Final Study Plan

Klamath Hydroelectric Project

Interim Measures 7 and 11 Study Activities for 2022

March 8, 2022

Introduction

The Klamath Hydroelectric Settlement Agreement (KHSA; as amended on November 30, 2016) includes Interim Measure 11 (Interim Water Quality Improvements), which is intended to address water quality improvement in the Klamath River during the interim period leading up to potential dam removal. Regarding Interim Measure (IM) 11, the KHSA states "The emphasis of this measure shall be nutrient reduction projects in the watershed to provide water quality improvements in the mainstem Klamath River, while also addressing water quality, algal and public health issues in Project reservoirs and dissolved oxygen in J.C. Boyle Reservoir." The measure calls for PacifiCorp to spend up to $250,000 per year[1] for studies or pilot projects in consultation with the Interim Measures Implementation Committee[2] (IMIC).

Interim Measure 7 requires PacifiCorp to provide $150,000 of funding per year for the placement of gravel into the Klamath River upstream of Copco Reservoir or "… other habitat enhancement projects that provide equivalent fishery benefits in the Klamath River above Copco Reservoir." In 2021, PacifiCorp, with the support of the IMIC, adjusted the approach to the IM 7 and IM 11 funded projects to include work that may have a direct benefit to returning salmonids when dam removal occurs. Although the application of funds to specific projects from IM 7 and IM 11 allocations still follows the requirements in the KHSA, a single study plan is more useful to the IMIC and other stakeholders. A draft study plan with 10 separate activities was provided to the IMIC in January 2022. In a meeting on March 2, 2022, the IMIC decided to allocate funding to the following activities. The 2022 activities described in this study plan that are related to IM 7 and IM 11 include:

1. Iron Gate Intake Barrier Curtain System Management for Water Quality Improvement of Powerhouse Releases
2. Klamath Irrigation District Modernization Study
3. J.C. Boyle Dam to Copco Reservoir: Cold-water Refuge Investigations
4. Spencer Creek Exclusion Fencing
5. Bypass Reach Fish Health Studies – Part 2

[1] Per year until the date that the Dam Removal Entity (DRE) accepts a Surrender Order issued by the Federal Energy Regulatory Committee (FERC) regarding the Klamath Hydroelectric Project. The KHSA indicates that up to 25 percent of the funding in this measure for pre-surrender-order acceptance studies and post-surrender-order acceptance implementation may be directed towards in-reservoir water quality improvement measures, including but not limited to J.C. Boyle Reservoir.

[2] The IMIC is comprised of representatives from PacifiCorp and other parties to the KHSA. The purpose of the IMIC is to collaborate with PacifiCorp on ecological and other issues related to the implementation of the Non-Interim Conservation Plan Interim Measures set forth in Appendix D of the KHSA.

1: Iron Gate Intake Barrier Curtain System Management for Water Quality Improvement of Powerhouse Releases

Submitted by: PacifiCorp

Funding source: IM 11

Purpose and Objectives

The purpose of this activity is to operate the intake barrier system in Iron Gate Reservoir to improve water quality in Iron Gate Powerhouse releases to the Klamath River. Annual studies from 2015 to 2021 indicate that the curtain upstream of the intake is effective as a means of reducing algae entrainment into the intake.[3] Work in 2022 will continue to inform management and operation of the system.

The concept behind the curtain is to control the depth at which water is withdrawn from the reservoir into the intake, and thereby enhance water quality downstream of Iron Gate Dam by reducing the entrainment of biomass from blooms of cyanobacteria (blue-green algae) and potential associated algal toxins (i.e., microcystin). These studies have provided valuable insights into the performance of the curtain system under varying conditions. The curtain has been deployed to different depths for different periods of time over the last 7 years with associated sampling and monitoring. This work has collectively indicated that the curtain functions as it was designed and selectively limits the entrainment of surface water in Iron Gate Reservoir. More recent operations indicate that curtain can serve to both reduce entrainment of cyanobacteria and potential associated algal toxins, as well as provide springtime reduction in water temperatures downstream of Iron Gate Dam, when deployed to the design depth early in the season. In the last 2 years the curtain has been operated in this manner by deploying to design depth early in the season and leaving the curtain at design depth through September or October.

Task and Work Elements

The tasks and work elements associated with this activity in 2022 will include the following efforts. Final data summary and reporting would occur after data collection is complete, likely in early 2023.

- Curtain deployment in the spring, summer, and early fall of 2022 to provide early season temperature benefit and summer and early fall reduced entrainment of cyanobacteria.
- Field data collection at the curtain in 2022 will focus on collecting information to manage curtain operations. PacifiCorp will deploy data sondes and thermograph arrays upstream and downstream of the curtain to continuously monitor conditions throughout the summer and early fall. The data sondes are automated to profile at fixed intervals and transmit data in real-time to operators so that curtain performance can be observed and any identified adjustments can be made in an efficient manner. Detailed vertical profiles will be conducted immediately before and after curtain deployment and

[3] PacifiCorp. 2017. 2016 Evaluation of Intake Barrier Curtain in Iron Gate Reservoir to Improve Water Quality in the Klamath River. Oct. 113 pp.

Watercourse Engineering, Inc. (Watercourse). 2016. Water Quality Effects of an Intake Barrier Curtain to Reduce Algae Concentrations Downstream of Iron Gate Reservoir. Prepared for PacifiCorp. July. 67 pp.

Watercourse Engineering, Inc. (Watercourse). 2020. 2019 Iron Gate Intake Curtain Barrier Data Summary. Technical Memorandum prepared for PacifiCorp dated November 4. 2020. 26 pp.

PacifiCorp. 2021. Final Intake Barrier Curtain Summary Report. May.186 pp.

repeated a few days after curtain deployment. These data, coupled with a data sonde downstream of the dam and a local meteorological station will add to the information collected over the previous years and allow PacifiCorp to continue to manage the curtain to maintain downstream water quality benefits prior to dam removal.

2: Klamath Irrigation District Modernization Study

Submitted by: Farmers Conservation Alliance (FCA)

Funding source: IM 11

Overview

Over the last 7 years, FCA has developed the Irrigation Modernization Program (IMP) to help irrigation districts and the farmers they serve revolutionize their infrastructure. Klamath Irrigation District (KID) delivers irrigation and stock water to 2,500 patrons across 53,638 acres in the Klamath Basin through 200 miles of canals and laterals, 10 drains, 200 miles of drainage ditches, and 7 pump stations. KID's major diversion supplies water from Upper Klamath Lake to the A-Canal (1,150 cfs) and the A-Canal headworks. Much of KID's infrastructure is aging and inefficient. Modernizing this infrastructure could improve irrigation water management by enhancing water conveyance efficiency, and reducing spillage, energy use, and operations and maintenance costs. These activities will provide important water use efficiency and operational flexibility that will improve water quality. Water quality degradation is a critical issue of concern in the Upper Klamath Basin.

Tasks and Work Elements

FCA's irrigation modernization study is the first step to inform strategic planning and on-the-ground project implementation needs for KID. FCA's irrigation modernization study will identify the infrastructure improvements and pathways to permitting, funding, and implementation that are unique to the KID. The first two tasks have already been completed and the third task is underway. FCA is requesting funding from IM11 to support Task 4.A through 4.E and Task 6. Funding is not being requested for items in italics below but they are included here so the complete scope of FCA's project is clear.

1. Initial findings assessment. *Task complete.*

2. Early-action project assessment. *Task complete.*

3. Stakeholder engagement. *Task is ongoing and supported by other funding sources.*

4. District assessments. FCA's initial findings report, already completed for KID, informs the assessments to be completed during the irrigation modernization study process. Depending on the KID's needs, these assessments may focus on the entire district, a subset of the district, and/or specific modernization needs as identified during the scoping process. FCA scales efforts in some or all the following assessments where appropriate based on its initial findings.

A. Water loss assessment. FCA develops a strategy to assess system losses in KID, with a focus on operational spills. FCA measures, evaluates, and develops a report characterizing these losses in KID.

B. GIS mapping. FCA conducts GIS mapping of district's canals, laterals, turnouts, and other infrastructure necessary to develop a model of a modernized system, as well as inform existing district operations.

C. System design. FCA develops a conceptual model of modernized infrastructure in collaboration with KID and appropriate partners. If necessary, FCA develops a hydraulic model using software that simulates the conceptual model. These models allow staff to identify options for improving the delivery of irrigation water to agricultural producers while reducing operational spills that contribute to water quality issues.

D. Energy assessment. Based on the hydraulic model and estimated irrigation water deliveries, FCA identifies potential reductions in pump energy use and operations costs associated with a modernized

system. Depending on KID priorities, FCA also identifies potential renewable energy generation opportunities and revenues within the district.

E. System Improvement Plan development. FCA works closely with districts to develop a high-level engineering plan, referred to as a System Improvement Plan. System Improvement Plans present feasibility-level designs of modernized infrastructure, including elements such as modernized canals and laterals, improved management and control structures, managed groundwater recharge structures, energy efficiency measures, and renewable energy generating facilities. FCA works closely with the district and appropriate partners to identify potential project phasing based on strategic priorities and engineering needs.

F. Financial/funding assessment. FCA works with districts to evaluate the financial outcomes of investing in irrigation modernization using different financing mechanisms. This analysis considers earned revenue, debt financing, and government grants. As appropriate, FCA develops relationships with potential funding partners to support modernization efforts. This task would not be funded by IM11.

G. Benefits evaluation. FCA evaluates the range and magnitude of potential benefits from irrigation modernization for agricultural, environmental, and community resources. These evaluations typically include benefits such as water saved for agriculture, environmental, or community use; water quality parameters improved; federally listed species benefitted; increased agricultural production; renewable energy generation capacity developed; and jobs supported through modernization investments. These evaluations help to inform project timing, develop funding and implementation partnerships, and communicate about the outcomes of district modernization efforts. This task would not be funded by IM11.

5. Modernization strategy development. *FCA develops and documents a comprehensive, high-level modernization strategy that summarizes the approach to and impacts and benefits from modernization. The strategy will include summaries of the assessments completed throughout the modernization study process to inform communications and potential funding and implementation partners. Strategy development begins early in the modernization process and builds on other tasks appearing in this scope of work. This task would not be funded by IM11.*

6. Project management. FCA works closely with KID, district board members, contractors, and partners to ensure that all their efforts are coordinated and achieve project goals and objectives. FCA ensures that tasks build on and complement each other throughout the modernization process.

3: J.C. Boyle Dam to Copco Reservoir: Cold-water Refuge Investigations

Submitted by: PacifiCorp

Funding source: IM 7 and IM 11

Purpose and Objectives

In summer 2021, PacifiCorp contracted E&S Environmental Chemistry and NV5 Geospatial to collect remotely sensed thermal data from J.C. Boyle Dam to the headwaters of Copco Reservoir. The primary deliverables from this work was a calibrated and orthorectified thermal image mosaic for the 22 miles of river from J.C. Boyle Dam to the headwaters of Copco Reservoir for the full river width at 0.5 meter resolution and spatial datasets representing longitudinal temperature profiles and significant thermal features. A full report has also been provided.

This work identified 119 significant thermal features in the Klamath River from J.C. Boyle Dam downstream to Copco Reservoir. These are mostly locations where the thermal data identified inflow of water that was cooler than the surrounding river water. These inflows are expected to be springs, seeps, tributaries, and areas of hyporheic flow. With the larger goal of designing habitat protection or restoration features that could aid in the creation or maintenance of cold-water refuge habitat, the follow-up studies discussed below are proposed to refine the thermal data collected in 2021.

Tasks and Work Elements

A technical advisory group has been formed to assist with the scoping and implementation of studies undertaken as part of this work plan in 2022. The following are a preliminary set of tasks that could be implemented to refine the thermal data collected in September 2021.

Task 1. Spring prioritization. The thermal flight identified 119 significant thermal features. This task would review those in terms of the temperature anomaly identified, location in the reach, and distance to other associated thermal features. The analysis would investigate the potential of developing a prioritization metric to assist in selecting features for further analysis.

Task 2. Habitat assessment at priority locations. Cool-water inflows may provide important refuge habitat for anadromous fish following dam removal. Some of the features identified are in the bypass reach between J.C. Boyle Dam and J.C. Boyle Powerhouse. This reach will be subject to higher flow rates, possibly resulting in dilution of these cool-water inflows. If these features are to be somehow protected from dilution, then understanding the existing habitat and potential restoration options would seem to be important. This scope of work therefore would include on-the-ground assessments of these features including an evaluation of existing fish habitat as well as the potential to create cold-water refuge areas.

Task 3. Detailed inflow assessment. While the total flow contribution of the springs in the bypass reach is relatively well understood, the amount of water flowing into the channel at any one location is not clear. Larger inflow areas may provide more opportunity for creating or improving existing refuge habitat for fish. This task would collect detailed flow data at priority complexes to help inform restoration planning.

Task 4. Additional thermal monitoring. The 2021 data set was collected over a short period of time at a single flow condition. More detailed monitoring of prioritized thermal features would help to understand the

contribution to local cooling under a variety of flow regimes over a longer period of time. This could be accomplished using unmanned aerial vehicles, land-based cameras, or additional flights.

Task 5. Flow and water quality modeling. Although detailed water quality models exist for the Klamath River, they do not include the detail necessary to account for the changes in water temperature at specific locations. If there is interest in evaluating the effect of different flow regimes on cold-water refugia after dam removal, more specific models would need to be developed for specific thermal features.

4: Spencer Creek Exclusion Fencing

Submitted by: PacifiCorp

Funding source: IM 7

Purpose and Objectives

Late in the summer of 2021, survey was completed of the exclusion fencing on PacifiCorp and Green Diamond property along the lower 8 miles of Spencer Creek. This survey documented the location and condition of about 5 miles of fence in four main areas along Spencer Creek. The survey provided data on the type of fence and location of areas in poor condition or where animals were passing through the fence. Much of the fence is in relatively poor state of repairs. In November, PacifiCorp met with Green Diamond, ODFW, and NMFS to discuss the results of the fence survey and possible next steps. PacifiCorp proposed work on about 4.1 miles of fence where existing fence completely enclosed areas of the creek. A the time, Green Diamond wanted to wait for the conclusion of the Reservoir Reach Tributary Assessment project that NMFS was leading before taking any additional actions. NMFS met with Green Diamond in February 2022 and Green Diamond is willing to support the repair of existing exclusion fencing on their property in 2022.

Tasks and Work Elements

The work to be accomplished under would include the repair of existing fence line. To accomplish this, PacifiCorp would retain the services of a local fencing contractor. That contractor would provide the equipment, staffing, and materials necessary to repair the roughly 4.1 miles of fence in the three identified areas. The goal of this work would be to create fences that are not permeable to cattle, thereby protecting the Spencer Creek riparian area from grazing impacts. Costs are based on estimates of $7,800 per mile.

5: Bypass Reach Fish Health Studies – Part 2

Submitted by: Oregon State University

Funding source: IM 7

Purpose and Objectives

Funds are requested to pursue two main areas of investigation in 2022. The first area is field sampling and sample analysis which would include the six sites identified below over a 6-month period. The sites are the same as those sampled in 2021:

1. Klamath mainstem at Keno Eddy (lower Keno Reach)
2. Lower Spencer Creek
3. Klamath mainstem below J.C. Boyle Dam
4. Klamath mainstem above J.C. Boyle Powerhouse
5. Klamath mainstem Frain Ranch (Peaking Reach above Caldera Rapid)
6. Klamath mainstem below Shovel Creek

Site selection was based on predicted migration routes after reintroduction, available spawning/rearing habitat and longitudinal water sampling conducted in 2018 - 2020 that measured *Ceratonova shasta* density. All index sites will provide data relevant for Coho Salmon, which are predicted to repopulate the Klamath River up to and including Spencer Creek, spring and fall-run Chinook Salmon, and Steelhead, which are expected to congregate just upstream of Keno Eddy before migrating further. Chinook are expected to spawn in the mainstem near these sites.

The 2021 study plan included only funding for sampling and analysis of three sites. In the site selection process, Oregon Department of Fish and Wildlife (ODFW) and California Department of Fish and Wildlife (CDFW) recommended six sites be sampled. OSU collected samples from all six sites, but does not have the funds to support analysis of the samples from the extra three sites. Funding this analysis would be the third main work area in 2022.

2022 Objectives:

Objective 1: Determine the spatial and temporal distribution and density of salmon parasites in the Project Reach

Objective 2. Determine the pre-dam removal distribution and infection prevalence of salmon parasites in annelid hosts in the Project Reach

Objective 3. Complete analysis of the three extra sites that were sampled in 2021

Tasks and Work Elements

Task 1. Collect 24-hour composite water samples from the six sites in the Project Reach. Samples would be collected once each month from May through October.

Task 2. Filter half the samples for parasite quantification and the other half for annelid eDNA quantification.

Task 3. Extract captured DNA and analyze parasite samples for *C. shasta* and *Parvicapsula minibicornis* and eDNA samples for *Manayunkia occidentalis.*

Task 4. In two separate months, collect a benthic invertebrate sample from each of the six sites.

Task 5. Process benthic samples for annelid density.

Task 6. Analyze benthic samples for infection with *C. shasta* and *P. minibicornis.*

Task 7. Analyze the samples collected at the three additional sites sampled in 2021, but that were not part of the 2021 scope of work.