Klamath Hydroelectric Project
FERC Project No. 2082

Klamath Hydroelectric Settlement Agreement
Interim Measure 7
J.C. Boyle Gravel Monitoring Report
2015-2016

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KLAMATH HYDROELECTERIC PROJECT SETTLEMENT AGREEMENT
INTERIM MEASURE 7
J.C. BOYLE 2015-2016 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); and one dam on Fall Creek, a tributary to the Klamath River in Iron Gate reservoir. The Link River dam is owned by the U.S. Bureau of Reclamation.

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 and habitat enhancement projects, including related monitoring, in the Klamath River above Copco Reservoir and below 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. The full text of Interim Measure 7 is included below.

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 of 2011, 2012, 2013, 2014, 2015, and 2016. This document describes the fourth year of monitoring (gravel placed in October 2015) under Interim Measure 7. The October 2016 gravel placement monitoring results will be reported in late 2017.

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 (October through June). 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?

Methods used for both implementation and effectiveness monitoring are described below.

2 METHODS

2.1.1 Implementation Monitoring

Implementation of the 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.

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. Based on previous years' monitoring, it was determined that visual/photo observations were sufficient to determine if placed gravel had moved at the 2015 placement sites since gravel had been placed at both these sites in previous years and previous monitoring determined that the majority of gravel had moved downstream. Gravel was placed at two new sites in October 2016; scour monitors and visual observations will be used to monitor these sites with results to be reported 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 only the 250 cubic yards that were placed at each of the sites at RM 219.9 and 216.8 in October 2015.

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

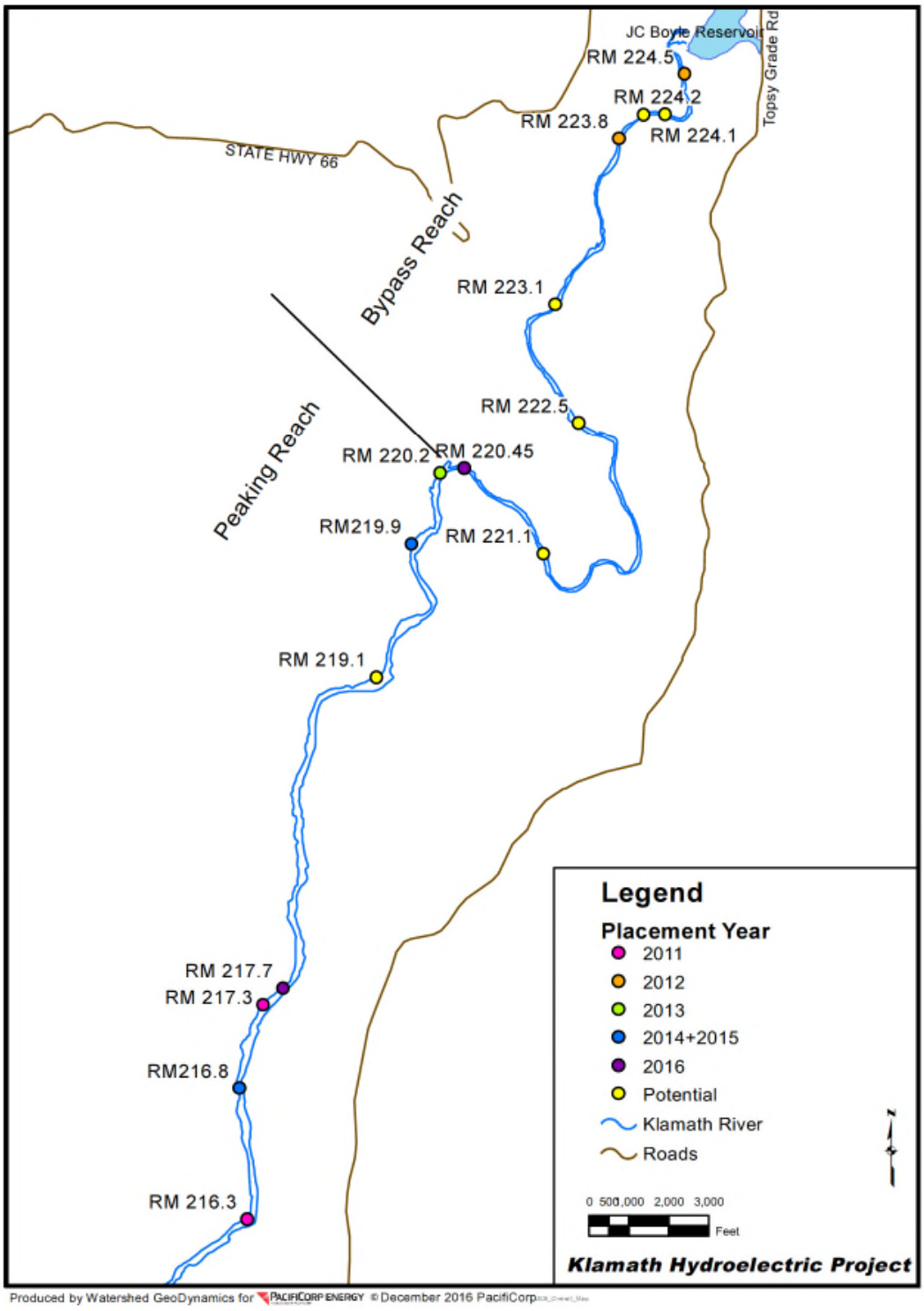
Site (River Mile)	Placement Date/Volume (cubic yards)					
	November 2011	October 2012	October 2013	October 2014	October 2015	October 2016*
224.5	-	225	-	-	-	-
223.8	-	105	-	-	-	-
220.45	-	-	-	-	-	300
220.2	-	-	250	-	-	-
219.9	-	250	250	250	250	-
217.7	-	-	-	-	-	100
217.3	250	-	-	-	-	-
216.8	-	-	-	250	250	100
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 220.45 and 216.8 since these had gravel access roads and were not affected by rainy conditions.

3.1 POST-PLACEMENT FLOWS

3.1.1 Peaking Reach Flows (RM 220.2 to RM 216.3)

Both 2015 gravel placement sites are located in the peaking reach downstream of the J.C. Boyle powerhouse. Flows at 15-minute intervals from the USGS gage downstream of the J.C. Boyle powerhouse (USGS 1151070) were collected from the USGS website. These flows are provisional and have not been finalized by the USGS but are unlikely to change substantially. Post gravel placement flows (October 2015-October 2016) ranged from 301 to 10,600 cfs (Figure 3.1-2).



Note: Gravel was placed at RM 219.9 in 2012, 2013, 2014, and 2015 and at RM 216.8 in 2014 and 2015

Figure 3.1-1. Gravel placement locations.

3.1.2 Bypass Reach Flows (RM 224.5 to RM 220.45)

Flows in the bypass reach were the normal minimum flows throughout most of the year with the exception of spill in March 2016 resulting from a rain-on-snow event in the Upper Klamath Lake watershed which combined with already high elevation in Upper Klamath Lake from a substantial amount of rainfall earlier in March (Figure 3.1-3). Spill was estimated to peak at 11,300 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 2015-2016 monitoring period was sufficient to move at least some of the gravel placed during previous years (2011-2015).

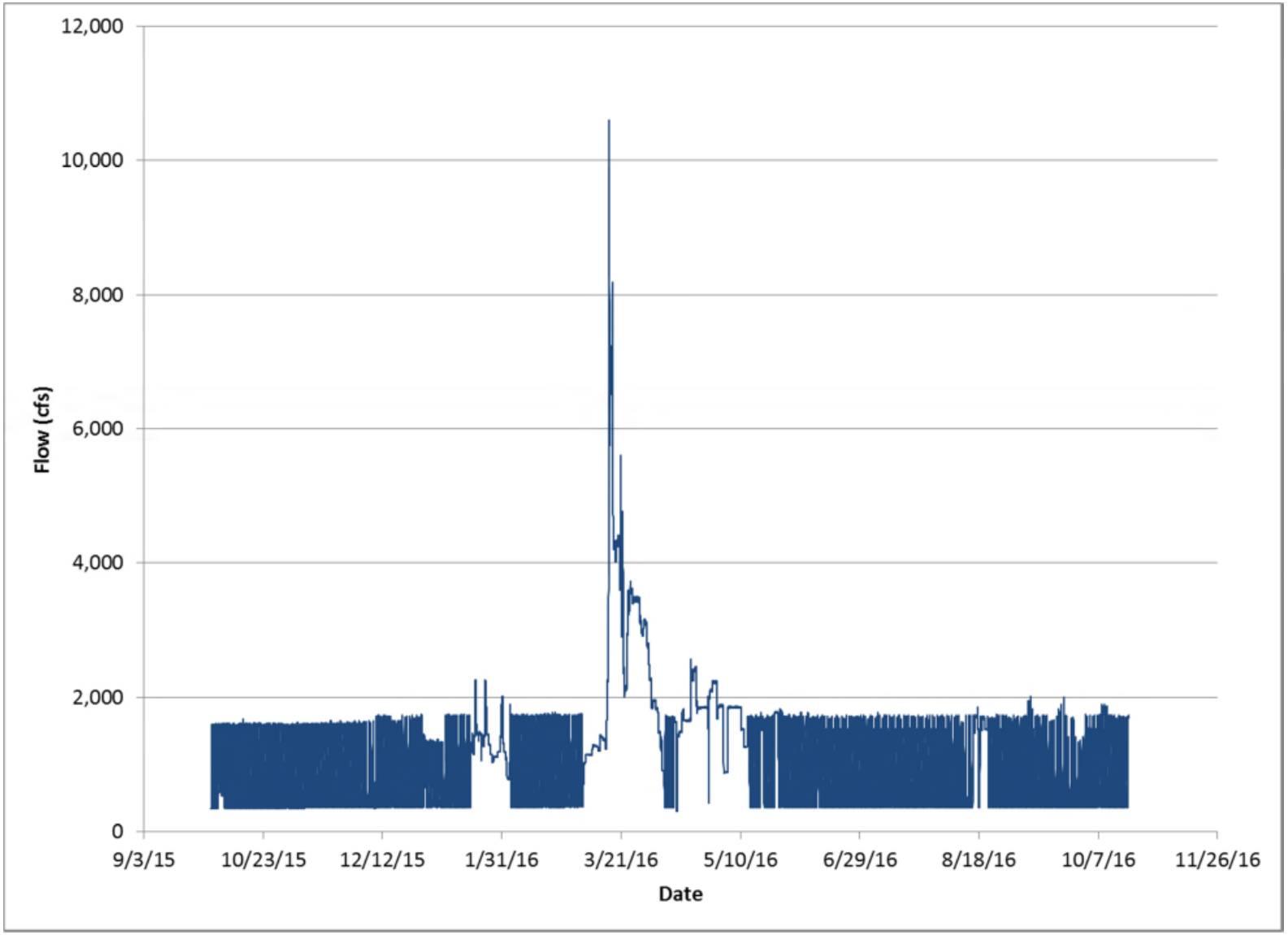


Figure 3.1-2. Post-gravel placement flows at USGS gage 1151070 downstream of J.C. Boyle powerhouse, October 2015-2016

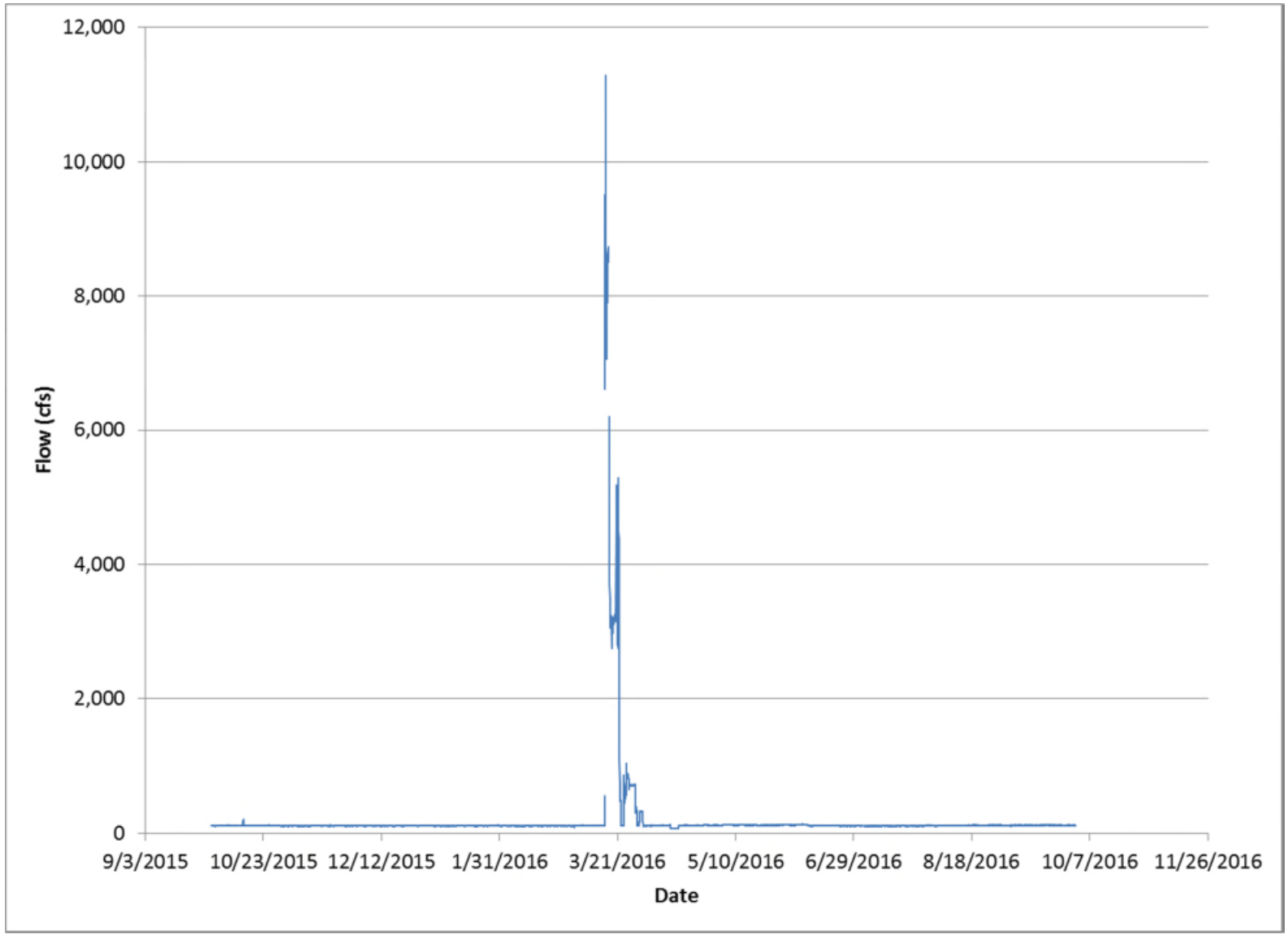


Figure 3.1-3. Post-gravel placement flows at PacifiCorp gage downstream of J.C. Boyle dam in the bypass reach, October 2015-2016

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 2015, approximately 250 cubic yards of gravel was placed using conveyored aggregate delivery (CAD) trucks at the RM 219.9 site and another 250 cubic yards at the RM 216.8 site. No safety issues or problems were encountered during placement. More traffic was encountered than anticipated on the road between the stockpile location near the J.C. Boyle powerhouse and the RM 216.8 site, but no problems were occurred because of this.

Table 3.2-1. Implementation monitoring questions, October 2015 placement.

Monitoring Question	2015 Results
How may cubic yards of gravel were placed at each site?	RM 219.9 – 250 cubic yards RM 216.8 – 250 cubic yards
Were the placement methods (truck/helicopter) able to place gravel where planned?	Both sites were placed using high speed CAD trucks (one 14- and one 16-cubic yard truck). No issues were encountered. Both sites are well suited for truck placement methods.
Were any safety issues encountered?	No safety issues were encountered. There was more traffic on the narrow road than anticipated (both public and BLM use) but using heightened awareness and proper vehicle speed, topics covered in the daily safety briefing, there were no issues.
Were any problems encountered during placement?	No problems were encountered.
Are there any recommendations to improve placement methods in the future?	None

3.3 EFFECTIVENESS MONITORING

Past bedload transport calculations at RM 219.9 suggested that flows of 1,800 cfs could initiate transport of 0.5 inch (12.7 mm) rocks, and flows above 2,200 to 3,900 cfs could move 1 to 3 inch (25.4 to 76.2 mm) rocks, respectively, at this site (PacifiCorp 2004, 2005). Gravel added in 2015 was within the 1 to 3 inch size range. Flows in the peaking reach where the RM 219.9 and RM 216.8 sites are located (downstream from the powerhouse) ranged from 301-10,600 cfs during the monitoring period (October 2015-October 2016). The gravel placed at the RM 219.9 site in previous years under lower peak flows was transported downstream, so it was expected that the gravel added in 2015 would also be transported away from the sites.

3.3.1 Turnoff Downstream of Spring Island Boat Launch, RM 219.9

The RM 219.9 site is located along the road just downstream of the Spring Island Boat Launch (Figure 3.1-1). Gravel was shot from a truck on the road into the river.

Location: Peaking reach, RM 219.9, right bank looking downstream

Type of placement: CAD Truck

Habitat Description: Boulder run, outside of river bend. Average wetted width 85 feet; average local gradient 0.013.

Placement volume: 250 cubic yards.

Scour monitors were not placed at this site since previous monitors (2012) disappeared when the gravel moved. Visual observations at the RM 219.9 site showed the majority of 2015 placed gravel had been transported away from the site during the monitoring period (Figure 3.3-1 and 3.3-2). This is consistent with measurements and observations in previous years that indicated the majority of gravel was transported away from this site on a regular basis.

Figure 3.3-1. Photo of placed gravel at RM 219.9, October 2015 (just after placement).

Figure 3.3-2. Photo of placed gravel at RM 219.9, October 2016 (post-flows).
Note: 2016 photo taken from a higher elevation than 2015 photo

3.3.2 Old Bridge Site RM 216.8

The RM 216.8 site is located at the old bridge site (Figures 3.1-1, 3.3-3, and 3.3-4). Gravel was placed at this site from a CAD truck in 2014 and 2015.

Location: Peaking reach, RM 216.8 right bank looking downstream

Type of placement: CAD Truck

Habitat Description: Cobble/boulder riffle. Average wetted width 85 feet; average local gradient 0.004.

Placement volume: 250 cubic yards.

The gravel that was placed at the RM 216.8 site was not visible because visibility was reduced by the deep water and swift current; it is assumed that all gravel was moved from the site by high flow conditions.

Figure 3.3-3. Photo of placed gravel at RM 216.8, October 2015 (after placement).

Figure 3.3-4. Photo of placed gravel at RM 216.8, October 2016 (post-flows).

3.4 SUMMARY OF 2015 GRAVEL PLACEMENT

Truck-based gravel placement at the RM 219.9 and RM 216.8 (peaking reach) sites occurred in October 2015. No safety or other issues were encountered during the 2015 gravel placement. Approximately 250 cubic yards of gravel was placed at each site. Visual observations of the sites showed that flows in the peaking reach from October 2015 to October 2016 removed the majority of gravel from the sites.

3.5 REVIEW OF PREVIOUS GRAVEL PLACEMENT SITES

Because flows in the bypass reach peaked over 10,000 cfs in March 2016 (Figures 3.1-2 and 3.1-3), all previous gravel placement sites were visited to determine if gravel had moved. Gravel movement had not been observed at most of these sites during previous visits when there were very limited spill events (see 2012-2015 monitoring reports).

3.5.1 RM 224.5

Gravel was placed at the RM 224.5 site in 2012. During previous checks at this site (2013, 2014, and 2015), the gravel did not appear to have moved, scour monitors did not record any scour, and grass had grown over the gravel deposits (Figure 3.5-1). As observed in October 2016, most of the gravel had been transported away from the site, and no scour monitors were found.

a) 2012

b) 2015

c) 2016

Figure 3.5-1. RM 224.5 Site showing much of placed gravel in 2012 (a) had not moved by October 2015 (b) but had moved by October 2016 (c).

3.5.2 RM 223.8

Gravel was placed at the RM 223.8 site in 2012. Little movement was noted during previous years (2013, 2104, and 2015). As observed in October 2016, none of the placed gravel was found, and high water marks were approximately 10 feet above normal water surface elevations (Figure 3.5-2).

a) 2012

b) 2015

c) 2016

Figure 3.5-2. RM 223.8 Site showing gravel placed in 2012 (a) has not moved from the site by October 2015 (b) but had moved by October 2016 (c).

3.5.3 RM 220.2

Gravel was added to the RM 220.2 site in 2013. The majority of the gravel at this site was transported downstream by October 2014 but some remained on the shoreline. All remaining shoreline gravel had been transported by October 2016 (Figure 3.5-3).

a) 2013

b) 2014

c) 2016

Figure 3.5-3. RM 220.2 Site showing gravel placed in 2013 (a) had moved from site by October 2014 (b) and 2016 (c).

3.5.4 RM 217.3

Gravel was placed at RM 217.3 in 2011. Previous checking of this site in 2012, 2013, 2014, and 2015 showed little gravel movement. In 2016, some of the gravel had been transported downstream, but much of the gravel close to the river bank remained (Figure 3.5-4).

a) 2011
(Note 2011 this photo taken looking upstream)

b) 2011 (looking downstream)

c) 2016 (looking downstream)

Figure 3.5-4. RM 217.3 Site showing some gravel placed in 2011 (a and b) has moved from site by October 2016 (c).

3.5.5 RM 216.3

Gravel was placed at RM 216.3 in 2011 and has been checked annually since then. Little movement of gravel at this site has been noted previously. In October 2016, following the high flow event, some of the gravel was moved from areas in the middle of the channel, but there was still a substantial amount along the shore (Figure 3.5-5).

a) 2011

b) 2016

Figure 3.5-5. RM 216.3 Site showing some gravel placed in 2011 (a) has moved from site by October 2016 (b).

3.6 FUTURE GRAVEL PLACEMENT SITES

Based on the placement and monitoring of gravel at the sites, it appears that gravel can be added to the peaking reach RM 220.2, RM 219.9, and RM 216.8 sites in the future; normal operating flows are capable of transporting added gravel from these sites. Gravel can also be added to the RM 223.8 and 224.5 sites (bypass reach) because previously added gravel has been transported away from these sites by the high flows in March 2016. However, gravel placement at RM 224.5 in 2012 was difficult because of the distance from the road. It was too far for CAD trucks to shoot gravel so a culvert was used for placement which, while successful, was difficult to implement.

No additional gravel should be placed at the RM 217.3 or 216.3 (peaking reach) sites until higher flows (e.g., very large spill) occur that have the opportunity to move the placed gravel. Considering that flows over 10,000 cfs in March 2016 moved only a portion of the gravel at these sites, it may not be advisable to place additional gravel here in the future.

4 REFERENCES

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