primary points of diversion along the Keno Impoundment that re-divert stored water and live flow from UKL are the North and Ady canals (200 cfs and 400 cfs capacity, respectively), which are owned and operated by KDD. In addition to lands within the boundaries of KDD, the Ady Canal also delivers water to the California portion of LKNWR. Together, the North and Ady canals deliver water to approximately 45,000 acres of irrigable lands in the Lower Klamath Lake area, including lands in KDD.

In addition to the lands served by the LRDC and Ady and North canals, Reclamation has entered into water supply contracts covering approximately 4,300 acres along the Keno Reservoir, including lands on the west side of the Klamath River and on Miller Island. Privately-owned pumps are generally used to serve these lands. Refer to Figures 1-1, 4-1, and Appendix 1A for maps showing the location of the facilities referenced above.

Demands for irrigation supply over the proposed lifetime of this BA are assumed to be similar to those that have occurred in the 36-year POR for water-year 1981 through 2016. However, continued improvements in irrigation infrastructure and equipment combined with advances in irrigation practices and technology will likely help to reduce Project irrigation demand in the future. The irrigation "demand" is the amount of water required to fully satisfy the irrigation needs of the Project. While these historical demands are retained for analysis and comparison purposes, irrigation deliveries to the Project within this PA were modeled using the Agricultural Water Delivery Sub-model (Part 4.3.2.2.2.2.; Appendix 4, section A.4.4.4). This sub-model includes variables such as deliveries during the previous timestep, meteorological conditions, and soil moisture to predict irrigation deliveries on a 5-day timestep, scaled to Project Supply (water available to the Project from UKL; *see* definition and additional details in Part 4.3.2.2.2.1) and water available from the LRDC and KSD. Modeled deliveries during this 36-year POR generally fall within the range of historical Project deliveries. In addition, the POR exhibits a large range of hydrologic and meteorological conditions, and the various modeled deliveries during this period are reasonably expected to cover the range of conditions likely to occur during the proposed term of this BA.

4.3.2.2. Operational Approach

This section of the PA provides a general overview of the operational approach for the PA; additional details regarding the fall/winter and spring/summer operational periods are discussed below in their respective sections and in Appendix 4.

Water management in the fall/winter operations period (November 1 – February 28/29 for the Project and from October 1 – February 28/29 for the Klamath River), employs a formulaic management approach focused on maintaining conditions in UKL and the Klamath River that meet the needs of the ESA-listed species as described in this BA and provide fall/winter water deliveries to the Project and LKNWR. This approach attempts to ensure appropriate water storage and sucker habitat in UKL (*see* Part 7 for details regarding sucker habitat) while providing Klamath River flows that mimic natural hydrologic conditions based on current conditions in the upper Klamath Basin. *See* Part 4.3.2.2.1 and Appendix 4, Section A.4.4.2 in-depth details regarding the fall/winter water management approach.

Water management in the spring/summer operational period includes March 1 – November 30 for Area A1 and March 1 – October 31 for Area A2. Limited overlap between spring/summer operations in Area A1 and fall/winter operations in October and November remains; in other words, as in the 2012 BA and 2013 BiOp, Area A1 may continue diverting spring/summer water (i.e., Project Supply) after October 1, when the fall/winter period begins (*see* Parts 4.3.2.2.1 and 4.3.2.2.2 for additional details). Note that Area A1 includes Project lands served by A Canal and the LRDC including KID, TID, and water supply contracts and Districts served by KID. Area A2 includes KDD and LKNWR served by the Ady and North canals.

Generally, Reclamation proposes to determine the total available UKL Supply, accounting for sucker needs [as outlined in Part 7] through the spring/summer period; (*see* Part 4.3.2.2.2.1), and then distribute this supply between the Project (Project Supply; water available to the Project from UKL; *see* definition and additional details in Part 4.3.2.2.2.1) and the Klamath River EWA (*see* Part 4.3.2.2.2.3 for definition and additional details). The division of the total available UKL water supply between EWA and Project Supply was determined through the iterative modeling process, relying on the expert opinion of Reclamation and, informally, the Services.

The management approach employed by Reclamation in this PA attempts to optimize the ecologic benefit of the available water supply, resulting in the ability to maximize the amount of remaining water available for the Project. In some instances, dry hydrologic conditions characterized by limited precipitation, runoff, and inflows to UKL may create shortages in the total available UKL water supply, which can result in a Project Supply that is less than the full irrigation demand. *See* Part 4.3.2.2.2. and Appendix 4, Section A.4.4.3 for in-depth details regarding the spring/summer operational approach.

The PA management approach has two major components:

1. UKL elevations and storage, specifically the UKL control logic and UKL Credit, to protect sucker habitat and ensure adequate storage to meet the needs of listed species in UKL and the Klamath River and water supply for the Project; and

2. Klamath River flows, specifically EWA to support coho needs and to produce flows for disease mitigation or protection of coho habitat during the spring/summer operational period (between March 1 and September 30), and a formulaic approach for calculating IGD releases in the fall/winter (October 1 – February 28/29).

Upper Klamath Lake
This operational approach seeks to fill UKL during the fall/winter to increase the volumes available for the EWA (including disease mitigation flows), UKL, and Project Supply during the spring/summer operational period. The PA also includes a "UKL control logic" that regulates certain releases (as described below) relative to UKL storage and recent hydrologic conditions in a manner that maintains UKL elevations important for suckers, and a "UKL Credit" that buffers UKL against uncertainties associated with NRCS forecast error and other factors affecting UKL inflow available for subsequent diversion.

The UKL control logic helps to manage UKL elevations for endangered suckers while ensuring adequate storage in UKL for both Klamath River and Project releases, utilizing a "central tendency." The central tendency is based on user-defined end-of-month UKL elevations which are subsequently interpolated to daily values (this is termed the generic central tendency). This results in a generic annual hydrograph that accounts for seasonal needs of suckers, seasonal water demand for the Klamath River and Project, and end-of-season elevations intended to result in (after winter inflows) storage volumes appropriate to meet the next year's demands on UKL. This generic hydrograph is then adjusted daily, based on a normalized 60-day trailing average of raw net inflow to UKL, producing an adjusted central tendency. If UKL elevations drop below the adjusted central tendency, then releases to the Klamath River (subject to IGD minimums described in Appendix 4, Section A.4.4.2, Table A.4.4.2.2) and winter deliveries to Area A2 are reduced until UKL elevations equal or exceed the adjusted central tendency line. The adjusted central tendency is not a target to which UKL should be managed, but rather a guideline that maintains UKL elevation in line with both hydrologic conditions and the multiple demands placed upon UKL storage throughout the year. Finally, note that the generic central tendency end-of-month UKL elevations were arrived at through the iterative modeling process and are not intended to change during operations under this PA. *See* Appendix 4, Section A.4.4.1.1 for technical details regarding the UKL control logic.

The purpose of the UKL Credit is to hold water in UKL to facilitate establishing a minimum Project Supply on April 1 with no later reduction below the April 1 value, and the possibility of an increase in subsequent May 1 and June 1 allocations. Accrual of UKL Credit provides a volume of water in UKL that can be drawn upon in the case of an early season over-forecast of seasonal inflow to UKL. Any UKL Credit accrued in UKL above and beyond that necessary for full delivery of Project Supply will remain in UKL to facilitate refill of UKL in the ensuing fall/winter period. There is no carryover of accrued UKL Credit from season to season. UKL Credit can only be accrued from March 1 – September 30 during controlled flow conditions (i.e., not during flood control operations), and is accumulated when LRDC flows and KSD discharges in excess of direct diversions for irrigation are utilized to meet IGD flow targets (i.e., Klamath River flows, as defined in section 4.3.2.2.2.3.), resulting in a reduction in LRD releases. In other words, when Project irrigators do not divert LRDC flow or KSD return flows and these unused volumes are utilized to offset LRD releases, a volume of water (the UKL Credit, equal to the reduction in LRD releases for river flows) is stored in UKL. As with current operations, Reclamation anticipates that PacifiCorp will adjust LRD releases as appropriate to meet IGD targets, accounting for these specific accretions to the Klamath River (i.e., if LRDC and KSD accretions increase, PacifiCorp would decrease LRD releases such that IGD targets are still met, but not exceeded). Reclamation will track accretions and IGD releases to properly calculate the UKL Credit. S*ee* Part 4.3.2.2.2. for additional details.

For several graphical examples of the anticipated UKL elevations, *see* Appendix 4, Section B. The model output graphs provided in Appendix 4, Section B provide examples of how the annual hydrographs might look. Real-time operations will not exactly replicate the modeled results and actual flow and elevation variability will differ during real-time operations.

Klamath River

Reclamation is proposing to distribute EWA from UKL based on the EWA allocation, UKL control logic, UKL net inflow, and NRCS-forecasted March – September net inflow (50 percent exceedance) from March 1 – September 30. From July 1 – September 30, Reclamation proposes to distribute EWA from UKL based on remaining EWA and UKL control logic. Reclamation also proposes to retain IGD as a compliance point for Klamath River flows (though *see* Part 3.7.1 for details about dam removal and associated implications for this BA). Finally, the PA incorporates into the EWA the augmented April, May, and June IGD minimums called out separately in the 2013 BiOp (*see* Appendix 4, A.4.4.6.1 for IGD minimums), and explicitly provides additional water to mitigate disease issues in years meeting specific criteria (*see* Part 4.3.2.2.2.4.).

As in the 2013 BiOp, IGD targets in the fall/winter and a portion of the spring/summer period are calculated using a hydrologic indicator of upper Klamath Basin conditions. Specifically, Reclamation proposes to utilize the net inflow to UKL to calculate IGD targets throughout the fall/winter period and for part of the spring/summer period (March 1 – June 30; note that from July 1 – September 30, EWA distribution is based on EWA allocation and UKL control logic as described above and in Part 4.3.2.2.2.3.). The intent of this method is to create a hydrograph downstream of IGD that approximates a natural flow regime reflective of actual hydrologic conditions and variability occurring in the upper Klamath Basin. Net UKL inflow was chosen over the previously-utilized Williamson River discharge because Williamson River flow is only reflective of hydrology in a portion of the UKL watershed, namely the ground-water dominated north-central portion. UKL net inflow is preferable given that it also accounts for hydrologic dynamics in the groundwater-dominated Wood River and snowmelt-runoff dominated tributaries originating in the Cascade Mountains. Additionally, UKL net inflow is calculated daily using a number of gages maintained by the USGS with consistent and reliable datasets over the POR. These gages are expected to remain in operation and the continued reliability of this hydrologic data is an important consideration to retain the ability to implement the PA in the future.

Utilizing UKL net inflow as the hydrologic proxy is expected to result in IGD flows of a similar timing and shape observed under the 2013 BiOp, with the exception that there is also sufficient EWA volume to implement disease mitigation in the Klamath River (*see* Part 4.3.2.2.2.4. for additional details). IGD targets may also now be adjusted based on the UKL control logic (*see* Parts 4.3.2.2.1. and 4.3.2.2.2.3. for additional details).

For several graphical examples of the anticipated IGD hydrograph, *see* Appendix 4, Section B. The model output graphs provided in Appendix 4, Section B provide examples of how the annual hydrographs might look. Real-time operations will not exactly replicate the modeled results and actual flow and elevation variability will differ during real-time operations. The daily IGD target flows will be implemented three days after the hydrologic conditions are observed in the upper Klamath Basin. The actual transit time may be more or less than three days depending on the magnitude of the flow rate, elevation of UKL, and the hydrologic conditions downstream of UKL. No attempt was made to calculate transit time and the three-day delay is not intended to precisely replicate flow conditions in the Klamath River. Rather, the three-day lead time is needed for IGD flow schedule planning purposes to accommodate PacifiCorp's operation of the Klamath Hydroelectric Project.

In the event of gage failure, professional judgment will be used in combination with all relevant hydrologic data to estimate UKL elevation and inflow, IGD releases, and/or LRD to IGD accretions. USGS gage failures occur infrequently and every attempt will be made to coordinate with USGS to appropriately estimate flow and/or elevation values whenever a gage failure occurs.

Finally, PacifiCorp's operation of the Klamath Hydroelectric Project will influence the timing and magnitude of the hydrograph downstream of IGD due to water travel time through the reservoirs and due to facilities operations. Under normal operating conditions, these influences are expected to be minimal because PacifiCorp manages hydroelectric operations to meet IGD targets.

4.3.2.2.1. Fall/Winter Operations

The fall/winter operational period extends from November 1 – February 28/29 for the Project and from October 1 – February 28/29 for the Klamath River (i.e., EWA no longer applies after September 30). Note that there is often overlap between the spring/summer and fall/winter operations in October and November because Area A1 and the LKNWR will likely divert a portion of the spring/summer Project Supply during these months, while EWA accounting ends on October 1. Spring/summer and fall/winter diversion accounts must be kept separate during the overlap period.

The fall/winter Project operational procedure distributes the available fall/winter UKL inflows among the following:

1. UKL:
   a. Increase UKL elevation to meet sucker habitat needs (as outlined in Part 7) throughout the fall/winter period and the following spring/summer period, as well as increase storage for spring/summer EWA releases and irrigation deliveries.
   b. This is achieved through a fall/winter UKL refill rate and the UKL control logic.

2. Klamath River:
   a. Release sufficient flow from IGD to meet ESA-listed species needs in the Klamath River downstream of IGD; this includes flows to support coho spawning from October 1 – November 15.
   b. This is achieved through the formulaic approach to calculating IGD targets.

3. Project:
   a. KDD (Area A2 – served by North Canal and Ady Canal)
   b. Lease Lands in Area K (Area A2 – served by Ady Canal)
   c. LKNWR (Area A2 – served by Ady Canal)

Additionally, sufficient flood pool capacity must be maintained in UKL to balance refilling UKL to meet legal requirements with flood-related public safety issues.

To satisfy these objectives, Reclamation proposes to calculate IGD target flows by means of a series of context-based real-time equations using the net UKL inflow as a hydrologic indicator. Specific steps for calculating IGD target flows include:

1. Determine the LRD flow target, which is the maximum of either the minimum LRD flow target (look up table) or the LRD release target to support IGD target flows (calculated as follows)
   a. October 1 – November 15
      i. Determine the IGD target necessary for coho spawning flows
   b. November 16 – February 28/29
      i. Determine yesterday's smoothed UKL net inflow

    ii. Subtract 1.5 times the average daily UKL fill rate necessary to attain a UKL elevation of 4,143 feet on February 28/29
  c. Adjust based on the difference in UKL storage between the UKL adjusted central tendency and UKL elevation
  d. Constrain by the maximum LRD release capacity, if applicable

2. Determine the IGD flow target, which is the maximum of either the minimum IGD flow requirement (look up table; Appendix 4, Section A.4.4.2, Table A.4.4.2.2) or the IGD flow target (calculated below)
  a. October 1 – November 15
    i. Determine the IGD target necessary for coho spawning flows
  b. November 16 – February 28/29
    i. To the LRD flow target calculated in step 1, add LRD to Keno Dam accretions from three days prior (i.e., this step relies on the accretion that occurred in a single day three days ago)
    ii. Add the value for today's Keno Dam to IGD accretions that was forecast three days ago (i.e., this step relies on the accretion forecast for the current day that was issued three days ago)
    iii. Add KSD discharge (assumes three-day lag)
    iv. Add the maximum of either LRDC flow towards the Klamath River minus diversion of LRDC water to North and Ady canals (assumes three-day lag), or zero

Note that it is operationally possible to reduce LRD flows below the flow 'minimums' referred to above (and further described in Appendix 4, Section A.4.4.2), but this requires Reclamation to conduct a fish stranding assessment below LRD (and possibly below Keno Dam). This requires additional personnel and other resources and Reclamation will weigh the benefit of flows below LRD minimums against the personnel, resource and safety requirements necessary for completion of the stranding assessments. If a reduction below LRD "minimum" flows is desired, Reclamation retains discretion in weighing the benefits of such an action against the issues described above. Additionally, note that the LRD target flow is not adjusted to account for the fill trajectory in UKL until November 16. October 1 through November 15 is a period of transition in Klamath Basin hydrology (i.e., UKL elevation transitions from decreasing to increasing), is a biologically sensitive time downstream of IGD (e.g., Chinook spawning and egg incubation) and is subject to highly variable accretions between LRD and IGD. Therefore, no adjustments beyond those of the UKL control logic are made to enhance UKL refill during this period.

Relative to fall/winter irrigation needs, up to 28,910 and 11,000 AF of fall/winter water is made available to KDD and LKNWR, respectively, subject to the UKL control logic. Specifically, if UKL elevation is at or above the adjusted central tendency throughout the fall/winter period, the only modeled constraints to delivery would be the delivery cap (28,910 and 11,000 AF for KDD and LKNWR, respectively), conveyance capacity, and demand. However, if UKL elevation is below the adjusted central tendency, daily deliveries to KDD and LKNWR will be reduced incrementally by up to 80 percent. Fall/winter water available for delivery to KDD and LKNWR will be assessed every 5 days, when the ratio determining the delivery adjustment (termed the "storage difference ratio") is calculated. Similarly, LRD releases can be reduced incrementally by up to 80 percent (possibly resulting in up to an 80 percent decrease at IGD, though IGD releases cannot drop below the IGD minimum flow requirements specified in the 2013 BiOp) when UKL elevation is below the adjusted central tendency; the maximum reduction occurs when UKL elevations approach the lower bound of the central tendency "envelope" as described in Appendix 4. *See* Appendix 4, Section A.4.4.1.1 for additional details.

It is possible to deviate from the fall/winter formulaic approach to calculating IGD flow targets. For instance, real-time hydrologic conditions, such as high flow events or emergency situations, or USGS rating curve adjustments may warrant the need to deviate from this formulaic approach. In addition, there may be specific ecologic objectives that water resource managers may want to address that can only be achieved by deviating from the formulaic approach to calculating IGD targets. Any time a deviation from the formulaic approach occurs, either by necessity or to address a specific ecologic objective, or if it is determined that the formulaic approach results in conditions that are not consistent with the intent of the PA, the process detailed in Part 4.3.2.2.3. will be followed. However, the formulaic approach for calculating IGD targets considered in this PA was designed to meet the key ecologic objectives for UKL and the Klamath River (with the exception of disease mitigation and habitat flows described in Parts 4.3.2.2.2.4 and 4.3.2.2.2.5). Therefore, Reclamation anticipates that implementation of the formulaic approach will address these ecologic objectives, and only infrequent deviations from this approach are expected to be necessary.

Finally, it is important to note that real-time hydrologic conditions will be closely monitored during the fall/winter to ensure that flood control elevations for UKL are not exceeded and adequate capacity remains in UKL to accommodate high runoff events, especially during rain on snow events. During high runoff events, deviations from the fall/winter management procedure may be required in order to protect public safety and the levees surrounding UKL. In addition, other unforeseen emergency and/or facility control issues could arise that would require deviations from the fall/winter management procedure. In such cases, Reclamation will return to the fall/winter management procedure as soon as the emergency or facility control issue is resolved, but Reclamation retains ultimate discretion regarding the timing of a return to the formulaic approach. *See* Part 4.3.2.2.4. for additional details regarding flood control for UKL.

4.3.2.2.2. Spring/Summer Operations

The previous section described the fall/winter operations which are the first half of each WY, while this section describes the second half of each WY, covering the irrigation season. The Project irrigation season is defined as March 1 – November 30 for Area A1 and March 1 – October 31 for Area A2.

The specific objectives during the spring/summer operational period include:

1. Provide irrigation deliveries to lands within the Project, including TLNWR and LKNWR, with a reasonable level of certainty; and

2. Maintain conditions in UKL and the Klamath River that meet legal requirements under section 7 of the ESA.

The irrigation season operations are controlled by defining the available UKL Supply, which is computed from end of February storage in UKL, observed (since March 1) and forecasted monthly UKL inflows (March-September) and an end of September storage target (*see* Part 4.3.2.2.2.1 for additional details). Division of this supply between the Klamath River (EWA) and Project (Project Supply; water available to the Project from UKL) is dependent on the size of UKL Supply. Any UKL inflow that is not delivered to the Project or released for Klamath River flows (EWA) will remain in UKL as storage. All water that leaves UKL through either LRD or the A Canal is accounted for against one of these two identified volumes; this includes flood control releases (but does not include spill of UKL credit, which is the first volume of water to spill during flood control operations). *See* Figure 4-4 for a schematic illustrating the division of UKL Supply.

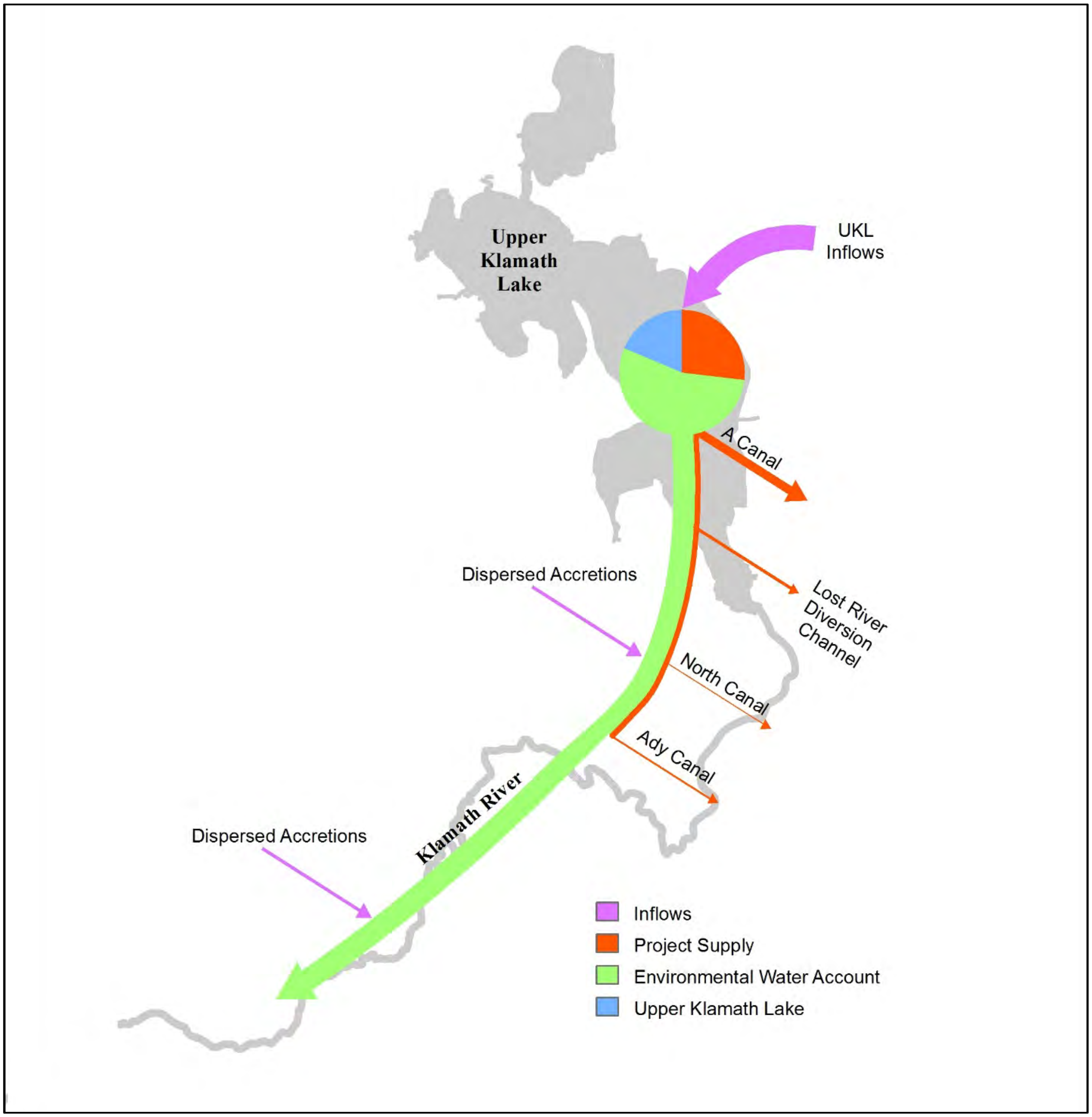

Figure 4-4. Schematic of spring/summer EWA, Project Supply, and volume remaining in UKL (i.e., the end of September storage target). The size of the pie chart and lines are proportional to average volumes of water modeled over the Period of Record. Project Supply includes both irrigation supply and a supply for Lower Klamath National Wildlife Refuge (LKNWR) deliveries; this figure does not include LKNWR deliveries associated with transferred water rights.

Source: Reclamation 2018.

Throughout the spring/summer operational period, Reclamation will track EWA, Project deliveries, remaining Project Supply, UKL elevation relative to the adjusted central tendency, LKNWR deliveries, and the anticipated remaining LKNWR deliveries every 5 days (corresponding to the 5-day time step for recalculation of the storage difference ratio; *see* below for details) and adjust releases as necessary to maintain operations consistent with this PA.

See Appendix 4, Section B for examples of how the annual hydrographs might look. Actual flow and elevation variability will differ during real-time operations as a result of hydrologic conditions specific to the current period of operation. Details regarding the accounting for EWA releases, as well as Project and LKNWR deliveries, are provided below.

4.3.2.2.2.1. UKL Supply

UKL Supply is calculated on the first of each month (or when Reclamation receives the NRCS UKL inflow forecast) from March – June. UKL Supply is calculated by adding the Mar50vol (50 percent exceedance volume) to the end of February UKL storage, and then subtracting the end of September UKL storage target. The specific steps for calculating UKL Supply and Mar50vol are detailed below.

First calculate the "Mar50vol," a combination of forecasted and observed March – September UKL inflow. For each month, Mar50vol is calculated as follows:

1. March 1
    a. Equal to the March 1 NRCS 50 percent exceedance March – September UKL inflow forecast

2. April 1
    a. April 1 NRCS 50 percent exceedance April – September UKL inflow forecast, plus
    b. Measured March net inflows

3. May 1
    a. May 1 NRCS 50 percent exceedance May – September UKL inflow forecast, plus
    b. Measured March net inflows, plus
    c. Measured April net inflows

4. June 1
    a. June 1 NRCS 50 percent exceedance June – September UKL inflow forecast, plus
    b. Measured March net inflows, plus
    c. Measured April net inflows, plus
    d. Measured May net inflows

Next, calculate the end of September UKL storage target. This target is dependent on the default end of September UKL central tendency elevation (4,139.1 feet), the end of September "envelope" around the UKL central tendency (+/- 0.4 feet), and the Mar50vol (*see* Appendix 4, Section A.4.4.3 for specific details). The purpose of the end of September UKL storage target in determining UKL Supply is to constrain the amount of UKL storage used in a given year. Such constraint is necessary to balance near-term demand for irrigation diversion or river flow with the uncertainties associated with future hydrologic conditions (e.g., the consequences of the upcoming winter being drier than normal). Note that the end of September UKL storage target is a mathematical term (and the name of this model variable is a legacy of the 2012 BA) and is not a management target. It is effective in "constraining" use of UKL storage since it is not mathematically allocated to EWA or Project Supply during the March 1 – June 1 spring/summer supply calculations.

4.3.2.2.2.2. Project Supply

As in the 2012 BA/ 2013 BiOp, Project Supply is calculated on the first of each month from March – June, after volumes have been set aside for coho (EWA, *see* Part 4.3.2.2.2.3.) and suckers (end of September target, *see* Section 4.3.2.2.2.1). To provide early-season certainty for Project irrigators, the calculated April 1 Project Supply is "locked in" such that Project Supply may go up as a result of increased NRCS UKL inflow forecasts on May 1 and June 1 but cannot drop below the April 1 calculation. In the event that the NRCS inflow forecasts are substantially lower in May and June, relative to the April forecast, UKL storage volume will be utilized to deliver the "locked-in" April 1 Project Supply. The UKL Credit as described above in Part 4.3.2.2. was specifically designed to help offset any negative effects to UKL storage and listed suckers (by increasing UKL elevation above what it otherwise would have been) potentially resulting from this scenario. Further, because UKL storage is utilized to offset NRCS forecast error, there is no direct effect on EWA calculations in a given WY (*see* below for additional details).

Maximum Project Supply is 350,000 AF, which occurs when UKL Supply is greater than 1,035,000 AF (which occurs in 30 percent of simulated years). When UKL Supply is less than 1,035,000 AF, Project Supply is equal to UKL Supply minus EWA (*see* below for additional details), except when April 1 EWA is greater than 400,000 AF (407,000 AF in even years, *see* Part 4.3.2.2.2.3) and less than 576,000 AF. In that case, the April 1 Project Supply is reduced by 10,000 AF (*see* Part 4.3.2.2.2.5 and Appendix A, Section A.4.4.3). The final determination for Project Supply is made in June and is then fixed through the end of September. It is important to note that *delivery* of the "fixed" Project Supply is not guaranteed; Reclamation retains discretion to curtail deliveries from UKL to comply with unforeseeable legal requirements and hydrologic conditions as necessary. Finally, the UKL control logic does not directly affect spring/summer Project deliveries, except delivery of Project Supply to LKNWR in the August – November period (which can be decreased by as much as 50 percent based on the UKL control logic).

Project Supply is only the supply of water to be made available to the Project and LKNWR from UKL and does not take into account diversions of discharge in the LRDC and return flows from the KSD. In other words, any water diverted from the LRDC or KSD for irrigation does not count against the Project Supply from UKL. Since only the water originating from UKL counts towards the Project Supply, Project diversions of LRDC discharge and KSD return flows will be evaluated on a daily basis and subtracted from the total Project diversion to compute the daily Project Supply usage. It is important to note that the KBPM utilizes perfect foresight to ensure that all of the Project Supply and all return flows that are needed to meet Project demand are diverted in full. As discussed above, any portion of LRDC or KSD return flows not diverted by the Project (that directly support IGD targets and result in a reduction in LRD releases) accrue as UKL Credit that remains in UKL to buffer against NRCS inflow forecast error.

In order to realistically distribute Project Supply over the irrigation period in the KBPM, which is critical in evaluating the effects of Project operations on listed species at specific times of the spring/summer period, Reclamation developed an Agricultural Water Delivery sub-model. The Agricultural Water Delivery sub-model simulated delivery of irrigation water on a 5-day timestep based on variables such as meteorological conditions, soil moisture, water availability, and deliveries in the previous 5-day timestep, scaled to Project Supply. To ensure that the sub-model would adequately simulate Project deliveries under this PA, the sub-model was first tested against historical Project deliveries and performed relatively well. This sub-model is a substantial improvement over past representations of agricultural deliveries in the KBPM. *See* Appendix 4, Section A.4.4.4 for a detailed description of the sub-model, sub-model development, and statistical analysis of sub-model performance.

Finally, Reclamation proposes to deliver Project Supply to LKNWR (not inclusive of Area K [Project Lease Lands served by Ady Canal which are served out of Project Supply]) in the spring/summer operational period. Proposed spring/summer LKNWR deliveries are likely to include a combination of water available from Project Supply and stored water from UKL available in wet years, as further described below.

Reclamation, and USFWS, in coordination with Project irrigators and other stakeholders, are currently undertaking a process to identify the relative priority of lands within LKNWR to available Project water, and to develop a shortage sharing agreement (pursuant to a 2017 memorandum from the Deputy Secretary of the Interior) to address delivery shortages to LKNWR. As that process is still on-going, the outcome from this process is not included in Reclamation's PA. However, because any volume identified for delivery to LKNWR through that process will not increase Project Supply (which is already modeled as coming from UKL in the KBPM), Reclamation has concluded that the distribution of Project Supply will generally remain consistent with the simulated distribution pattern and magnitude and will not alter the effects of Project operations on ESA-listed species described herein. In other words, if in the future a shortage sharing agreement is finalized and deliveries to LKNWR are part of Project Supply, the effects of that delivery to listed species should be no different than under the PA analyzed in this BA and therefore reinitiation of consultation should not be required under 50 CFR 402.16(a) or (c).

Until the process described above is complete, Reclamation proposes to coordinate with USFWS and other Project water users to determine when Project Supply during the spring/summer operational period can be made available to LKNWR consistent with Reclamation's and delivery agencies' contractual and other legal obligations. When Reclamation determines that there is Project Supply not needed to meet other Project demands, such water can be delivered to LKNWR, as the model assumes delivery of the full Project Supply allocation in all years. *See* Part 4.3.2.2.8. and Appendix 4, Section A.4.4.9 for additional details regarding LKNWR operations.

In addition to a portion of Project Supply, LKNWR may also receive spring/summer deliveries in June and July if Project Supply is 350,000 AF and UKL elevations are above 4,142.5 and 4,141.5 feet, respectively, on the first of each month; daily values to be exceeded are linearly interpolated thereafter. When these conditions were met in the modeled POR (11 of the 36 years), a maximum of 3,000 AF was made available to LKNWR from this source. Note that this water is not considered Project Supply.

4.3.2.2.2.3. Environmental Water Account

Similar to IGD flow targets in the fall/winter period, EWA (the volume of water used to meet IGD flow targets in spring/summer) distribution is based on a spring/summer formulaic approach for calculating IGD flow targets. The spring/summer formulaic approach is based on the EWA allocation, UKL control logic, UKL net inflow, and NRCS-forecasted March – September net inflow (50 percent exceedance) from March 1 – June 30. From March 1 – June 30 there is also a correction applied that accelerates EWA release if there was under-release in previous days (e.g., due to UKL control) and decelerates EWA release if there was an over-release in previous days (e.g., due to flood control or disease mitigation flows). From July 1 – September 30, EWA distribution is based on remaining EWA and UKL control logic. EWA releases for disease mitigation/habitat flows (as defined in Parts 4.3.2.2.2.4. and 4.3.2.2.2.5, and Appendix 4, Sections A.4.4.7 and A.4.4.8), minimum required IGD flows (Appendix 4, Section A.4.4.7, Table A.4.4.6.1), and IGD ramping flows (Part 4.3.2.2.5.) are not subject to reduction under UKL control logic. Finally, KSD return flows are no longer considered accretions upon which EWA releases rely, which is a change from the 2013 BiOp. In the spring/summer, any return flows from LRDC and KSD not used by the Project contribute to the UKL Credit during controlled flow conditions (and when LRD releases are above the minimum flow targets).

The specific steps for calculating IGD target flows in the spring/summer include:

1. Determine the LRD flow target as follows:
    a. March 1 – June 30
        i. Determine the release adjustment factor (termed “in_pct_Mar50vol”) that combines observed and forecasted net inflow, NRCS forecast error, and UKL Supply
        ii. Multiply by the calculated EWA allocation, minus the 130,000 AF EWA volume reserved for the July to September baseflow period (137,000 AF in Boat Dance years), minus the release correction that accounts for the difference between the previous day’s actual and calculated LRD releases (termed “Link_release_ss_diff”)
    b. July 1 – September 30
        i. Divide the volume of EWA remaining for the current month by the number of days in the current month
    c. Adjust based on the difference in UKL storage between the UKL adjusted central tendency and UKL elevation
    d. Constrain by the maximum LRD release capacity, if applicable

2. Determine the IGD flow target, which is the minimum of either the maximum IGD flow (look up table) or the IGD flow target (calculated below)
    a. To the LRD flow target calculated in step 1, add LRD to Keno Dam accretions from three days prior (i.e., this step relies on the accretion that occurred in a single day three days ago)
    b. Add today’s forecasted Keno Dam to IGD accretions from three days prior (i.e., this step relies on the accretion forecast for the current day that was issued three days ago)
    c. Increase to the minimum IGD flow requirement (Appendix 4, Section A.4.4.6, Table A.4.4.6.1), if applicable

Note that in years that meet the criteria for enhanced May/June flows, May/June IGD targets are supplemented with an additional 20,000 AF, as described below and in Part 4.3.2.2.2.5. Similarly, IGD targets can be increased to implement surface flushing flows between March 1 and April 15, as described below and in Part 4.3.2.2.2.4.

The EWA volume is calculated on the first of each month from March – June as a portion of UKL Supply. Minimum EWA is 400,000 AF, which occurs when UKL Supply is less than 660,000 AF. When UKL Supply is greater than 1,035,000 AF, EWA is calculated as UKL Supply minus the maximum Project Supply (350,000 AF). When UKL Supply is between 660,000 AF and 1,035,000 AF, EWA is calculated as described in Appendix 4, Section A.4.4.3. Note that EWA is increased by 7,000 AF in even years to augment IGD releases for the Yurok Boat Dance ceremony, typically occurring in late August or early September. Additionally, 20,000 AF is added to May and June IGD targets in years with April 1 EWA greater than 400,000 AF (407,000 AF in even years) and less than 576,000 AF (*see* Part 4.3.2.2.2.5 and Appendix 4, Section A.4.4.3). The EWA volume calculated from the June 1 UKL inflow forecast is the final EWA volume for the year, with the exception of years with enhanced May/June flows in which July 1 EWA is supplemented with 20,000 AF (*see* Appendix 4, Section A.4.4.3). Finally, it is possible that the spring/summer formulaic approach to calculating IGD targets described above will result in an "overspend" (i.e., formulaic approach required more volume than was calculated for EWA, particularly if the Klamath River is at minimums) or an "underspend" (i.e., formulaic approach required less volume than was calculated for EWA) between March 1 - September 30. Regardless of the calculated EWA volume, IGD releases will reflect calculated IGD targets, with the exception of implementation of surface flushing flows and enhanced May/June flows (as described above and in Parts 4.3.2.2.2.4 and 4.3.2.2.2.5). If EWA is overspent, UKL storage will be utilized to continue meeting IGD targets through September 30. If EWA is underspent, the unused EWA volume remaining on September 30 will remain in UKL. There is no inter-annual carryover of EWA.

The EWA is accounted for through both releases for the Klamath River through LRD and releases during flood control operations. In other words, all LRD releases between March 1 and September 30 that are not diverted to the Project and/or LKNWR are counted as EWA. Conversely, all stored water and live flow that is diverted at the A Canal or released from UKL via LRD and diverted at the LRDC, North Canal, or Ady Canal during the spring/summer period will count towards use of the Project Supply. Measurements for these diversions will be obtained at the point of diversion or measured at the location identified in the ACFFOD. For the measurement of these diversions below LRD, the UKL contribution will be the overall measurement less any flows from the LRDC and KSD. Any flow released from LRD during the spring/summer period (March 1 – September 30), that is not diverted into the LRDC, North Canal, or Ady Canal, is considered an EWA release and is counted towards the EWA. Furthermore, during IGD controlled flow conditions (e.g., minimum required flows, IGD targeted flows, ramping flows), contributions to IGD flow from LRDC discharge and KSD return flows are counted as EWA releases when they result in an equivalent reduction in LRD releases to support Klamath River flows (i.e., when UKL Credit is accrued). This does not happen when UKL is in flood control.

In order to ensure that sufficient EWA volume remains to complete formulaic IGD releases during the "baseflow" months of the spring/summer period (July through September), EWA volume may need to be reset to a higher volume to account for high expenditures during March through June. When EWA releases above those needed to meet LRD minimum flows (as defined in Part 4.3.2.2.1) are made, these volumes are tracked cumulatively. If the cumulative volume exceeds a percentage of total EWA, a protective increase in EWA is made to support completion of formulaic flows. This protection is considered whenever the total releases made to support river flows in excess of the minimum LRD release (termed excess releases) have exceeded 22 percent of the total EWA from July 1 to the end of September. *See* Appendix 4, Section A.4.4.8 for specific details

As with fall/winter operations, close coordination and communication between Reclamation and PacifiCorp on the operation of the Klamath Hydroelectric Project will be required to efficiently implement any EWA flow schedule. PacifiCorp will implement releases downstream of IGD based on target flows provided by Reclamation. Reclamation will calculate those target flows according to the EWA distribution formula starting on March 1 of each year, with the exception of surface flushing flows and May/June flows when additional volume will be added to the IGD targets. Once implementation of the formulaic approach to EWA distribution is initiated, Reclamation will monitor IGD flows to ensure that the actual observed flows are consistent with the EWA flow schedule. *See* Part 4.3.2.2.6. for additional information regarding coordination with PacifiCorp.

As described above, EWA distribution will follow the spring/summer formulaic approach for calculating IGD target flows. However, in addition to the opportunity for disease mitigation/habitat flows using a total volume of around 50,000 AF and/or enhanced May/June flows when EWA is less than 576,000 AF (*see* Parts 4.3.2.2.2.4. and 4.3.2.2.2.5), it is possible to deviate from the spring/summer formulaic approach to EWA distribution. Specifically, real-time hydrologic conditions, such as high flow events or emergency situations, may warrant the need to deviate from this formulaic approach. In addition, there may be specific ecologic objectives that water resource managers may want to address that can only be achieved by deviating from the formulaic approach to EWA distribution. Any time a deviation from the formulaic approach occurs, either by necessity or to address a specific ecologic objective, or if it is determined that the formulaic approach results in conditions that are not consistent with the intent of the PA, the process detailed in Part 4.3.2.2.3. will be followed. However, the formulaic approach for EWA distribution considered in this PA was designed to meet the key ecologic objectives for UKL and the Klamath River. Therefore, Reclamation anticipates that implementation of the formulaic approach will address these ecologic objectives, and frequent deviations from this approach are not expected to be necessary, aside from those anticipated for disease mitigation/habitat flows (*see* Parts 4.3.2.2.2.4. and 4.3.2.2.2.5).

4.3.2.2.2.4. Disease Mitigation Flows

Reclamation proposes flexibility to deviate in real-time from the spring/summer formulaic approach to deliver:

1. Approximately 50,000 AF of EWA in a manner that best meets coho needs (i.e., disease mitigation, habitat, etc.) in dry years (as defined below) or

2. An "opportunistic" surface flushing flow in average to wet years (as defined below) if hydrologic conditions allow.

3. An additional volume of 20,000 AF for enhanced May/June flows in years meeting specific criteria defined below in section 4.3.2.2.2.5.

Reclamation has modeled use of the approximately 50,000 AF of EWA in dry years as a disease mitigation flow, specifically a surface flushing flow. Surface flushing flows in the KBPM reflect those described as Disease Management Guidance #1 in the Disease Management Guidance document (Hillemeier et al. 2017) and constitutes an average release of at least 6,030 cfs from IGD for at least 72 consecutive hours. The specific objective of the surface flushing flows is to disturb surface sediment along the river bottom and disrupt the life cycle of *Manayunkia speciosa* (a polychaete), which is a secondary host for the *C. shasta* parasite central to salmonid disease dynamics in the Klamath River.

Implementation of approximately 50,000 AF of EWA described above must not result in impacts to suckers in UKL outside of those analyzed by USFWS; if Reclamation believes implementation of this volume may result in impacts to suckers outside of those analyzed by USFWS, Reclamation will coordinate with the Services.

Dry Years (March/April 1 EWA less than 576,000 AF)
KBPM model logic incorporated "forced" surface flushing flows in dry water years. However, this model logic does not limit NMFS's ability to request implementation of this 50,000 AF volume in an alternative distribution. Reclamation proposes the following criteria for implementation of forced surface flushing flows:

1. Date is between March 1 and April 15 in dry years;

2. March 1 and/or April 1 EWA is less than 576,000 AF;

    a. If March 1 EWA and April 1 EWA are less than 576,000 AF, a forced surface flushing flow will be implemented between March 1 and April 15;

    b. If March 1 EWA is greater than or equal to 576,000 AF, but April 1 EWA is less than 576,000 AF, a forced surface flushing flow will be implemented between April 1 and April 15 (unless an opportunistic surface flushing flow was implemented in March);

    c. If March 1 EWA is less than 576,000 AF and April 1 EWA is greater than or equal to 576,000 AF, a forced surface flushing flow will be implemented in March. However, if Reclamation and the Services determine that delaying the release until after March 31 minimizes impacts to UKL and listed suckers, optimizes EWA efficiency, and maximizes benefits to coho salmon, then the forced surface flushing flow will be implemented between April 1 and April 15;

3. There is sufficient head behind LRD to produce 6,030 cfs for 72 hours at IGD; and

4. The previous day's UKL elevation is greater than or equal to 4,142.4 feet.

In the event that by April 15, a surface flushing flow (or other use of the 50,000 AF), has not been attempted and March 1 and/or April 1 EWA is less than 576,000 AF, Reclamation will initiate a forced surface flushing flow event regardless of UKL elevation, maximum LRD capacity, or IGD flow in a manner that, to the maximum extent practicable, approximates the magnitude and duration described in 3. above.

Average/Wet Years (March/April 1 EWA greater than or equal to 576,000 AF)
Reclamation proposes implementation of an opportunistic surface flushing flow in average/wet years. Specific criteria for implementing an opportunistic surface flushing flow include all of the following:

1. Date is between March 1 and April 15;

2. March 1 and April 1 EWA are greater than or equal to 576,000 AF;

3. There is sufficient head behind LRD, and accretions between LRD and IGD, to produce 6,030 cfs for 72 hours at IGD;

4. The previous day's UKL elevation is greater than or equal to 4,142.4 feet; and

The previous day's IGD flow is greater than or equal to 3,999 cfs.

Surface Flushing Flow Accounting Details
Reclamation proposes the following rules to account for surface flushing flows:

1. Any flow event producing an average of 6,030 cfs at IGD for 72 hours that occurs outside of the March 1 to April 15 window, does not fulfill surface flushing flow criteria incorporated into the KBPM logic.

2. All surface flushing flow volumes that meet the KBPM criteria for a surface flushing flow are a component of the annual EWA.

3. Surface flushing flows are not subject to reductions under UKL control logic.

4. Surface flushing flows are subject to ramping rates outlined in Section 4.3.2.2.5.

See Appendix 4, Part A.4.4.7 for additional information regarding implementation of surface flushing flows in the KBPM.

Deep Flushing Flows

KBPM model logic does not incorporate "forced" deep flushing flows (11,250 cfs for 24 hours), described as Disease Management Guidance #2 in the Disease Management Guidance document (Hillemeier et al. 2017). However, Reclamation will attempt to implement deep flushing flows when hydrologic conditions and public safety allow. Specifically, infrastructure limitations and public safety issues (particularly release capacity at LRD and flood concerns in the middle and lower Klamath Basin) are such that a suite of conditions must be present in order to implement a flow of sufficient magnitude to accomplish the objectives of a deep flushing flow event. These conditions include, but are not limited to, UKL storage to allow for sufficient LRD release capacity, UKL storage sufficient to protect sucker needs, substantial accretions, and Klamath River tributary discharge that does not result in public safety and property concerns. Typically, this suite of conditions occurs when UKL is at flood curve in the late winter or early spring and there is a rain-on-snow hydrologic event. Maximum LRD capacity at the maximum allowable UKL elevation under the current flood curve (4,143.3 feet) is approximately 8,600 cfs, meaning that additional accretions of up to approximately 2,650 cfs for 24 hours would be necessary to achieve 11,250 cfs from IGD at full UKL storage under this Proposed Action; accordingly, larger accretions are necessary if UKL elevation is less than 4,143.3 feet. Implementation of a deep flushing flow will require coordination with PacifiCorp and numerous public safety entities.

4.3.2.2.2.5. Enhanced May/June Flows

In years in which April 1 EWA is greater than 400,000 AF (407,000 AF in years 2020, 2022, and 2024) and less than 576,000 AF, an additional 20,000 AF (10,000 AF from Project Supply and the balance from a combination of live flow and UKL) is distributed in May and June. This action is meant to improve coho habitat in specific years of concern to NMFS. NMFS has requested flexibility in the distribution of the 20,000 AF to maximize the benefit to listed coho, while maintaining UKL elevations/conditions necessary for listed suckers. However, for purposes of modeling effects of the enhanced May/June flows and Reclamation's planning needs (unless NMFS requests alternative management scenarios in a given water year), the specific "default" rules for implementing this 20,000 AF for enhanced May/June flows are as follows:

1. April 1 EWA is greater than 400,000 AF (407,000 AF in years 2020, 2022, and 2024) and less than 576,000 AF;
    a. May 1 and June 1 EWA volume calculations do not affect the addition or delivery of 20,000 AF for enhanced May/June flows
2. Daily calculated May IGD flow targets are increased by 195 cfs (12,000 AF total in May);
3. Daily calculated June IGD flow targets are increased by 134 cfs (8,000 AF total in June); and
4. April 1, May 1, and June 1 Project Supply estimates are reduced by 10,000 AF.

Because the 20,000 AF for enhanced May/June flows is counted against EWA when the flows are implemented in May and June (when the intention is for this volume to be in addition to EWA), 20,000 AF is added to the July 1 EWA to ensure proper EWA accounting for the remainder of the spring/summer season. Additionally, the default rules assume that when enhanced May/June flows are implemented and IGD flow targets would otherwise be at minimums, Reclamation would implement flow variability (up to +/- 75 cfs around enhanced IGD flow targets).

Implementation of enhanced May/June flows as described above must not result in impacts to suckers in UKL outside of those analyzed in this document; if Reclamation determines that implementation of these flows may result in impacts to suckers outside of those analyzed here, Reclamation will coordinate with the Services.

Reclamation anticipates NMFS will recommend alternative distributions to default rules 2 and 3 described above, based on information specific to environmental conditions and forecasts, as a means to optimize the benefit to coho salmon. NMFS will lead annual efforts to evaluate and seek input from the Flow Account Scheduling Technical Advisory (FASTA) Team members on alternatives to deviate from default rules used to implement both the May/June 20,000 AF volume, the and 50,000 AF volume for disease mitigation and habitat flows. *See* Section 4.3.2.2.3 for details regarding the FASTA adaptive flow management process.

4.3.2.2.3. FASTA Team and the Flow Management Process

As discussed above, there may be opportunities to benefit coho through deviations from the formulaic approach to IGD targets in the fall/winter and EWA distribution in the spring/summer. Additionally, NMFS has recommended that Reclamation retain flexibility in shaping approximately 50,000 AF of EWA in years with March/April 1 EWA volumes less than 576,000 AF (*see* Part 4.3.2.2.2.4.) and 20,000 AF for May/June habitat flows in years with April 1 EWA volumes greater than 400,000 AF (407,000 AF in even years) and less than 576,000 AF (*see* Part 4.3.2.2.2.5). Reclamation, in coordination with the Services, will consider input from Klamath Basin technical experts relative to these actions and opportunities. Reclamation therefore proposes that the FASTA Team be the venue in which these technical experts provide input on flow management options.

The primary purpose of the FASTA Team is to share information on hydrologic, meteorological, disease, and other conditions among Klamath Basin technical experts. However, an important secondary function will be to serve as a venue for input on flow management options, including input or evaluations regarding the shaping of approximately 50,000 AF of EWA for disease mitigation or habitat improvement/protection in years with March/April 1 EWA volumes less than 576,000 AF (*see* Parts 4.3.2.2.2.4. and 4.3.2.2.2.5). Participants in the FASTA Team are technical specialists focused on meaningful participation, facilitating timely implementation of the flow input process (described below), and providing input to Reclamation and the Services. Operational or compliance decisions will not be made by the FASTA Team or during FASTA Team calls or meetings.

Reclamation retains decision-making authority relative to flow management and operations on and related to the Project, though Reclamation encourages input and feedback from the FASTA Team. Reclamation also retains discretion regarding FASTA Team participants. Finally, the FASTA Team was created under a previous BiOp with a slightly different purpose in mind; Reclamation is choosing to retain the previous name for consistency, but the name itself does not convey additional purpose beyond that described here.

Ultimately, Reclamation, acting under the authority of the Secretary of the Interior, makes flow management decisions affecting UKL and the Klamath River; the process outlined below does not relinquish this Secretarial responsibility. Additionally, Reclamation determines whether proposed flows are consistent with flood control, public safety, and operational constraints for UKL and the Klamath Project.

The specific process for providing flow management input via the FASTA Team is as follows:

1. A FASTA Team member (inclusive of the Services) provides input regarding flow management during a FASTA Team call, or via email or call directly to the Klamath River Manager.
   a. If the input is provided outside of a FASTA Team call, the Klamath River Manager may choose to schedule a call or otherwise discuss the input with other FASTA Team members prior to moving to step two.

2. The Klamath River Manager initiates internal Reclamation discussions to determine if the proposed flows are operationally feasible. Specifically, this will include evaluating whether:
   a. The proposed flows are feasible given Reclamation infrastructure and operations, public safety, flood control, and other operational constraints;
   b. Evaluating whether the proposed flows comply with applicable state and federal law; and
   c. Evaluating whether the proposed flows are consistent with the PA.
   d. If the proposed flows are determined by Reclamation to not be operationally feasible for the Klamath Project, no further action is necessary.

3. If Reclamation determines the proposed flows are operationally feasible, Reclamation will initiate conversations with PacifiCorp to determine if the proposed flows are operationally feasible for PacifiCorp's Klamath Hydroelectrical Project (additional information relative to coordination expectations is described in Part 4.3.2.2.6.)
   a. If the proposed flows are determined by Reclamation and/or PacifiCorp to not be operationally feasible, no further action is necessary.

4. If the proposed flows are operationally feasible for both Reclamation and PacifiCorp, Reclamation will initiate conversations with the Services to determine if the proposed flows provide additional ecological benefit to coho, while maintaining UKL elevations/conditions necessary for listed suckers.
   a. If the proposed flows are determined by Reclamation and/or Services to not provide additional ecological benefit, no further action is necessary.

5. If the Services determine that the proposed flows are likely to result in benefit to coho and would not adversely affect listed suckers, then Reclamation will take steps to implement the

proposed flows. Reclamation will be responsible for implementing the proposed flows, coordinating with PacifiCorp, issuing public safety notices, and any other coordination required to implement in a timely manner.

Reclamation retains discretion to deviate from the steps outlined above when considering flow management input. Additionally, Reclamation will communicate with FASTA Team members the outcome of the steps above, when possible and appropriate.

Finally, the Klamath River Manager is the individual responsible for scheduling and holding FASTA Team calls (as needed, but typically weekly or every other week) and distributing relevant information (as needed, but typically weekly, typically in the form of a slide presentation). Weekly updates will typically include information such as EWA use, Project deliveries, remaining Project Supply, UKL elevation, LKNWR deliveries, projected IGD target flows, meteorological information, etc. Reclamation retains discretion regarding the content of the FASTA slides and any other information made available to the FASTA Team, and the timing and frequency of FASTA Team calls. Also note that Reclamation retains discretion to end FASTA calls if participants other than technical experts call in.

4.3.2.2.4. Flood Control Operations

Maximum UKL flood control elevations are utilized as a guideline in an attempt to provide adequate storage capacity in UKL to capture high runoff events, to avoid potential levee failure due to overfilling UKL, and to mitigate flood conditions that may develop in the Keno plain upstream of Keno Dam. The general process of flood control consists of spilling water from UKL when necessary to prevent elevations from increasing above flood pool elevations, which change throughout the year in response to inflow forecasts and experienced hydrology. Flood pool elevation is calculated each day to create a smooth UKL operation, allowing UKL to fill (i.e., approach 4143.3 ft) by the end of March in drier years and by the end of April in wetter years. The UKL flood control elevations are intended to be used as guidance, and professional judgment will be utilized in combination with hydrologic conditions, snowpack, forecasted precipitation, public safety, and other factors in the actual operation of UKL during flood control operations.

The flood control elevations are set at 4,141.4 feet in September and October and then increase from 4,141.4 to 4,141.8 feet from November 1 through December 31 (daily values are obtained through interpolation). In most years, there are no flood control releases during these months.

From January 1 through April 30, the UKL flood control elevations are determined based on the forecasted inflow and the day of the month. The NRCS UKL net inflow forecast is used to determine the end of month flood control elevation (Appendix 4, Section A.4.4.10, Table A.4.4.10.1) and the daily flood control elevation is linearly interpolated between the current end of month elevation and the previous month's end of month flood control elevation.

Additionally, UKL flood control elevations vary between wet and dry year types. The distinction is based on the NRCS March through September 50 percent exceedance forecast for UKL net inflow issued in January, February, and March. The forecast issued in March is used for both March and April. If the forecast March through September net UKL inflow is greater than 710,000 AF, the year is considered wet; the WY is considered dry if the forecast net inflow is equal to or less than 710,000 AF. It is important to note that the flood control curve and flood control operations are consistent with what has been implemented under the 2013 BiOp. *See* Appendix 4, Section A.4.4.10 for details.

Reclamation retains sole discretion to determine when to initiate or cease flood control operations.

4.3.2.2.5. Flow Ramping

Ramping rates limit rapid fluctuations in streamflow downstream of dams. Reclamation proposes a ramping rate structure that varies by release rate at IGD. The ramp rates proposed below are as measured at the USGS gaging station located immediately downstream of IGD (USGS Station ID#: 11516530). IGD is owned and operated by PacifiCorp and the ramp down rates will be implemented by PacifiCorp as part of IGD operations. Reclamation will coordinate with PacifiCorp as appropriate on the implementation of the ramp down rates.

The target ramp down rates at IGD, when possible, are as follows:

- <u>When IGD flows are greater than 4,600 cfs:</u> decreases in flows of no more than 2,000 cfs per 24-hour period, and no more than 500 cfs per six-hour period.

- <u>When IGD flows are greater than 3,600 cfs but equal to or less than 4,600 cfs:</u> decreases in flows of 1,000 cfs or less per 24-hour period, and no more than 250 cfs per six-hour period.

- <u>When IGD flows are greater than 3,000 cfs but equal to or less than 3,600 cfs</u>: decreases in flows of 600 cfs or less per 24-hour period, and no more than 150 cfs per six-hour period.

- <u>When IGD flows are above 1,750 cfs but equal to or less than 3,000 cfs</u>: decreases in flows of 300 cfs or less per 24-hour period, and no more than 125 cfs per four-hour period. (Note that ramp rates can be slower, such as 75 cfs per six-hour period, if Reclamation and PacifiCorp agree on a schedule).

- <u>When IGD flows are 1,750 cfs or less</u>: decreases in flows of 150 cfs or less per 24-hour period and no more than 50 cfs per two-hour period.

Upward ramping is not restricted. Additionally, NMFS concluded in their 2002 BiOp that ramp down rates below 3,000 cfs, as outlined above, adequately reduce the risk of stranding juvenile (and fry) coho salmon (p. 111, NMFS 2010a).

Facility control limitations and stream gage measurement error limit the ability to accurately manage changes in releases from IGD at a fine resolution. In addition, facility control emergencies may arise that warrant the exceedance of the proposed ramp down rates. Therefore, Reclamation recognizes that minor variations in ramp rates (within 10 percent of targets) will occur for short durations and all ramping rates proposed above are targets and are not intended to be strict maximum ramp rates. Reclamation expects significant exceedance of the proposed ramp rates due to facility control limitations, stream gage error, and/or emergency situations will occur infrequently and will be corrected as soon as possible when they do occur.

Under some circumstances (based on presence and abundance of ESA-listed species, life cycle stage, hydrologic conditions in the Klamath River and tributaries, and other considerations) the proposed ramp rates may be more stringent than necessary to prevent the stranding of ESA-listed species downstream of IGD. Reclamation, in coordination with NMFS, may explore more flexible ramping rates to determine under what conditions those rates would be appropriate to implement.

IGD is a PacifiCorp facility and Reclamation does not have control over the implementation of ramp down rates and operations at IGD. However, Reclamation will coordinate with PacifiCorp as appropriate to ensure that implementation of the ramp down rates is consistent with those proposed herein and required by PacifiCorp's Interim Operation Habitat Conservation Plan for Coho Salmon (HCP) (PacifiCorp 2012).

4.3.2.2.6. Coordination with PacifiCorp

PacifiCorp is required by its 2012 Biological Opinion (PacifiCorp 2012) to implement flow-related operations consistent with Reclamation's BiOp requirements. This, combined with the fact that Reclamation's PA includes IGD as a compliance point, means close coordination between Reclamation and PacifiCorp is necessary for implementation of the PA and corresponding BiOps.

All IGD target flows will be determined and coordinated with PacifiCorp three days in advance. Reclamation will also provide an IGD target forecast for an additional 11 days using projections based on NRCS UKL inflow forecasts (if available), California Nevada River Forecast Center hydrologic forecasts (namely, for accretions and some UKL tributaries), meteorological forecasts, measured flows, historical patterns, and professional judgement. If these information sources do not adequately predict flows for ongoing operations, Reclamation may ask PacifiCorp to provide accretion estimates between Keno and Iron Gate as they have since the 2013 BiOp. This additional 11 days of forecasted IGD flow targets is intended to provide additional advanced planning opportunities for resource managers and PacifiCorp. However, provisional flow targets provided for these additional 11 days are estimates and the actual IGD target flows will be determined after the upper Klamath Basin hydrologic conditions and LRD to IGD accretions are actually observed.

PacifiCorp has successfully coordinated with Reclamation to implement the requirements associated with the 2013 BiOp for the last five years and Reclamation expects this close coordination to continue for the implementation of Project operations resulting from this consultation. In addition, emergencies may arise that necessitate PacifiCorp to deviate from the IGD release target. These emergencies may include, but are not limited to, flood control, and facility and regional electrical service emergencies. Reclamation will closely coordinate with PacifiCorp should the need to deviate from the IGD flow target be identified due to an emergency. Such emergencies occur infrequently and are not expected to significantly influence flows downstream of IGD.

On a weekly basis, Reclamation will assess how the actual observed IGD flows compare to the target flows and communicate any necessary adjustments of LRD releases to PacifiCorp. During periods of rapid hydrologic change and/or during an urgent in-season flow schedule adjustment, it may be necessary to coordinate with PacifiCorp more frequently. PacifiCorp will make every attempt to follow the flow schedule provided by Reclamation (and based on the EWA distribution/IGD formulaic approach described in Parts 4.3.2.2.1. and 4.3.2.2.2.3.) as closely as possible within the operational constraints of the Klamath Hydroelectric Project facilities and based upon their obligations under the existing HCP (PacifiCorp 2012), except when requested otherwise by Reclamation for events such as flushing flows and enhanced May/June flows. If Reclamation determines that actual mean daily flows deviate from the flow schedule above the percentages described in Part 3.6.1., Reclamation may need to coordinate with PacifiCorp, the FASTA Team, and Klamath Basin Area Office (KBAO) Area Manager to take corrective action, which may result in the need for a formal in-season deviation from the formulaic approach for IGD targets and EWA distribution. The relative effect of deviating from the flow schedule depends on many hydrologic, climatologic, and ecologic factors, and the same amount of deviation from the flow schedule does not warrant the same response in all situations. For example, a deviation of 100 cfs downstream of IGD when flows are in excess of 3,000 cfs doesn't require the same consideration as a deviation of 100 cfs when IGD flows are at 900 cfs. Each instance will need to be considered on a case-by-case basis.

Relative to the process laid out in Part 4.3.2.2.3., Reclamation will provide PacifiCorp with adequate lead time when implementing deviations from the formulaic approach. Reclamation will make every attempt to provide two weeks advanced notice to PacifiCorp when requesting flow schedule adjustments. In some circumstances Reclamation may request PacifiCorp to respond in less than two weeks if the adjustment to the flow schedule is urgent due to the need to respond to real-time and/or emergency conditions that warrant rapid response (i.e., fish disease, fish die-off, poor water quality, unexpected hydrologic conditions, imminent flooding or other health and safety issues, etc.). Finally, this section is not inclusive of all possible Reclamation-PacifiCorp coordination needs and processes. Additional coordination details regarding specific management actions (i.e., ramping rates) are contained within sub-sections of Part 4.3.2.2.

4.3.2.2.7. Tule Lake Sump operations

The proposed minimum elevations for Tule Lake Sump 1A are described below. Tule Lake National Wildlife Refuge (TLNWR) deliveries are outlined in Part 4.3.2.2.8. Actual water availability and TID return flows will determine the amount of water available for TLNWR including federal lease lands. Reclamation proposes to maintain a consistent year-round minimum elevation in Tule Lake Sump 1A (Table 4-2).

During excessively dry periods when the UKL Supply is inadequate to meet Project demands, it may not be possible to maintain Tule Lake Sump 1A elevations due to decreased runoff to Tule Lake Sump 1A. This condition would be outside of Reclamation's control and the proposed minimum elevations would not apply. In the event that surface water supply is estimated to be unavailable or is insufficient to maintain biological minimum elevations of Tule Lake Sump 1A (e.g., greater than 95 percent exceedance inflow years such as 1992 and 1994), Reclamation proposes to coordinate with USFWS as early as is possible to determine if relocation of adult suckers from the sumps to more permanent bodies of water within the species range is prudent.

Table 4-2. Minimum Sump 1A Elevations (Reclamation Datum).

Time Period	Elevation (feet)
April 1 through September 30 (each year)	4,034.0
October 1 through March 31 (each year)	4,034.0

During dry winter conditions, Reclamation will initiate discussions with USFWS to determine the best course of action, including the likelihood of a sucker relocation effort from Tule Lake. If Reclamation and USFWS deem it necessary to relocate suckers from Tule Lake during these discussions, Reclamation, in coordination with the USFWS, will develop a proposal that Reclamation will employ to relocate suckers from the Tule Lake Sumps before seasonally stressful conditions develop. The proposal will describe methods for capture and transport of fish, release sites, fish handling techniques, and the appropriate level of effort expected to relocate suckers (*See* Appendix 4 for example).

4.3.2.2.8. Other Refuge Deliveries

Federally-owned lands within TLNWR and LKNWR receive and use Project water from multiple sources, in a variety of ways as described below.

For TLNWR, irrigated agricultural lands generally obtain water for irrigation and refuge use from return flows from irrigated lands within the Project. These return flows accumulate in the Tule Lake Sumps and are diverted via the R and Q canals or are pumped into the N Canal from drains serving private lands in TID.

Generally, irrigation return flows and tributary runoff are adequate to meet irrigation and refuge demands within TLNWR, limiting the need for direct deliveries from UKL and the Klamath River. When irrigation demands are high, Project Supply during the spring/summer period (i.e., water from UKL and the Klamath River) may be needed for irrigation use within TLNWR. All deliveries to TLNWR are coordinated between TID and USFWS, Reclamation, or the individual lessee of the lands, consistent with Reclamation's water supply contract with TID.

LKNWR deliveries proposed as part of this PA are discussed in Parts 4.3.2.2.1. and 4.3.2.2.2. above. In addition to the proposed fall/winter and spring/summer deliveries, Reclamation also anticipates that from April 1 – September 30 LKNWR *may* exercise a water right temporarily transferred from the Agency Lake and Barnes Ranch properties to irrigable lands in LKNWR (*see* Part 1.3.6 for further information on the current transfer order applicable to these water rights). In the State of Oregon, a valid water right, such as those appurtenant to the Agency Lake and Barnes Ranch properties, can be exercised at any time for the authorized beneficial purpose within the authorized period of use, to the extent water is physically available at the point or points of diversion and the water right is not otherwise subject to regulation based on a call by a senior water rights holder (*see* Part 1.3.2., for background information on the prior appropriation doctrine as applicable in the State of Oregon).

Collectively, the transferred water right from the Agency Lake and Barnes Ranch properties allows for diversions at the Ady Canal of up to approximately 31 cfs and 11,200 AF in total annually. This transferred water right has a priority date of September 13, 1920 and is potentially subject to water rights regulation in the Upper Klamath Basin based on calls by senior water rights holders, including potentially a call made on behalf of the water rights for the Project. In the event of call by the Project or other senior water rights holders, USFWS may not be able to exercise this transferred water right due to regulation by OWRD. For purposes of this PA, the KPBM assumes that diversions at the Ady Canal associated with this transferred water right will be approximately 11,000 AF.

Water diversions by the USFWS to the Ady Canal pursuant to the water right transferred from the Agency Lake and Barnes Ranch properties are not subject to UKL control logic, given that in approving this transfer, OWRD determined that this water would have historically been diverted and consumed upstream of UKL.

In addition to water from the Project, water associated with the transferred water right from the Agency Lake and Barnes Ranch properties, local tributary runoff (e.g., Sheepy Creek), and groundwater sources utilized by the USFWS (all when available), LKNWR receives water from the Tule Lake Sumps via the Tule Lake Tunnel and Pumping Plant D, which are all Project facilities.

TID operates and maintains the Tule Lake Sumps, Pumping Plant D, and the Tule Lake Tunnel. Generally, Pumping Plant D is operated as necessary to maintain water surface elevations in the Tule Lake Sumps consistent with rules and regulations issued by Reclamation (primarily for flood control purposes), levels to meet USFWS migratory bird/wildlife needs, and ESA requirements (*see* Part 4.3.2.2.7).

Deliveries to LKNWR via Pumping Plant D have significantly decreased in recent years due to drought, regulatory limitations on Project diversions, and increases in power costs associated with pumping. These factors have resulted in decreased pumping from Tule Lake to LKNWR through Pumping Plant D. The historical average annual volume pumped dating back to 1941 is approximately 70,000 AF. Over the last ten years the annual average volume has been under 20,000 AF. Regardless, these pumping activities are not part of Reclamation's PA and are not modeled in the KBPM, which focuses on UKL and the Klamath River.

4.3.2.2.9. Deliveries of Stored Water from Clear Lake and Gerber Reservoirs

Clear Lake and Gerber reservoirs are used to store seasonal runoff to meet irrigation needs of the Project and to prevent flooding in and around Tule Lake. Stored water from Clear Lake and Gerber reservoirs is generally used for irrigation purposes within LVID, Horsefly Irrigation District (HID), and for lands covered by individual contracts; however, Reclamation can and historically has at times released water from both reservoirs for use for irrigation purposes within KID and TID (*see* Part 1.3.3., regarding Reclamation's water supply contracts with KID and TID).

Stored water released from Clear Lake Reservoir is generally diverted at Malone Diversion Dam into either the West Canal or East Malone Lateral. The East Malone Lateral serves approximately 1,800 acres on the east side of the Lost River. The West Canal serves approximately 6,750 acres within LVID. The West Canal also has a spill structure at its terminus, so that water can be discharged into the Lost River for re-diversion and use within

HID. Stored water from Clear Lake Reservoir can also be released through the spillway gates on Malone Diversion Dam, for use within LVID, HID, KID, and TID.

Stored water released from Gerber Reservoir is generally diverted at Miller Creek Diversion Dam into the North Canal, for irrigation use within LVID. The North Canal serves approximately 9,550 acres within LVID.

In addition to irrigation deliveries, Reclamation makes flood control releases from Clear Lake and Gerber reservoirs, when conditions necessitate.

Reclamation proposes to operate the portion of the Project served by Clear Lake and Gerber reservoirs as described below.

4.3.2.2.9.1. Clear Lake Reservoir Operations

Under the PA, Clear Lake Reservoir will provide a range of water supplies consistent with historical operations necessary to meet demand throughout the period covered by this BA. Reclamation proposes to operate Clear Lake Reservoir to meet the full irrigation demand of the Project, while maintaining the end of September minimum elevation. Historical annual releases vary based on available water supply and demand, with an average release of approximately 35,000 AF, based on the POR for which adequate data is available (1986-2016). With 35,000 AF being the approximate average annual release from Clear Lake Reservoir, a volume greater than 35,000 AF will be released in approximately half of years. Historical releases from Clear Lake Reservoir have ranged from zero AF, when no irrigation water supply was available, to more than 115,000 AF when flood control operations occurred. Water supply for irrigation purposes is generally used from April 15 – September 30 of each year. The outlet at Clear Lake Dam is generally opened on April 15 and closed by October 1, although slight deviations have occurred in the 1986-2016 POR. The typical release rate during irrigation season is approximately 120 cfs, with a typical maximum irrigation release of approximately 170 cfs. Releases can be greater during flood control operations and when irrigation demand is high. Table 4-3 summarizes monthly releases from Clear Lake Reservoir by month for the April through October time period. Some releases have also historically occurred during the months of February and March, primarily for flood control, and are not included in the table below.

Table 4-3. Summary of monthly 1986-2016 Clear Lake Reservoir releases (thousand acre-feet).

	April	May	June	July	August	September	October
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.22	5.22	6.10	7.68	7.34	5.56	0.00
Average	2.58	5.45	6.41	6.99	6.54	4.71	0.04
Maximum	31.27	29.20	16.32	15.73	18.68	27.44	0.42

Available water supply from Clear Lake Reservoir is estimated annually using a seasonal forecasting model (*see* Appendix 4, Section D). The model allows Reclamation to estimate available water supplies and provide insight on appropriate deliveries that will provide elevations greater than the end of September minimum reservoir elevation, while taking into account projected inflows, typical delivery patterns, seepage, and evaporation. Changes in releases during the irrigation season are largely dictated by irrigation demand throughout the spring/summer period. Table 4-4 lists the end of September minimum proposed elevation for Clear Lake Reservoir.

Table 4-4. Minimum Clear Lake Reservoir end of September elevation (Reclamation Datum).

Water Body	Elevation (feet)
Clear Lake Reservoir	4,520.6

4.3.2.2.9.2. Gerber Reservoir Operations

Under the PA, Gerber Reservoir will provide a range of water supplies consistent with historical operations that are necessary to meet demand throughout the period covered by this BA. Reclamation proposes to operate Gerber Reservoir to meet the full irrigation demand of the Project, while maintaining the end of September minimum elevation. Historical annual releases vary based on available water supply and demand, with an average of approximately 35,000 AF, based on the POR for which adequate data is available (1986 through 2016). With 35,000 AF being the approximate average annual release from Gerber Reservoir, a volume greater than 35,000 AF will be released in approximately half of years. Historical releases from Gerber Reservoir have ranged from approximately 1,000 AF, when little irrigation water supply was available, to almost 95,000 AF when flood control operations occurred. Water supply for irrigation purposes is generally used from April 15 to September 30 each year. The outlet of Gerber Dam is generally opened on April 15 and closed on October 1, although slight deviations have occurred in the 1986 through 2016 POR. The typical release rate during irrigation season is approximately 120 cfs with a typical maximum irrigation release of approximately 170 cfs. Releases can be greater during flood control operations and when irrigation demand is high. Table 4-5 summarizes monthly releases from Gerber Reservoir by month for the April through October time period. Some releases have also historically occurred during the months of November through March, primarily for flood control, and are not included in the table below.

Table 4-5. Summary of monthly 1986 through 2016 Gerber Reservoir releases (thousand acre-feet).

	April	May	June	July	August	September	October
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.10	5.56	6.76	7.87	7.53	6.08	0.00
Average	1.46	4.88	6.44	7.22	6.58	5.39	0.07
Maximum	17.03	7.85	8.63	8.94	8.35	7.34	0.80

Historically, approximately two cfs is bypassed and released into Miller Creek during the winter months to prevent a valve in the dam from freezing and improve conditions for ESA-listed suckers that may be present in pools below the dam when irrigation deliveries are not occurring. This bypass has typically occurred in late October or early November until the beginning of the following irrigation season, although it has occurred as early as July. Reclamation intends to continue the two cfs bypass from Gerber Reservoir as part of operations in this PA. In the event of a mid-irrigation season shut off (as occurred in 2015), or concerns about meeting minimum lake elevations, Reclamation will coordinate with the USFWS on whether or not opening the frost valves is warranted.

Available water supply from Gerber Reservoir is estimated annually with a seasonal forecasting model (*see* Appendix 4, Section D). The model allows Reclamation to estimate available water supplies and provide appropriate deliveries that will provide elevations greater than the established end of September minimum lake elevation while taking into account projected inflows, typical delivery patterns, seepage, and evaporation. Changes in releases during the irrigation season are largely dictated by irrigation demand throughout the spring/summer period. Table 4-6 lists the end of September minimum proposed elevation for Gerber Reservoir.

Table 4-6. Minimum Gerber Reservoir end of September elevation (Reclamation Datum).

Water Body	Elevation (feet)
Gerber Reservoir	4,798.1

4.3.2.2.10. Diversions of Live Flow from the Lost River

In addition to stored water from Clear Lake and Gerber reservoirs, live flow in the Lost River is used for irrigation within portions of HID, LVID, Poe Valley Improvement District (PVID), and for lands covered under individual contracts in the south end of Langell Valley. The live flow from the Lost River generally consists of natural accretions and tributary runoff, particularly discharges from the Bonanza Big Springs, as well as return flows from irrigation.

Whereas LVID primarily relies upon gravity diversions of stored water, HID, PVID, and other individual landowners are primarily dependent upon pumping water (live flow and stored) from the Lost River. To facilitate its pumping operations, HID operates Harpold Dam and a series of small dams in the Lost River near Bonanza to maintain upstream water levels. Similar private dams and other structures, including private pumps, exist in the Lost River downstream of Harpold Dam.

Downstream of Poe Valley and the Olene Gap, absent significant precipitation or other operational requirements (e.g., maintenance), all flow in the Lost River is diverted at the Lost River Diversion Dam into the LRDC, where the water can be exported to the Klamath River. The LRDC has a capacity of approximately 3,000 cfs. During the irrigation season, live flow from the Lost River diverted into the LRDC (in addition to any direct storage releases from Clear Lake or Gerber reservoirs) is re-diverted for irrigation purposes prior to reaching the Klamath River (at Station 48, the Miller Hill Pumping Plant, or the various private pumps that exist along the LRDC).

Generally, there is always some water from the Lost River flowing into the LRDC, although during the spring/summer irrigation season, water from this source is relatively small compared to the amount from UKL and the Klamath River simultaneously being diverted into the LRDC for delivery through the Miller Hill Pumping Plant, Station 48, and private pumps along the LRDC.

During high flow events, the entire capacity of the LRDC (approximately 3,000 cfs) is used for diverting water from the Lost River to the Klamath River for flood control purposes. Any water in the Lost River in excess of LRDC capacity must be released through Lost River Diversion Dam and at least temporarily stored in the Tule Lake Sumps. Through Pumping Plant D, the Tule Lake Tunnel, the P Canal, and finally the KSD, such water can be exported to the Klamath River, in order to limit flooding of lands in and around Tule Lake.

4.3.2.2.11. Water Rights Regulation in the Upper Klamath Basin

The KBPM does not separately account for additional inflows to UKL that occur due to enforcement of water rights by OWRD in the Upper Klamath Basin. *See* Part 1.3.2., regarding the ACFFOD, the doctrine of prior appropriation as applied in the State of Oregon, and water rights enforcement by OWRD. The KBPM treats all inflow the same for purposes of the PA, regardless of whether that inflow has been altered by upstream tributary water diversions (or the lack thereof).

Consistent with the laws of the State of Oregon, live flow that is physically available at the established point or points of diversion for a water right is subject to appropriation for beneficial use, subject to any restrictions that may exist on the exercise of that water right as a matter of state and/or Federal law. Accordingly, additional inflow to UKL resulting from water rights regulation in the Upper Klamath Basin is available for appropriation and beneficial use within the Project, just like any other live flow that may exist in UKL. However, as noted above, state and Federal law, including the ESA, may nevertheless limit the extent to which this water can be appropriated and applied to beneficial use. Accordingly, additional inflow to UKL due to water rights regulation in the Upper Klamath Basin is subject to the same operational regime as outlined in this PA, with respect to ESA requirements, as all other water in UKL.

There is one notable exception to this aspect of the PA, necessitated by Oregon law. As discussed in Part 1.3.2., Project water rights recognized in the ACFFOD are currently enforceable, absent a judicial stay. In accordance with the doctrine of prior appropriation, when the amount of live flow available for appropriation in UKL and the Klamath River is insufficient to meet the actual beneficial irrigation demands within the Project, a call may be made on the Project water rights determined in the ACFFOD. However, OWRD's administrative rules provide that an otherwise enforceable call may be disregarded if the water made available due to enforcement is not available for use or is not otherwise being used by the senior rights holder making the call. *See* Or. Admin. R. §690-250-020. Accordingly, as part of this PA, to the extent a call is made on Project water rights, the additional inflow to UKL resulting from the call will be delivered for irrigation purposes within the Project and in addition to the Project Supply identified above in section 4.3.2.2.2.2.

In the event of a Project call, for purposes of this PA and overall compliance with the ESA, Reclamation proposes the following process to quantify and deliver for irrigation purposes available UKL inflow resulting from a Project call:

1. Reclamation will quantify inflow to UKL as a result of a Project call. Reclamation retains discretion regarding the quantification method.

2. Reclamation will review with the Services the quantification method and UKL inflow rates and volumes resulting from a Project call.

3. Reclamation will make the final determination whether and to what extent the additional water resulting from a Project call can be delivered from UKL for irrigation use within the Project consistent with Reclamation's obligations under the ESA.

4. Reclamation will continue to monitor deliveries of Project Supply, including any deliveries as a result of a Project call for consistency with the PA and BiOp, including potentially adjusting UKL central tendency to account for these inflows.

The OWRD is responsible for regulating water rights in the State of Oregon. Reclamation has no role in this process except to the extent of making a call on Project water rights when the amount of water physically available at the designated points of diversion for the Project is inadequate to meet beneficial irrigation demands within the Project. The above described process explains how and to what extent Reclamation will determine and make additional water available to the Project due to water rights regulation, consistent with ESA.

4.3.3. Element Three

Perform the O&M activities necessary to maintain Project facilities.

This section outlines the O&M activities that are performed on Reclamation's various features within the Project. These activities have been on-going throughout the history of the Project and have been implicitly included in previous consultations with the USFWS on Project operations (*See* Part 2, Consultation History). No new maintenance activities are being proposed, rather these are only included in detail in this consultation to provide a more complete, explicit description of Project maintenance activities so that the potential effects of these actions on listed species can be more specifically analyzed. Reclamation has attempted to include all maintenance activities necessary to maintain Project facilities and to continue proper long-term functioning and operation. Reclamation also recognizes that this is not an exhaustive list and that there may be items that were inadvertently omitted. However, Reclamation believes that any omitted activities are similar in scope and are not outside the effects analyzed for the activities included in the following sections.

O&M activities are carried out either by Reclamation or through contract by the appropriate irrigation district according to whether the specific facility is a reserved or transferred work, respectively.

4.3.3.1. Dams and Reservoirs

4.3.3.1.1. Exercising of Dam Gates

The gates at Gerber, Clear Lake, Link River, and Lost River Diversion dams are exercised bi-annually, before and after each irrigation season to be sure they properly operate. The approximate dates the gates are exercised are March to April 15 and October 15 to November 30, and potentially in conjunction with any emergency or unscheduled repairs. The need for unscheduled repairs is identified through site visits. Once identified, the repair need is documented and scheduled. Exercising gates requires anywhere from 10 to 30 minutes depending on the facility. The gates at Gerber, Link River, and Lost River Diversion dams are opened, and water is discharged during the exercising process. Additional information that describes associated maintenance activities performed when exercising gates at specific facilities is included as follows:

1. LRD is operated by PacifiCorp who does not schedule when gate exercise occurs. The dam is operated continuously due to the flows required from UKL to the Klamath River. As such, the gates are considered exercised whenever full travel of the gates and a minimum flow of 250 cfs is achieved; PacifiCorp documents these occurrences. The stoplog gates at LRD are not exercised annually and are typically only removed under flood control operations and during infrequent stoplog replacement. A Review of O&M inspection should be performed every six years.

2. Clear Lake Dam gate exercise activities include exercising both the emergency gate and the operation gate. Depending on water conditions, some water may be allowed to discharge in order to allow for sediment flushing. Flushing requires a release of flows that must be near 200 cfs for approximately 30 minutes. This activity occurs once a year generally between March and April and is contingent on Clear Lake Reservoir surface water level elevations.

3. The frost valves at Gerber Dam are exercised annually in order to prevent freezing of dam components. Valves are opened in the fall, at the end of irrigation season, at a flow rate of approximately two cfs and closed in the spring once persistent freezing temperatures have ceased.

4.3.3.1.2. Stilling Well Maintenance

Gage maintenance is required at various project facilities to ensure accurate measurement of flows. Gage maintenance generally includes sediment removal from the stilling well, replacement of faulty equipment, modification and/or relocation of structural components, and/or full replacement of the structure, as necessary. Reclamation estimates that every 5 to 10 years, one structure is replaced. Stilling wells are cleaned once a year during the irrigation season which typically runs from April 1 through October 15.

4.3.3.1.3. Other Maintenance

To determine if repair and/or replacement of dam components is necessary, activities may include land-based observation and/or deployment of divers. Divers are deployed at Clear Lake Reservoir, Gerber Reservoir, Lost River Diversion Dam and LRD every six years prior to the Comprehensive Facilities Review for inspection of the underwater facilities. In addition, at Gerber Dam, the adjacent plunge pool is de-watered approximately every eight years for inspection of headgates, discharge works, and other components; fish salvage by Reclamation staff would be conducted for this effort. Through these inspections, if replacement is deemed necessary, Reclamation would evaluate the potential effects to federally-listed species and determine if additional ESA consultation would be required.

At LRD, the replacement of the remaining wood stop logs with concrete stop logs is proposed to occur over the next three to five years. This action may require in-water work as a floating caisson (i.e., a watertight chamber) would be placed in front of the stop log bay and then filled with water in order to submerge and seal the bay. Once sealed, the bay would be de-watered to allow for maintenance and stop log replacement. When work is completed, air would be pumped into the caisson so that it floats to the surface, and the caisson would be moved to another bay to begin work. Appropriate Reclamation staff would be on-site during the de-watering process to conduct fish salvage as needed.

At the LRDC, the removal and rebuild of the headgates is currently required. As no stop log bays exist at the channel headworks, which, if present, could isolate the gates for removal, fabrication of a bay will be necessary. This bay would be created by the installation of structural "C" channel beams in the channel walls and pier noses to allow for placement of a steel bulkhead. With a bulkhead in place, water flow can be controlled and allow for the removal of the gates. No de-watering is necessary for this activity; however, some in-water work will be required.

Design Operation Criteria, which outlines O&M guidelines for facilities maintenance is required at LRD, Clear Lake Dam, Gerber Dam, and the LRDC gates. The Design Operation Criteria is used to develop Standard Operating Procedures for Reclamation facilities. The Standard Operating Procedures outline the maintenance procedures, requirements, and schedule. The activities address the structural, mechanical, and electrical concerns at each respective facility. Some of the components of facilities that require maintenance are typically reviewed outside of the irrigation season and include, but are not limited to, the following:

- Trash racks - Maintained when necessary and are not on a set schedule. Trash racks are cleaned and debris removed daily and is specific to each pump as individual pumps may or may not run year round. Cleaning can take anywhere from one to eight hours.
- Fish screens (Screens at Clear Lake Reservoir are cleaned as described below).
- Concrete repair occurs frequently and as needed (not on a set time schedule). The amount of time necessary to complete repairs to concrete depends on the size and type of patch needed.
- Gate removal and repair/replacement (performed when needed, no set time schedule.) Inspections of gates occur during the dive inspection prior to the Comprehensive Facilities Review every six years. Gates are continually visually monitored.

Boat ramps and associated access areas at all reservoirs must be maintained, as necessary, in order to perform all weather boating access to carry out activities associated with O&M of the Project. If the boat ramp is gravel, it should be maintained on a five-year cycle. If the structure is concrete, it should be maintained on a 10-year cycle. Maintenance can include grading, geotextile fabric placement, and gravel augmentation/concrete placement depending on boat launch type. Reclamation does not perform maintenance of boat ramps on a time schedule, but rather as needed.

4.3.3.2. Canals, Laterals, and Drains

All canals, laterals, and drains are either dewatered after irrigation season (from approximately October 15 through April 15) or have the water lowered for inspection and maintenance every six years as required as part of the Review of O&M or on a case by case basis. Inspection includes checking the abutments, examining concrete and foundations, examining mechanical facilities, pipes, and gates. The amount of time necessary for inspection is based on size and specific facility.

As with other typical facilities, the C Siphon, which replaced the C Flume in 2018, would be operated, maintained, and monitored in a similar manner. Along with the external inspection of the facility, maintenance staff would enter the siphon, when de-watered, to perform an inspection of the siphon's internal features. Additionally, inspections of the concrete piers that support the siphon above the LRDC would be conducted. As necessary, hardware would be replaced throughout the life of the facility. Historically, dewatering of canals, laterals, and drains has included biological monitoring and (as needed) listed species salvage. This practice would continue under the current PA as described in Part 4.5.1.

The facilities are also cleaned to remove sediment and vegetation on a timeline ranging from annually to every 20 years. Inspections of all facilities take place on an annual basis. Inspections occur year-round or as concerns are raised by Project patrons; cleaning and maintenance takes place year-round on an as-needed basis. Cleaning the facilities may include removing sand bars in canals, silt from drains, or material filling the facilities. Animal burrows that may be impeding the facilities are dug up and compacted in order to repair them. Trees that are deemed to interrupt operations of facilities (and meet criteria outlined in the O&M guidelines) and/or pose a safety threat to the structural integrity of the facilities are removed and the ground returned to as close to previous conditions as practicable.

All gates, valves, and equipment associated with the facilities are to be exercised bi-annually before and after the irrigation season. Any pipes and structures located on dams or in reservoirs that are associated with irrigation facilities are replaced when needed and have an average lifespan of 30 years. Reclamation O&M staff replace approximately 10 sections of pipe per year and attempt to perform this maintenance activity when the canals are dry. Additional information that describes associated maintenance activities performed when exercising gates at specific facilities are included as follows:

1. A Canal headgates include six gates that need to be checked. The A Canal headgates are only operated and exercised when the fish screens are in place. If the breakaway screens were to fail, the A Canal would still be operating until the screen is put back into place. This allows for uninterrupted operation at A Canal in the event that a screen needs to be replaced to their previous position. Screens typically break once or twice a year (during normal operation), and KID is notified through alarm and the screens are repaired at the earliest time practicable.

2. The A Canal headgates are typically exercised in the spring (February through March timeframe) and fall (October through November timeframe). This activity occurs when the bulkheads are in place and the A Canal is drained and empty.

3. The LRDC diagonal gates and banks should be inspected every six years. Review of O&M inspections alternate every six years and take place anywhere from October 15 through March 31. This inspection would require drawdown of the LRDC (i.e., drawdown at least once every six years; however, as maintenance requires, LRDC drawdowns may be more frequent). The drawdown of the LRDC would leave enough water to ensure that fish were not stranded during this activity. The appropriate drawdown level is coordinated by

Reclamation O&M and fisheries staff. Biological monitoring would be incorporated, and, if necessary, flows would be increased for fish protection.

4. The gates in the concrete structure in the railroad embankment immediately upstream of the Ady Canal are exercised annually. This activity includes closing and opening the gates and this activity typically occurs in the July to September timeframe. All debris is also removed once a year, generally some time during the June through September timeframe.

4.3.3.3. Fish Screen Maintenance

The A Canal fish screens have automatic screen cleaners. Cleaning is triggered by timing or head difference. When cleaned on a timer, the timing intervals are set at 12 hours, but intervals can be changed at (KID) operator's discretion for a period defined by hours or on a continuous basis.

Fish screens at Clear Lake Dam are cleaned periodically when 6 to12 inches of head differential between forebay one and forebay two is encountered. The need for cleaning the fish screen is dictated by water quality and lake elevation and varies from year to year. For instance, in some years, such as 2009, the screen was cleaned every other day beginning approximately the end of June/early July until it was shut off. Whereas in 2011, no cleaning took place during irrigation season. During irrigation season the head differential never exceeded 0.3 foot. There is an extra set of fish screens that the O&M crew uses during the cleaning process. The extra fish screen is lowered in place behind the first set of screens so that no fish will be allowed to pass. The primary screens are then lifted and cleaned and then placed behind the second pair of screens in the lineup. This process is continued until all screens are cleaned. This process can take up to 10 hours. Upon completion, the remaining set is stored away until the next cleaning which is anytime a head difference of 0.5 foot occurs. During flood releases (when Clear Lake elevations are 4,543.0 feet or above), fish screens would not be in place.

4.3.3.4. Fish Ladder Maintenance

LRD fish ladder gate exercise activities include exercising both the head gate and the attraction flow gate which includes closing and opening the gates and physical inspection of the ladder. This activity occurs twice annually and generally occurs in the February/March timeframe and again in the November/December timeframe. The amount of time necessary for the gates to be exercised is no longer than 15 minutes. This activity includes biological monitoring by Reclamation staff biologists.

4.3.3.5. Roads and Dikes

Road and dike maintenance, including gravel application, grading, and mowing, occurs as necessary from April through October. Pesticides and herbicides are also used on Reclamation managed lands, primarily canal rights-of-way to control noxious weeds. This activity typically occurs annually. The activity of pesticide spraying occurs generally from February through October (in compliance with the Pesticide Use Plan) and is applied according to the label. Vegetation control occurs on facilities where necessary throughout the year. Techniques used to control noxious weeds may include cultural, physical, and chemical methodologies for aquatic and terrestrial vegetation. The effects of these activities have been evaluated in previous section 7 consultations, and incidental take coverage was provided in the USFWS's BiOps 1-7-95-F-26 and 1-10-07-F-0056 dated February 9, 1995 and May 31, 2007, respectively. In both

BiOps, the USFWS determined that the maintenance action of pesticide application would not jeopardize the continued existence of LRS and SNS. The products used for this maintenance activity are still being used to minimize take and are in compliance with current Integrated Pest Management Plans required by the Reclamation Manual's Directive and Standard ENV 01-01. At this time, there have been no changes to the action.

4.3.3.6. Pumping Facilities

All pumping plants are monitored yearly by visual evaluation. Dive inspections occur every six years according to the Review of O&M inspection criteria. This activity would include dewatering of the adjacent facility and installation of coffer dams. Dive inspections and dewatering of the facilities typically occurs in the August to December timeframe. Biological monitoring occurs daily during the dewatering of the facility and has historically been, and will continue to be, incorporated into maintenance activities to ensure the protection of fish as necessary. Aquatic weeds that collect on trash racks and around pump facilities are monitored continuously throughout the irrigation season and removed as needed. Weed removal typically occurs on a daily basis for those pumps that are operating continually through the season.

All pumps are greased, oil checked, cleaned, and exercised monthly if they are not in regular use. Pumps used for irrigation are maintained daily during the irrigation season. Drainage pumps would be maintained and operated on a daily basis, year-round. Pumps are greased and oiled according to the pump manufacturer's specifications. Excess grease and oil is removed and cleaned. When oil is being changed oil spill kits are kept on site and used as necessary.

Should a pump require repair, the pump chamber would be isolated from the water conveyance facility by placement of a gate, bulkhead, or coffer dam. The chamber would then be de-watered to allow for maintenance access. Appropriate staff would be on-site to perform fish salvage, as necessary, during the de-watering process.

4.4 Water Shortage Planning

Reclamation generally follows an established process for identifying and responding to the situation where available water supplies are inadequate to meet beneficial irrigation demands within the Project.

During the fall-winter period, Reclamation coordinates directly with KDD and the USFWS regarding Project water availability and demands (for both refuge and irrigation purposes). Reclamation does not make any public announcement of the volume of water available during the fall-winter period for delivery to the Project, including LKNWR.

Near the beginning of the spring-summer irrigation season, Reclamation issues an annual Operations Plan, which identifies the anticipated volume of water available from the various sources utilized by the Project, and the associated operating criteria applicable that year. The Operations Plan is posted on Reclamation's website, a press release is issued, and copies are sent by letter to Project water users and affected Tribes.

In the event of an anticipated shortage in the volume of water available for irrigation use from Clear Lake and Gerber reservoirs, Reclamation coordinates the allocation and delivery of limited supplies with LVID, HID, and others with a contractual right to receive stored water from these reservoirs.

In the event of an anticipated shortage in the volume of water available for irrigation use from UKL and the Klamath River, Reclamation will coordinate with irrigation districts and water users regarding anticipated irrigation demands within the Project. If the volume of water or the timing when it is available is less than the anticipated demands of these two districts, Reclamation may determine it necessary to issue an Annual Drought Plan (Drought Plan), which identifies and explains how water from UKL and the Klamath River is to be allocated among various entities with different contractual priorities to Project water (*see* Part 1.3.3., Reclamation Water Supply Contracts). The Drought Plan is posted on Reclamation's website, a press release is issued, and affected Project water users are provided a copy and notified by letter of the volume of water available under their respective contract.

The Drought Plan will identify an initial allocation for entities and individuals with a secondary priority to Project water from UKL and the Klamath River. Reclamation then updates the allocation (either increasing or decreasing the water available) as the irrigation season progresses and hydrologic conditions change, again notifying affected contractors by letter. Reclamation attends district board meetings, calls contractors by telephone, and answers direct inquiries related to the Drought Plan allocation.

In addition to possibly allocating the available water through the Drought Plan, there are other actions that Reclamation can take or directly facilitate, in response to a shortage in water available from the Project.

Consistent with Reclamation policy, Reclamation may administratively approve the transfer of water between districts and individual water users within the Project. Such transfers do not increase the amount of water available to the Project or expand the Project's service area but rather simply change the place of use within the Project. Prior to approval, Reclamation reviews each application on a case-by-case basis to make sure these basic conditions are met.

These internal transfers are generally used by irrigators to address a shortage in the water available under a given contract, based on the contractual priority it provides to Project water. Overall, these types of transfers promote the efficient and economical use of water.

Internal Project transfers are also available for irrigable lands within Lower Klamath and Tule Lake NWRs, subject to the approval of the USFWS. Water made available to a NWR through an internal transfer approved by Reclamation is separate from any water that may be available for delivery to the NWR consistent with the terms of this PA.

As has occurred in the past, Reclamation may also engage in irrigation demand reduction activities within the Project, on a year-by-year basis. There is no program currently in place for such activities, but such efforts have occurred periodically over the last two decades, subject to proper legal authority and the availability of federal appropriations. In the past, these activities have included agreements with individual landowners to forgo use of Project water or to produce supplemental groundwater.

4.5. Conservation Measures

The term "conservation measure" is defined as an action to benefit or promote the recovery of listed species that are included by the federal agency as an integral part of the PA. These actions will be taken by the federal agency or applicant, and serve to minimize or compensate for, project effects on the species under review. These may include actions taken prior to the initiation of consultation, or action which the federal agency or applicant have committed to complete in a BA or similar document. The conservation measures proposed assist Reclamation in best meeting the requirements under section 7 of ESA by (1) "…utilizing our authorities in furtherance of the purpose of this Act by carrying out programs for the conservation of endangered species…" and (2) avoiding actions that jeopardize the continued existence of listed species.

4.5.1. Canal Salvage

Fish salvage of Project canals occurs when canals are: (1) temporarily dewatered for a discrete action related to maintenance and/or repairs at Project facilities (described in Part 4.3.3), and (2) when canal systems are dewatered at the end of each irrigation season. Under both circumstances fish are salvaged from pools where they are stranded.

Reclamation proposes, in coordination with USFWS, to continue the salvage of suckers both for routine maintenance and repair at Project structures and at conclusion of the irrigation season when Project canals, laterals, and drains are dewatered consistent with past salvage efforts since 2005.

At conclusion of each irrigation season, Reclamation will coordinate fish salvage activities with irrigation districts, principally KID and TID. Future fish salvage of the canal system will include areas where suckers are annually encountered in reliable numbers since 2005, including the A Canal forebay, C4 Canal, D1 Canal, and D3 Canal within the KID and J Canal within the TID. Other locations within the Project canals will be periodically checked during dewatering and fish will be salvaged if deemed feasible and productive. Reclamation will also continue to pursue alternative methods of dewatering canals, laterals, and drains and which could result in less sucker presence within these facilities at the end of the irrigation season. Fish salvage will be coordinated with USFWS each year.

Reclamation will coordinate with USFWS on the disposition of endangered suckers resulting from salvage activities, including release to natural waters or retention for disease treatments, studies, and captive rearing.

4.5.2. Sucker Captive Rearing Program

Since 2000, Reclamation has supported various conservation measures within the upper Klamath Basin which have resulted in significant improvements to the Baseline (including fish screen installation at A Canal and Geary Canal, removal of Chiloquin Dam on the lower Sprague River, fish passage at LRD, increasing wetland and lake habitat at the Williamson River Delta, and annual salvage of suckers from canals). However, there are few, if any, practicable options for reducing incidental take which is an effect of the Project.

Reclamation proposes to continue support of a captive rearing effort by USFWS for LRS and SNS. The intention is to improve the numbers of suckers reaching maturity in UKL. Ultimately, the function of a captive rearing program would be to promote survival and recovery of the sucker populations that suffer losses from entrainment as a result of the Project or other threats. Captive propagation is already an important part of listed fish recovery efforts nation-wide, including at least three sucker species (i.e., June sucker, razorback sucker, and robust redhorse sucker).

The USFWS has already implemented initial efforts to rear LRS and SNS to a size that may increase individual survival. Sucker larvae collected from Williamson River were reared in tanks and holding ponds for approximately two years. Juvenile suckers salvaged from Project canals have also been held prior to release to UKL. Based on these efforts, captive rearing of LRS and SNS appears feasible and practicable. Reclamation envisions that future efforts by USFWS will expand on these initial efforts.

Specifically, Reclamation proposes support of a captive rearing program by providing funding in the amount of $300,000 annually. These funds will be used to cover costs associated with capture, rearing, release, and monitoring of released suckers in UKL. As requested by USFWS, Reclamation staff will provide personnel assistance with the rearing program when not in conflict with other necessary work. The USFWS will have oversight of the rearing program. Reclamation's support of the captive propagation program would be for the period of this consultation (April 1, 2019 to March 31, 2029) and adhere to regulations of an interagency agreement between USFWS and Reclamation. The program is envisioned as having a positive effect on the species that offsets impacts due to entrainment at LRD, A Canal, and other Project facilities. Monitoring will determine the actual effectiveness and the program's continuation will be coordinated between Reclamation and USFWS.

4.5.3. Sucker Monitoring and Recovery Program Participation

Since about 2000, Reclamation has funded monitoring of sucker populations in the lakes and reservoirs of the Upper Klamath Basin. Reclamation has also funded projects identified through USFWS' Sucker Recovery Implementation Team since 2013 and participated in the Recovery Implementation Team discussions and project identification. In coordination with USFWS, Reclamation proposes to continue efforts to monitor adult suckers in UKL, Clear Lake and Gerber Reservoirs, monitor juvenile suckers in UKL and Clear Lake, and fund sucker research, restoration and recovery actions throughout the Upper Klamath Basin. Contingent upon Reclamation's annual budget process and appropriations, Reclamation anticipates annual funds of approximately $1.5 million base funding annually with an additional $700,000 for the first two years (fiscal year 2019 and 2020) for UKL adult monitoring, Clear Lake adult monitoring, and juvenile cohort monitoring, research, and recovery projects. Funding in fiscal years beyond 2020 will be supplemented with $700,000 should appropriations materialize. Reclamation envisions that monitoring and research projects funded through the Recovery Program will answer questions about sucker recruitment in UKL and sucker population trends in both UKL and Clear Lake Reservoir. Reclamation also envisions that projects under a sucker Recovery Program will improve the amount and quality of sucker habitats, sucker passage issues, and sucker survival in the Upper Basin thereby offsetting PA impacts to habitat and entrainment of suckers at UKL, Gerber Reservoir, and Clear Lake Reservoir.

In coordination with USFWS, Reclamation proposes to continue participation in the Klamath Sucker Recovery Program.

4.5.4. Coho Restoration Grant Program

Reclamation will provide $500,000 annually with an additional $700,000 for the first two years (fiscal year 2019 and 2020) for program administration and projects that address limiting factors for SONCC coho salmon in the Klamath Basin contingent upon Reclamation's annual budget process and appropriations. Funding in fiscal years beyond 2020 will be supplemented with $700,000 should appropriations materialize. The program targets projects that have both the greatest impact on promoting survival and recovery and provide sustainable and lasting ecological benefits in the Klamath River Basin for coho salmon. Projects given the highest priority under this program include access improvement and barrier removal, improved habitat and access to coldwater refugia, instream habitat enhancement and protections, and water conservation. Restoration projects minimize habitat related effects of the Project by individually and comprehensively improving critical habitat conditions for coho individuals, populations, and overall.