Water year (WY) 2023 Coarse Sediment Augmentation Proposed for
Cableway at Lewiston and Fenceline at Lowden Ranch

March 15, 2023

Todd Buxton
Trinity River Restoration Program, Weaverville, CA

Overview

The Trinity River Restoration Program (TRRP) adds gravel to the Trinity River to mitigate for Trinity and Lewiston dams blocking sediment from upper watershed areas and to provide substrate for instream and floodplain habitat construction. Grain sizes added to the channel range from 13 to 127 mm diameter, and fine sediments are lacking in the mixture except in trace amounts. High flow injections of coarse sediment are permitted at six locations on the river (Figure 1). This proposal is for 1,000 cubic yards (cy) of gravel to be added to the Trinity River at Cableway and 1,800 cy to be added at Fenceline on Lowden Ranch during the latter portion of the elevated winter baseflow period in WY 2023.

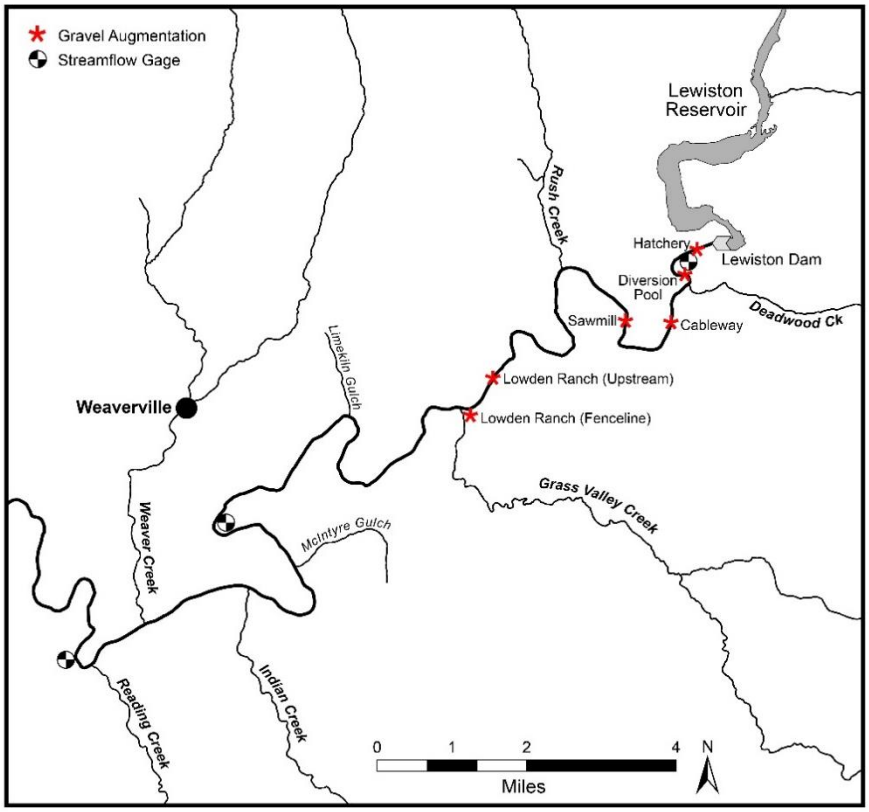

FIGURE 1. Permitted gravel augmentation locations (red stars).

Site selection

The proposed augmentation sites were identified by systematically eliminating sites from the list of candidates for gravel placement in WY 2023. This was done by reviewing the recent history

of high flow augmentations, considering water year types that have occurred since recent augmentations were made, inspecting annual aerial photographs of the sites, and making field visits to view local conditions.

The Sawmill site was easiest to remove from consideration because it is currently not available for augmentations due to administrative issues. The hatchery and diversion pool sites were the next to be removed from consideration for adding gravel in WY 2023. The hatchery site was eliminated from consideration because only critical dry WYs have occurred since 5,660 cy of gravel were added to this site in July 2021. The short timeframe since placement and lack of discharges that significantly mobilize coarse sediment have caused most of the placed material to remain on site, so that no additional material is needed at this time. Similarly, the Trinity River near Diversion Pool maintains a large volume of gravel stored on the flanks and floodplain on the right bank just downstream of the injection location and a visually large amount of gravel appears to be stored just downstream of both Deadwood Pool in the vicinity of the vegetated island there and at the upper Lowden site. This leaves Cableway at Lewiston (river mile (RM) 110.4) and Fenceline at Lowden Ranch (RM 104.4) as candidates for sediment placement.

History and purpose for augmentation at proposed sites

In the Trinity River at Cableway, the first recorded gravel augmentation occurred in August 2003. This action involved placing the use of a loader to place 2,000 cy of gravel to a depth of around 2 ft deep for 300 ft downstream. The most recent augmentation in the vicinity of Cableway occurred in 2008 and totaled 6,700 cy. The sediments included 2,100 cy of structural material (140 to 305 mm diameter) that were placed on the channel bed in the shape of alternating lateral bars (Figure 2). This material was a foundation for capping with 4,600 cy of gravel 13 to 140 mm in diameter. Following construction, the channel banks between Cableway and the Old Lewiston Bridge were unable to erode and accommodate the deposits. As a result, the bars have themselves been eroded to their foundations and the channel bed hardened in many areas by the oversized material and lack of gravel (13 to 102 mm diameter) that salmon and steelhead target for redd construction. The proposed augmentation at Cableway is intended to replenish the top material on the bars and restock spawning substrate that appears to be in deficit in the Lewiston reach.

The last augmentation at Fenceline involved the placement of 1,400 cy in 2019. This gravel was placed during the rising limb of the spring hydrograph for this wet water year. Following the augmentation, three consecutive critically dry water years were experienced, and the peak daily average flow released from Lewiston Dam only reached 3,970, 4,070, and 6,030 cfs in 2020, 2021, and 2022, respectively. These flows were insufficient to substantially mobilize the bars near Fenceline, and this has enabled a fringe of woody riparian plants to colonize the channel margins on these structures. The proposed augmentation at Fenceline is therefore intended to maintain the availability of sediment for transport and help remove vegetation that could fossilize the bars. The vegetation removal would result from the augmented pile of gravel forcing river flows toward the bar labeled “1” in Figure 3 and scouring vegetation from the bar’s flanks. The gravel augmentation could also help remove vegetation that has colonized the flanks of bars that are further downstream by mechanical crushing.

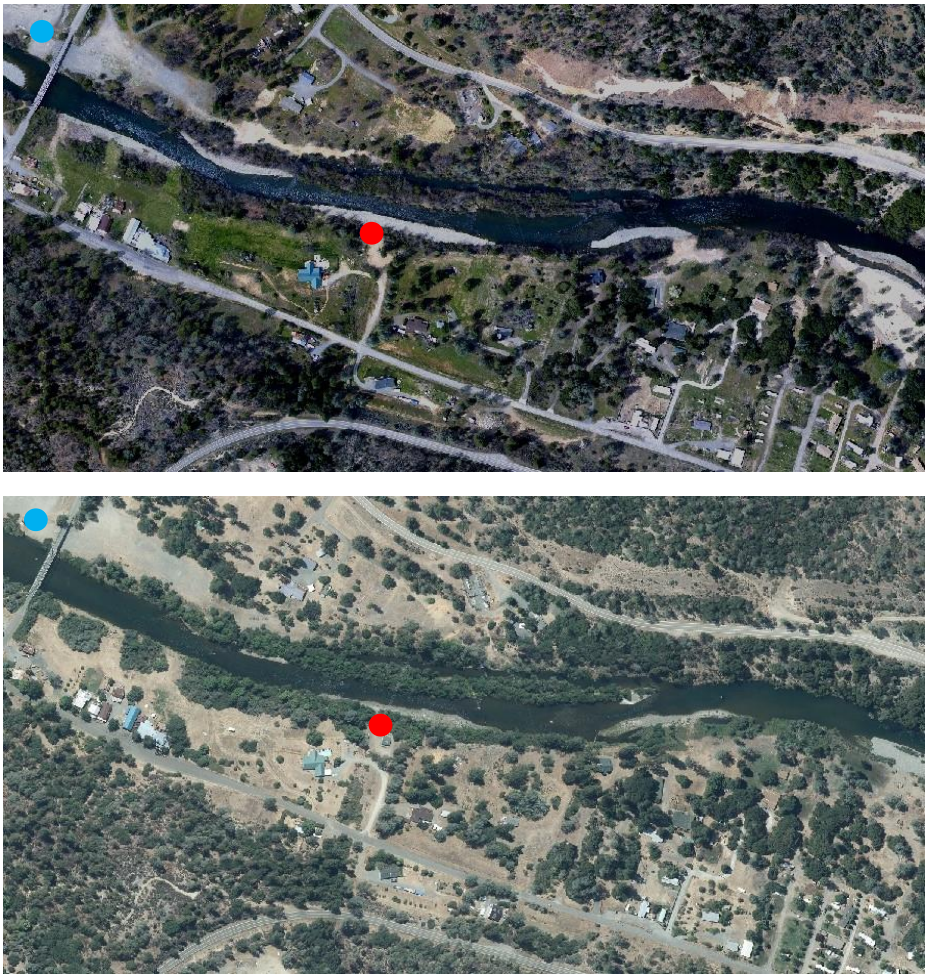

FIGURE 2. Bars constructed on the Trinity River at Lewiston in the vicinity of Cableway (red dot) and old Lewiston Bridge in 2008 (blue dot). The top panel shows the bars with the river flow at 291 cfs in 2009 and the bottom panel shows the same view at 453 cfs in 2021.

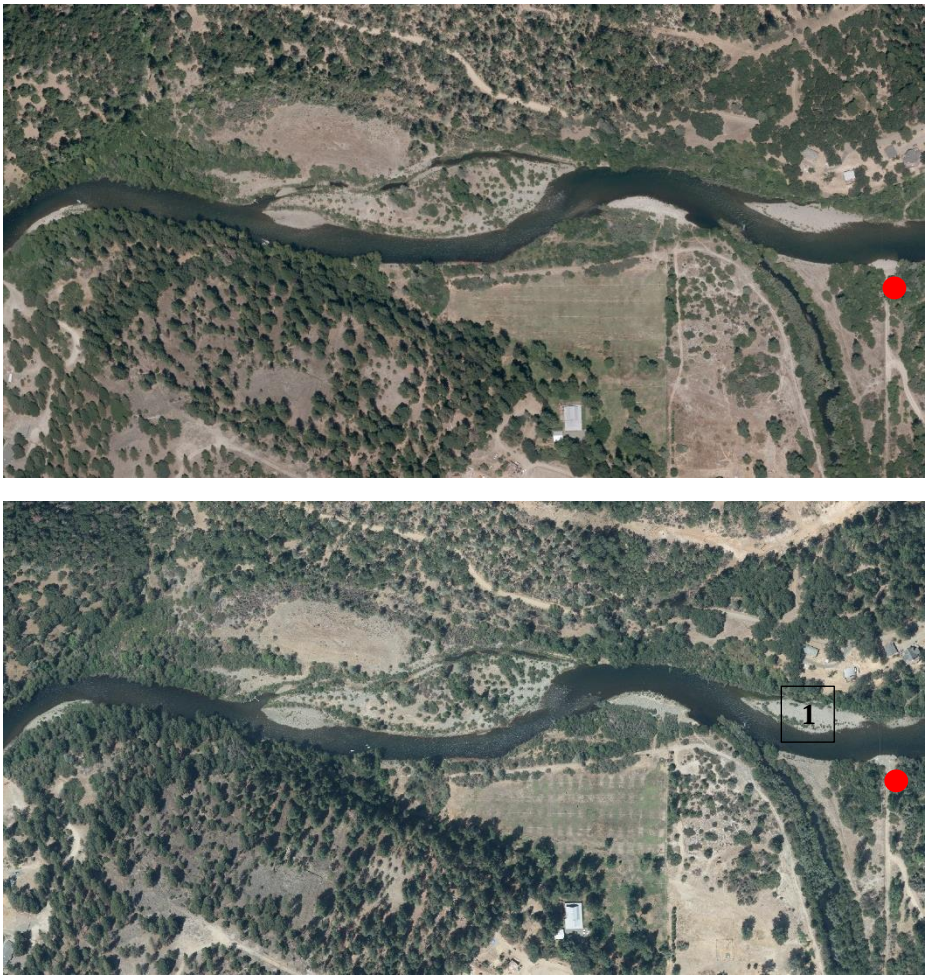

FIGURE 3. Fenceline (red dot) site located at lower Lowden Ranch near the confluence of Grass Valley Creek and the Trinity River. The top panel shows the bars with the river flow at 683 cfs in 2019 and the bottom panel shows the same view at 453 cfs in 2021.

Augmentation volume

The volume of gravel for addition to the channel was computed for hydrographs that were considered for release from Lewiston Dam in a wet or normal WY by the TRRP flow workgroup in its March 9, 2023 meeting (Figure 4). The computations involved estimating the discharge that would occur at Cableway and Fenceline if the flow schedules were implemented in the most recent wet (2019) and normal (2012) WYs. The discharges were estimated for both water years and augmentation sites with RBM10 (Jones et al., 2016) using the flow schedules as the upstream boundary condition at Lewiston Dam. The resulting flows were used with coarse bedload (>8 mm) to discharge relationships measured at Douglas City in 2012 and 2019 to estimate the total flux for each respective flow release in these years.

The measured relationship at Douglas City is used for the computations because the sediment flux at this station is assumed to be largely unaffected by the dams. This results because the Douglas City is located downstream of several major tributaries that contribute flow and sediment to the river. The lower river flows that occur closer to Lewiston Dam at a given dam release are then used to scale the loads from what has been observed at Douglas City to what can be expected if the availability of gravel for transport is not limited at the augmentation sites.

The coarse bedload transport calculations were made with an equation of the form

$$Q_b = \alpha(Q - Q_c)^{\beta}$$

where Q_b is the bedload flux (tons/day), Q is daily average flow (cfs), Q_c is the critical flow, and α and β are the respective base and exponent in the power relationship between Q and Q_b measured for competent flows by Graham Mathews and Associates on the Trinity River at Douglas City. In 2012, hysteresis in coarse sediment transport was not observed and the critical discharge was estimated as 2,684 cfs by the reference transport method (see Buxton, 2021), and α and β values were $6.86*10^{-7}$ and 2.361. In 2019, hysteresis in coarse sediment transport was observed and a critical discharge of 2,890 cfs was estimated for the rising limb and 2,020 cfs for the falling limb of the hydrographs (Buxton, 2021). In this same year, the α and β values for the rising and falling limbs were respectively $4.62*10^{-4}$ and $5.26*10^{-3}$ and 1.629 and 1.266. The resulting volumes for each proposed hydrograph at Cableway and Fenceline and the recommended augmentation volumes at both locations are given in Table 1.

TABLE 1. Computed and recommended gravel augmentation volumes (cy) for Cableway and Fenceline.

Normal water year			Wet water year		
Hydrograph	Cableway	Fenceline	Hydrograph	Cableway	Fenceline
	Calculated; Recommended	Calculated; Recommended		Calculated; Recommended	Calculated; Recommended
TBuxton	1195; 1000	1293; 1000	SNaman	1480; 1000	1588; 1300
KDeJuilio	1362; 1000	1439; 1200	JBair	3419; 1000	3543; 1800

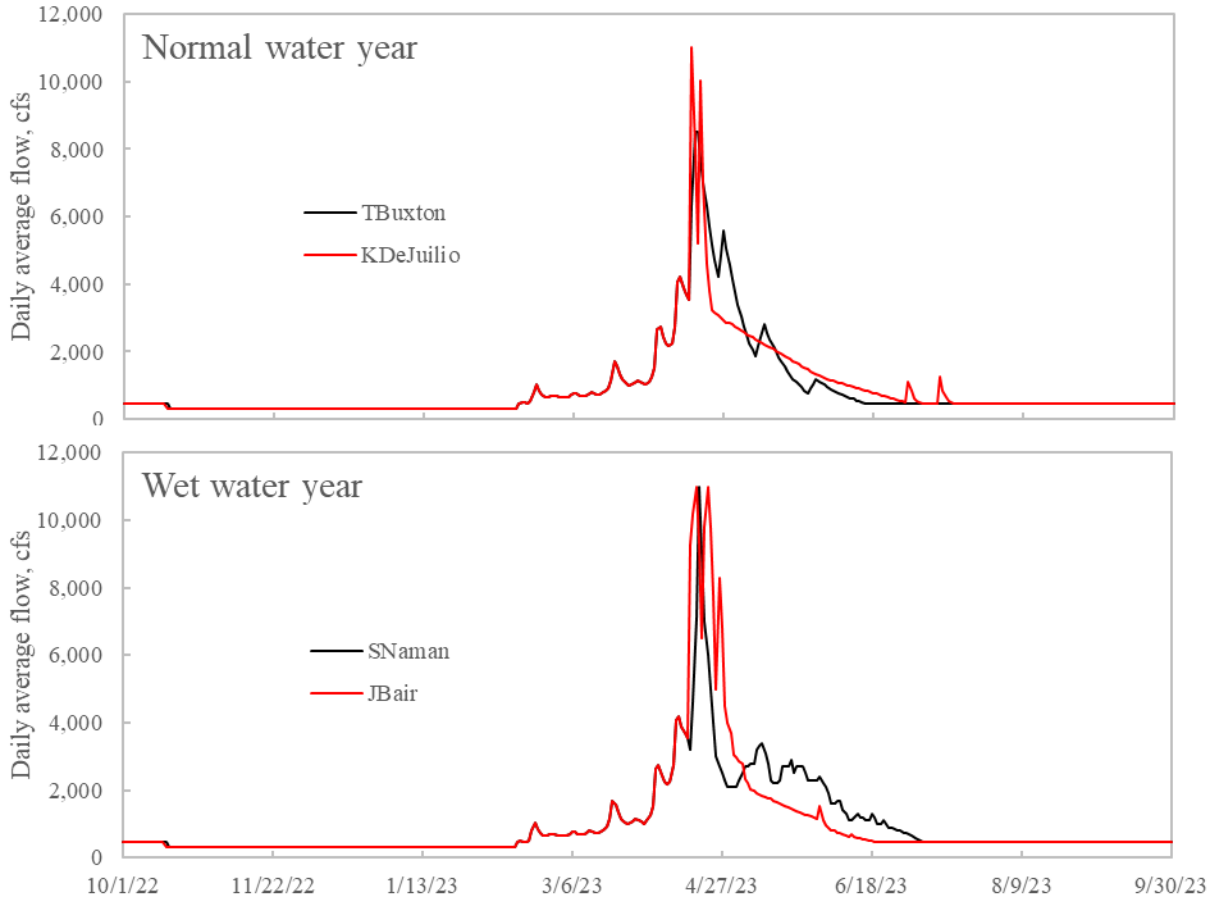

FIGURE 4. Hydrographs proposed for release from Lewiston Dam for a normal and wet water year.

Material sources and logistics

Three potential sources of gravel for placement in the Trinity River are available, including Chapman B, Sawmill, and Weir Hole (Table 2). It is preferable to prioritize use of material stockpiled at Sawmill because it is closest to the augmentation sites, but it is not yet clear whether the Sawmill material will be accessible due to reasons mentioned above. Therefore, a logistics plan is only provided for augmenting gravel stored at Chapman B, upper Lowden Ranch, and Weir Hole. In the presentation, volumes recommended for the wet WY hydrograph proposed by JBair are considered. The logistics would be adjusted to utilize gravels at Sawmill if they become available and to accommodate volumes associated with other proposed hydrographs (Table 1, Figure 4) if they are implemented instead.

TABLE 2. Locations and volumes of gravel available for augmentation.

Location	River Mile	Volume (cy) available	Volume (cy) after augmentation
Chapman B	83.1	2,000	0
Upper Lowden Ranch	104.9	300	0
Sawmill	109.0	2,800	2800
Weir Hole	111.2	1,000	500

1. Load and haul 1000 cy of gravel from Chapman B to Cableway for direct placement and 1000 cy to Fenceline for stockpiling at (1) (Figure 5). Equipment includes a loader at Chapman B, a loader at Cableway, and haul trucks for transporting material from Chapman B to the augmentation sites.

2. After cleanup at Cableway, relocate the loader to Lowden Ranch and the loader and haul trucks from Chapman B to Weir Hole (Figure 1). Load and haul 500 cy from Weir Hole for direct placement at Fenceline on Lowden Ranch.

3. Relocate the loader and haul trucks from Weir Hole to Lowden Ranch and transport the 300 cy of existing gravel with oversized material at (2) (Figure 5) for direct placement at Fenceline.

4. Once placement of material in 3) is completed, release one loader and the haul trucks and use the remaining loader at Lowden Ranch to place gravel stockpiled at (1).

5. Project cleanup and closeout at Fenceline.

NOTE: Direct placement is required at Cableway because space is not available for stockpiling, but material can be stockpiled at two locations at Lowden Ranch (Figure 5). The approximate capacity of location (1) is 1100 cy and 6,200 cy at (2). Location (1) is available for short-term (within year) storage, whereas location (2) can be used for long (multi-year) or short-term storage. Around 300 cy of gravel is currently stored at (2). This gravel includes approximately 5% (by volume) of oversized (>127 mm) material.

FIGURE 5. Locations for short (1) and long-term storage of gravel at Lowden Ranch.

Placement methods and timing

Gravel will be placed at Cableway by dumping gravel loads at the yellow polygon and then hauling the material with a loader to within the green polygon in Figure 6 (Table 3). The polygon traces the edge of an existing bar composed largely of oversized material and extends 250 ft downstream from the access to the channel and ~30 ft from the river's left bank. Under no circumstances should material be placed upstream of the polygon so as to avoid impacting the water infiltration gallery for the Lewiston Community Services District that is beneath this upstream bar surface. Once placed, the material pile will average 3.5 ft in depth; the pile will be highest toward the middle of the channel and taper towards the local bank height.

FIGURE 6. Gravel dump (yellow polygon) and placement area (green polygon) at Cableway. The shaded area in the channel is 1,050 cfs modeled on the 2016 topography by Bradley (2018). Approximate property boundaries are shown and parcel ownership type are labeled.

TABLE 3. Gravel haul and placement volumes and dates at Cableway and Fenceline.

Date	Haul volume to… (cy)		Placement volume at… (cy)		Daily avg flow (cfs)[a]
	Cableway	Fenceline	Cableway	Fenceline	
Monday, March 27, 2023	400[b]	0	400[b]	0	1,083[a1]
Tuesday, March 28, 2023	500[b]	0	500[b]	0	1,133[a1]
Wednesday, March 29, 2023	100[b]	500[b]	100[b]	0	1,121[a1]
Thursday, March 30, 2023	0	500[b]	0	0	n/a
Monday, April 10, 2023	0	500[c]	0	500[c]	3,027[a2]
Tuesday, April 11, 2023	0	300[d]	0	800[b,d]	4,291[a2]
Wednesday, April 12, 2023	0		0	500[b]	4,385[a2]

[a]Projected for location where augmentation being made at Cableway (a1) or Fenceline (a2) using JBair hydrograph as the upstream boundary condition at Lewiston Dam and RBM10 output for the wet WY 2019.
[b]From Chapman B. [c]From Weir Hole. [d]From Upper Lowden Ranch.

Gravel will be added to the river channel at Fenceline by dumping material near the Fenceline location and then pushing it into the channel with a loader or dozer directly after hauling or by relocating material from the stockpile location at (1) into the channel. The material will be placed in the channel at an approximately 30-degree angle to flow to force the flow toward the right bank without extending far enough into the channel to impact boat passage (Figure 7). River flows during the additions at this site will be sufficient to mobilize a portion of the gravel downstream as it is placed, and so further reduce its accumulation in the channel.

FIGURE 7. Gravel augmentation location at Fenceline on Lowden Ranch (yellow polygon). The shaded area in the channel is 4,000 cfs modeled on the 2016 topography by Bradley (2018). Approximate property boundaries are shown and parcel ownership type are labeled.

Monitoring

Game cameras will be placed to capture still images of the augmentation operation and evolution of the placed gravel piles beginning with the initial placement and lasting until the river flow return to around 1,000 cfs after the spring flow peak. The cameras will be set to take images every hour in this period to track progress in introducing and then eroding sediments placed at each of the sites.

Turbidity will be monitored both upstream and within 500 ft downstream of the augmentation locations where turbid water generated by the gravel additions is fully mixed with the ambient flow. The turbidity readings will at first be taken and recorded along with their time and location every 15 minutes until the technician learns to visually associate the cloudiness of the flow with a given level of turbidity, which typically requires a few hours of measurements. After this, when the turbidity appears to be increasing towards the threshold value of 20% above the level

measured upstream of the augmentation location, turbidity measurements will be restarted. If the recorded value exceeds this threshold, the gravel additions must cease until the turbidity lowers below the threshold. Once this occurs, gravel additions may resume and continue as long as turbidity in the well-mixed area downstream of the augmentation location remains less than 20% above the value that occurs upstream of where gravel is being added.

References

Bradley, D.N. (2018), Trinity River 40 Mile Hydraulic Model: Update with 2016 Topography, Technical Report No. SRH-2018-11, Prepared for Trinity River Restoration Program, March 2018.

Buxton, T.H. (2021), History of fine sediment and its impacts on physical processes and biological populations in the restoration reach of the Trinity River, CA. Report for the Trinity River Restoration Program, Weaverville, California. www.trrp.net/library/document?id=2483.

Jones, E.C., R.W. Perry, J.C. Risley, N.A. Som, N.J. Hetrick (2016), Construction, calibration, and validation of the RBM10 water temperature model for the Trinity River, northern California. U.S. Geological Survey Open-File Report 2016–1056.