

Klamath Hydroelectric Project
FERC Project No. 2082

Klamath Hydroelectric Settlement
Agreement
Interim Measure 7
J.C. Boyle Gravel Monitoring Report
2017-2018



Prepared by



Prepared for



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KLAMATH HYDROELECTRIC PROJECT SETTLEMENT AGREEMENT INTERIM MEASURE 7 J.C. BOYLE 2017-2018 GRAVEL MONITORING REPORT

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1 INTRODUCTION

1.1 PROJECT DESCRIPTION

PacifiCorp owns and operates the Klamath Hydroelectric Project (Project), located on the upper Klamath River in Klamath County (south-central Oregon) and Siskiyou County (north-central California). The Project has five dams on the Klamath River: Keno, J.C. Boyle, Copco 1, Copco 2, and Iron Gate (Figure 1.1-1). The Link River dam is owned by the U.S. Bureau of Reclamation and operated by PacifiCorp.



Figure 1.1-1. Location map.

1.2 BACKGROUND

On February 18, 2010, the United States, the States of California and Oregon, PacifiCorp, Tribes, and a number of other stakeholder groups signed the Klamath Hydroelectric Settlement Agreement (KHSa). The KHSa was amended by many of these same parties and signed on April 6, 2016. The KHSa includes provisions and detailed actions for the interim operation of

PacifiCorp's dams prior to removal of the dams or the termination of the KHSA. One of the measures, titled Interim Measure 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement, requires habitat restoration in the J.C. Boyle bypass and peaking reaches.

As described in Interim Measure 7 of the KHSA, PacifiCorp is to provide funding annually for the planning, permitting, and implementation of gravel placement or habitat enhancement projects, including related monitoring, in the Klamath River upstream of Copco Reservoir and downstream of J.C. Boyle dam. The key objective of this measure is to place suitable gravels in the J.C. Boyle bypass and peaking reaches for resident trout, potential future salmon spawning, and ecological restoration purposes. In full, Interim Measure 7 states:

Interim Measure 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement

Beginning on the Effective Date and continuing through decommissioning of the J.C. Boyle Facility, PacifiCorp shall provide funding of \$150,000 per year, subject to adjustment for inflation as set forth in Section 6.1.5 of the Settlement, for the planning, permitting, and implementation of gravel placement or habitat enhancement projects, including related monitoring, in the Klamath River above Copco Reservoir.

Within 90 days of the Effective Date, PacifiCorp, in consultation with the IMIC, shall establish and initiate a process for identifying such projects to the Committee, and, upon approval of a project by the Committee, issuing a contract or providing funding to a third party approved by the Committee for implementation of the project.

The objective of this Interim Measure is to place suitable gravels in the J.C. Boyle bypass and peaking reach using a passive approach before high flow periods, or to provide for other habitat enhancement providing equivalent fishery benefits in the Klamath River above Copco Reservoir.

Interim Measure 7 falls under the auspices of the Interim Measures Implementation Committee (IMIC). The IMIC is comprised of state, federal, tribal, and private signatories to the KHSA whose purpose is to collaborate with PacifiCorp on ecological and other issues related to the implementation of several Interim Measures as set forth in the KHSA. The IMIC formed a technical subcommittee comprised of representatives from the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Water Resources (ODWR), the Klamath Tribes, PacifiCorp, and the Bureau of Land Management (BLM) to discuss the goals, objectives, regulatory requirements, and planning for Interim Measure 7. This subcommittee recommended the development of a long term gravel enhancement plan that would cover the expected time period (2010-2020) for implementation of Interim Measure 7.

Per the KHSA, PacifiCorp developed the J.C. Boyle Gravel Placement and Monitoring Plan (Plan) in the spring of 2011 (Mason, Bruce and Girard et al. 2011). The Plan details monitoring objectives, methods for both gravel placement and monitoring, and annual reporting requirements. Following this Plan, approximately 500 cubic yards of gravel was placed in the river each year in the fall from 2011 through 2018. This document describes the sixth year of monitoring (gravel placed in October 2017) under Interim Measure 7. The October 2018 gravel placement monitoring results will be reported in late 2019.

1.3 MONITORING OBJECTIVES

The monitoring objectives outlined in the Plan include assessments of both the implementation and effectiveness of gravel enhancements under Interim Measure 7. Field observations related to implementation were intended to answer three primary questions:

1. Were placement methods cost-effective and implemented within the proposed budget constraints?
2. Were placement procedures safe and effective for getting gravel placed in the intended locations and quantities?
3. Were there any unanticipated problems in either the implementation or the effectiveness of the placements?

Effectiveness monitoring was intended to evaluate whether the placed gravel distributed and sorted as intended given the flow regime experienced during the performance period (date of placement through October of the following year). Effectiveness monitoring was designed to answer the following specific gravel distribution/sorting questions for each gravel placement site:

- Did the flows that occurred since the previous gravel placement result in movement (scour) of the placed gravel?
- Did the flows that occurred since the previous gravel placement result in a change in channel cross section (net scour or aggradation) across the gravel placement site or some distance downstream?
- Did the gravel placement result in a change in substrate composition across the gravel placement site or some distance downstream?

2 METHODS

2.1.1 Implementation Monitoring

Implementation monitoring for gravel placement was addressed primarily through a questionnaire given to PacifiCorp's project manager and the on-site gravel placement foreman. Responses addressed gravel quantities, the methods and safety of gravel placement activities, and any recommended actions to improve placement methods or related operations. In addition, measurements of turbidity upstream and downstream of gravel placement were made to confirm compliance with State water quality standards.

2.1.2 Effectiveness Monitoring

Effectiveness monitoring methods were designed to determine whether placed gravel was distributed and sorted as intended given the flow regime experienced during the monitoring period. During previous monitoring periods, a combination of surveyed cross sections, scour monitors, and visual/photo observations were used to determine if placed gravel moved or not.

Gravel was placed at three sites in October 2017; scour monitors and/or visual observations were used to evaluate gravel movement at these sites in fall of 2018.

In October 2018, gravel was placed at two sites in the peaking reach (RM 220.2 and 216.8). Gravel had been placed at both of these sites in past years. Based on previous years' monitoring, it was determined that visual/photo observations were sufficient to determine if placed gravel had moved at both sites. The results of the October 2018 placement will be discussed in next year's monitoring report.

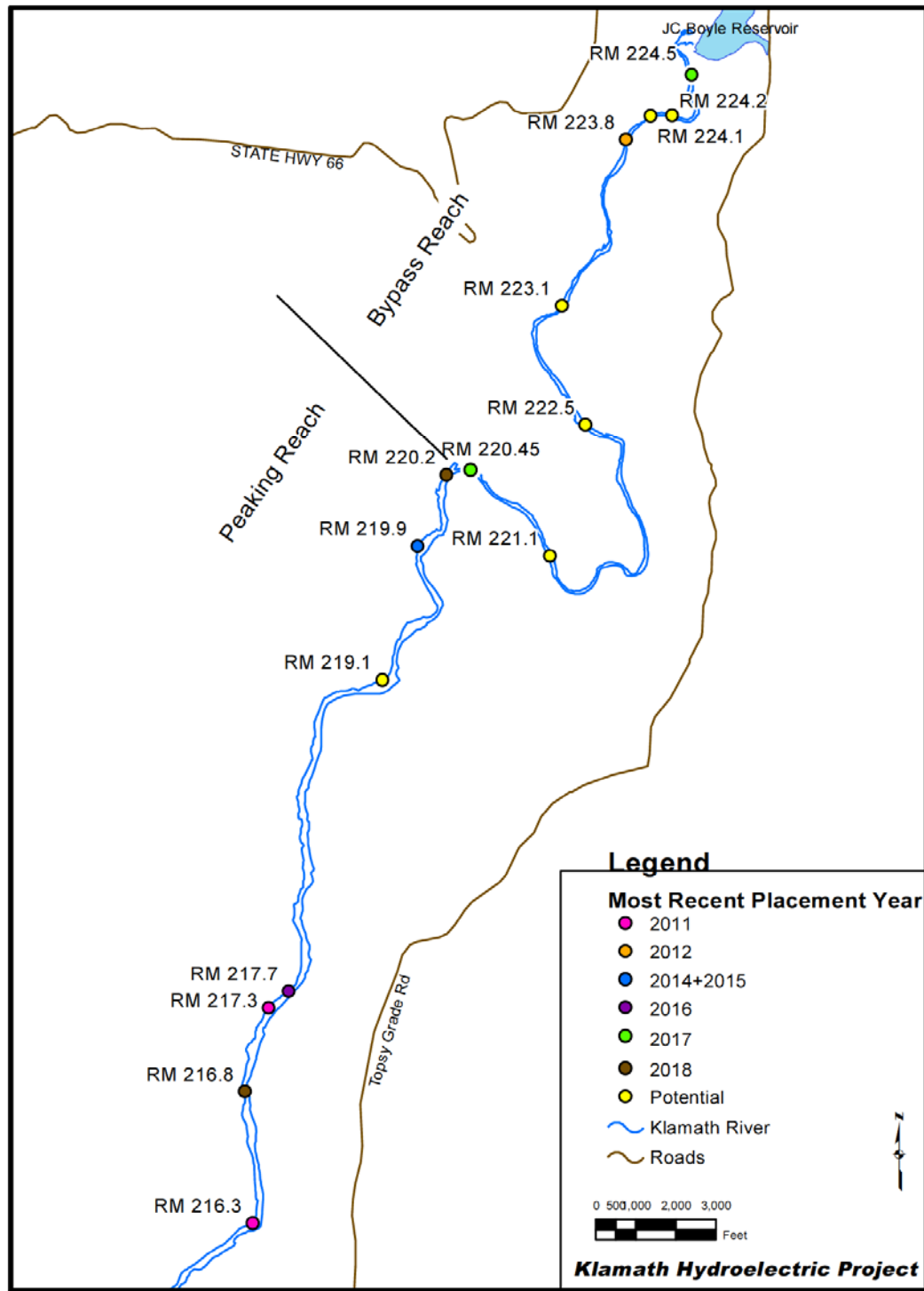
3 RESULTS

Since 2011, approximately 500 cubic yards of gravel was placed in the Klamath River below the J.C. Boyle dam each year (Table 3.1-1, Figure 3.1-1). This monitoring report considers the gravel that was placed at the sites at RM 224.5, 220.45, and 220.2 in October 2017.

Table 3.1-1. Gravel Placement Locations, Dates, and Volumes.

Site (River Mile)	Placement Date/Volume (cubic yards)							
	November 2011	October 2012	October 2013	October 2014	October 2015	October 2016*	October 2017	October 2018
224.5	-	225	-	-	-	-	150	
223.8	-	105	-	-	-	-	-	
220.45	-	-	-	-	-	300	20	
220.2	-	-	250	-	-	-	230	250
219.9	-	250	250	250	250	-	-	
217.7	-	-	-	-	-	100	-	
217.3	250	-	-	-	-	-	-	
216.8	-	-	-	250	250	100	-	250
216.3	250	-	-	-	-	-	-	

* Note: Due to safety concerns with muddy road conditions, only 100 cubic yards of gravel could be placed at RM 217.7 in October 2016; the remaining gravel intended for 217.7 was placed at RM 216.8.



Note: Gravel was placed at RM 224.5, RM 220.45, RM 220.2, RM 219.9, and RM 216.8 in multiple years; see Table 3.1-1.

Figure 3.1-1. Gravel placement locations.

3.1 POST-PLACEMENT FLOWS

3.1.1 Peaking Reach Flows (sites downstream of RM 220.2)

One of the 2017 gravel placement sites is located in the peaking reach downstream of the J.C. Boyle powerhouse (RM 220.2). Flows from the USGS gage downstream of the J.C. Boyle powerhouse (USGS 1151070) recorded at 15-minute intervals were collected from the USGS website. These flows are a mix of approved and provisional data that have not been finalized by the USGS but overall are unlikely to change substantially. Post gravel placement flows (October 2017-October 2018) ranged from approximately 350 to 5,730 cfs (Figure 3.1-2).

3.1.2 Bypass Reach Flows (sites between RM 224.5 and RM 220.45)

Flows in the bypass reach were the normal minimum flows throughout much of the year with the exception of several spill events in April and May 2018 (Figure 3.1-3). The peak spill in April was estimated to be 3,622 cfs at the upstream end of the bypass reach. Note that these data are provisional and subject to error; PacifiCorp does not rate data with any accuracy above 500 cfs at this gage location.

The peak flow within both the peaking and bypass reaches during the 2017-2018 monitoring period was sufficient to move the gravel placed during October 2017. Spill during March 2016 and spring 2017 had moved much of the gravel placed during previous years (2011-2016) as reported in last year's monitoring report (MB&G and WatershedGeoDynamics 2017).

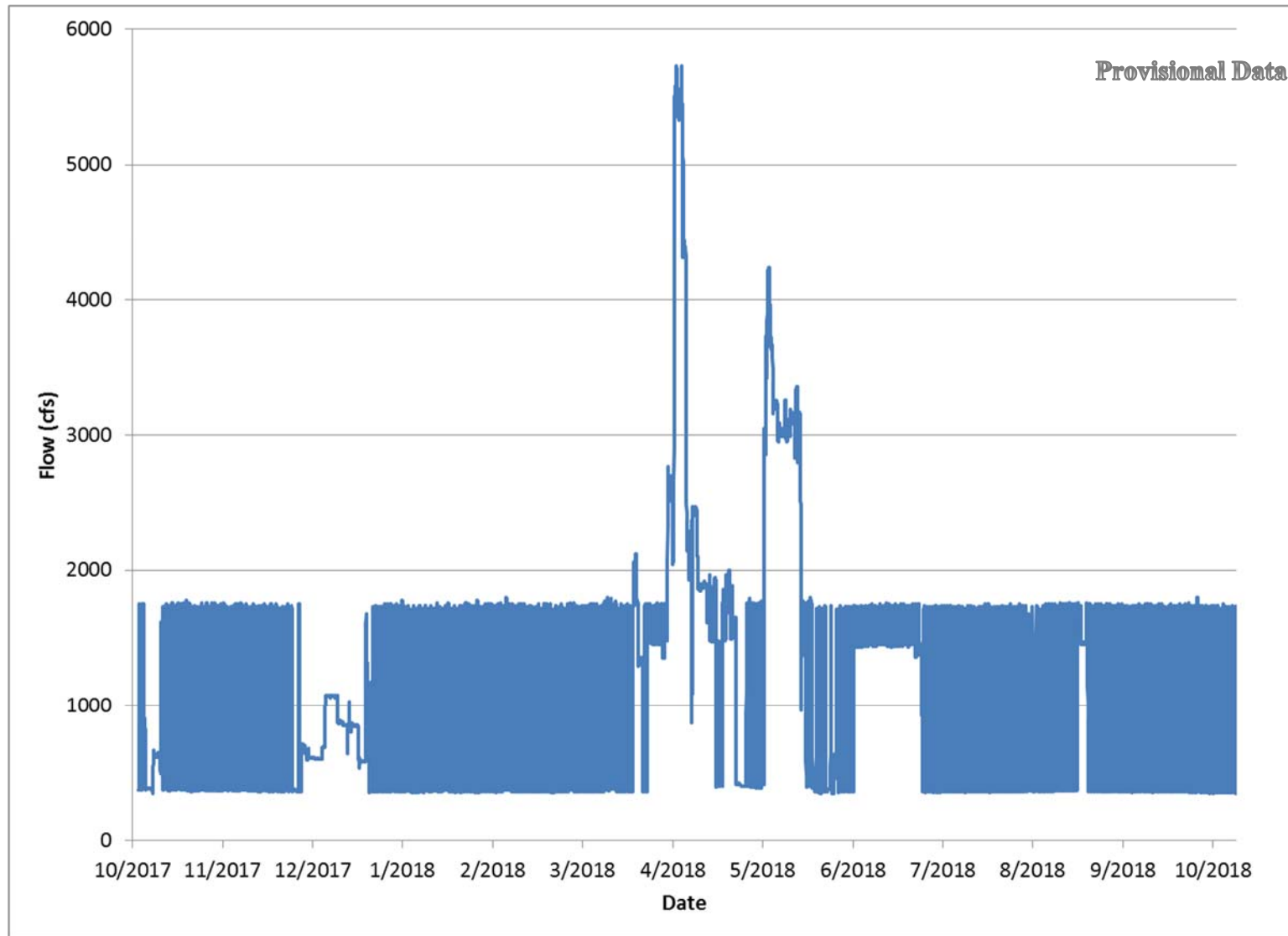


Figure 3.1-2. Post-gravel placement flows at USGS gage 1151070 downstream of J.C. Boyle powerhouse, October 2017 – October 2018

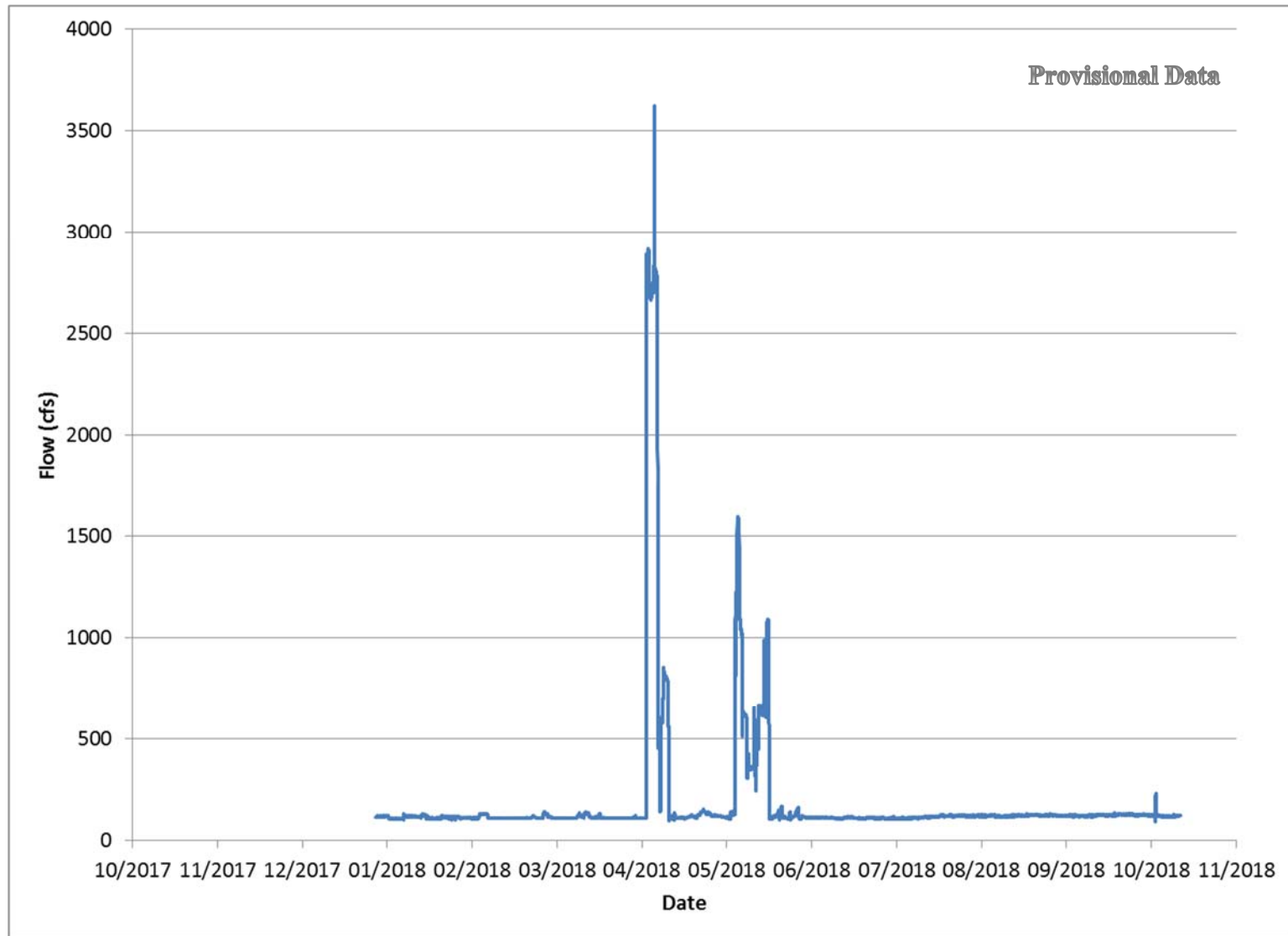


Figure 3.1-3. Post-gravel placement flows at PacifiCorp gage downstream of J.C. Boyle dam (bypass reach) October 2017–October 2018
(at flows greater than 500 cfs these gage values may not be precise)

3.2 IMPLEMENTATION MONITORING

Implementation monitoring questionnaires were filled out by the PacifiCorp project manager and the construction foreman to determine the amount of gravel placed, placement costs, and any efficiency/safety issues (Table 3.2-1). In October 2017, approximately 150 cubic yards of gravel were placed using conveyored aggregate delivery (CAD) trucks at the RM 224.5 site, 20 cubic yards at the RM 220.45 site and 230 cubic yards at the RM 220.2 site. No safety or placement issues were encountered other than the request to flag potential placement locations prior to start of work. Measurements of turbidity upstream and downstream of both locations were conducted during gravel placement; no exceedances occurred at either site.

Table 3.2-1. Implementation monitoring questions, October 2017 placement.

Monitoring Question	2017 Results
How many cubic yards of gravel were placed at each site?	RM 224.5 – 150 cubic yards RM 220.45 – 20 cubic yards RM 220.2 – 230 cubic yards
Were the placement methods (truck/helicopter) able to place gravel where planned?	All sites were placed using high speed CAD trucks. No issues were encountered with the conveyor placement.
Were any safety issues encountered?	No safety issues were encountered.
Were any problems encountered during placement?	There were no PacifiCorp representatives on site for the first three hours to verify placement locations.
Are there any recommendations to improve placement methods in the future?	Flagging or otherwise designating placement locations prior to start of work would be helpful.

3.3 EFFECTIVENESS MONITORING

Gravel added to the placement sites was in the 0.5 to 3-inch (12.7 to 76.2 mm) median diameter size range. Gravel had been added at each of the three 2017 placement sites in previous years, and high flows/spill or normal operating flows (at the peaking reach site) had previously moved gravel from these areas. Results of effectiveness monitoring for the 2017-2018 period at each of the three sites are described below.

3.3.1 Downstream of JC Boyle Dam Site, RM 224.5

The RM 224.5 site is located approximately 1,500 feet downstream from JC Boyle Dam (Figure 3.1-1). Approximately 150 cubic yards of gravel were shot from a truck parked on the road on the east side of the river.

Location: Bypass reach, RM 224.5, downstream from the JC Boyle Dam

Type of placement: CAD Truck

Habitat Description: Run just upstream from cobble/boulder riffle. Average wetted width 70 feet; average local gradient 0.013.

2017 Placement volume: 150 cubic yards.

Four scour monitors were placed at this site since previous monitoring at this site indicated that gravel was not transported unless there was spill through the bypass reach. All gravel and scour monitors were moved from this site (Figures 3.3-1 and 3.3-2) following the Spring 2018 high flows (Figure 3.1-3).



Figure 3.3-1. Photo of placed gravel at RM 224.5, October 2017 (after placement).



Figure 3.3-2. Photo of gravel site at RM 224.5, October 2018 after high flows.

3.3.2 Upstream of Powerhouse Site, RM 220.45

The RM 220.45 site is located at the upstream end of the switchyard/powerhouse parking lot, just upstream from the powerhouse at the end of the bypass reach (Figure 3.1-1). Approximately 20 cubic yards of gravel were shot from a truck in the parking lot into the river.

Location: Bypass reach, RM 220.45, just upstream from the powerhouse

Type of placement: CAD Truck

Habitat Description: Cobble/boulder riffle. Average wetted width 40 feet; average local gradient 0.013.

2016 Placement volume: 20 cubic yards.

Observations in October 2018 following spill/high flows in the bypass reach showed that there was little, if any, of the 20 cubic yards remaining at the placement location, but the deep fast water and small amount of gravel made precise observations difficult (Figures 3.3-3 and 3.3-4).



Figure 3.3-3. Photo of placed gravel at RM 220.45, October 2017 (after placement).



Figure 3.3-4. Photo of gravel site at RM 220.45, October 2018 (after high flows).

3.3.3 Downstream of Powerhouse Site, RM 220.2

The RM 220.2 site is located in the peaking reach just downstream of the powerhouse (Figure 3.1-1). Approximately 230 cubic yards of gravel were placed at this site in 2017 from a CAD truck located on the northwest bank of the river.

Location: Peaking reach, RM 220.2, right bank looking downstream

Type of placement: Truck – gravel shooter

Habitat Description: Boulder/cobble riffle. Average wetted width 90 feet.

Placement volume: 230 cubic yards.

All of the 2017 gravel was moved from the RM 220.2 site prior to October 2018 (Figures 3.3-5 and 3.3-6). Previous gravel placed at this site had been moved by normal peaking flows, so the 2017-2018 results were consistent with previous observations of gravel movement at the site.



Figure 3.3-5. Photo of gravel site at RM 220.2, October 2017 (after placement).



Figure 3.3-6. Photo of gravel site at RM 220.2, October 2018 (after high flows).

3.4 SUMMARY OF 2017 GRAVEL PLACEMENT

Truck-based gravel placement at the RM 224.5, RM 220.45 (bypass reach), and RM 220.2 (peaking reach) sites occurred in October 2017. Visual observations at the sites showed that flows between October 2017 and October 2018 removed the majority of gravel from the October 2017 placement sites.

The high flows in Spring 2018 contributed to movement of gravel at all the sites, particularly the site in the bypass reach. The highest flow in the peaking reach (5,730 cfs) was less than the magnitude of flows (15,000 to 18,000 cfs) estimated to move the largest sized gravel added to peaking reach sites (3 inch median diameter; PacifiCorp 2005); however the mix of gravel sizes added and the loose nature of the added gravel likely make it possible for the majority of the larger particles to be transported from the peaking reach site at RM 220.2.

3.5 FUTURE GRAVEL PLACEMENT SITES

Based on the placement and monitoring of gravel at all the sites (Figure 3.1-1), gravel can be added at any of the sites in the bypass reach and all but two of the sites in the peaking reach (Table 3.5-1). High flows in the Spring of 2017 and/or 2018 transported the gravel that had been previously added at bypass reach sites. Gravel can be added to the peaking reach RM 220.2, RM 219.9, and RM 216.8 sites any time in the future; normal operating flows are capable of transporting gravel added to these sites. Gravel can be added at any of the potential helicopter sites in either the bypass or peaking reach as discussed in the gravel augmentation

plan (see Mason Bruce and Girard et al. 2011) since gravel has not been previously added at these sites.

No additional gravel should be placed at the RM 217.3 or RM 216.3 (peaking reach) sites until higher flows (e.g., very large spill) occur that move the placed gravel. Considering that estimated flows of 5,265 cfs in March 2016, 8,300 cfs in March 2017, and 5,730 in April 2018 moved only a portion of the gravel at these two sites, it may not be advisable to place additional gravel at these locations in the future.

Table 3.5-1. Potential for Future Gravel Placement.

Site (River Mile)	Placement Method	Most Recent Gravel Placement	Possible 2019 Placement?
224.5	CAD Truck	2017	Yes
224.2	Helicopter	-	Yes
224.1	Helicopter	-	Yes
223.8	Helicopter*	2012	Yes
223.1	Helicopter	-	Yes
222.5	Helicopter	-	Yes
222.1	Helicopter	-	Yes
220.45	CAD Truck	2017**	Yes
220.2	CAD Truck	2018	Yes
219.9	CAD Truck	2015	Yes
219.1	Helicopter	-	Yes
217.7	CAD Truck	2016	Yes
217.3	CAD Truck	2011	No
216.8	CAD Truck	2018	Yes
216.3	CAD Truck	2011	No

* The RM 223.8 site was placed by truck and culvert/chute in 2012, but placement using this method was very difficult; any future placement at this site should utilize helicopter placement.

** A very small amount of gravel (20 cubic yards) was placed at the RM 220.45 site in 2017.

4 REFERENCES

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