

**RESPONSE TO FEBRUARY 16, 2018 REQUEST FOR ADDITIONAL
INFORMATION, RESOURCE AGENCY LATE FILING, AND
OTHER RELATED INFORMATION**

ATTACHMENT L

**LOWER TUOLUMNE RIVER GRAVEL AUGMENTATION
RECONNAISSANCE-LEVEL COST ESTIMATE**

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LOWER TUOLUMNE RIVER GRAVEL AUGMENTATION
RECONNAISSANCE-LEVEL COST ESTIMATE

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The following memorandum summarizes anticipated reconnaissance-level costs for implementing coarse sediment and gravel placement, as recommended by state and federal resource agencies in their review comments of the Notices of Ready for Environmental Analysis (REA) submitted in January 2018. For simplicity, the term “gravel augmentation” is used throughout this document, and assumes a grain size that ranges from 5/16” diameter to 5” diameter per the 2004 Lower Tuolumne River Coarse Sediment Management Plan (CSMP). The resource agency REA comments are virtually identical in their recommendations, with approximately 564,000 yd³ of gravel augmentation in the first 15 years that focus on upstream sites (LaGrange Dam to Roberts Ferry Bridge), followed by another 1,400,000 yd³ of gravel augmentation over 10 years to fill in historic instream gravel mining pits (Special Run Pools, or SRPs) generally downstream of Waterford.

The following estimate includes: implementation, contingency, permitting, detailed design, owner’s contract administration costs, and monitoring and reporting costs. Total costs are summarized at the end of this memorandum in 2018 dollars, along with a separate calculation applying an annual inflation rate of 3.22%, which was the long-term (1913-2018) average annual inflation rate in the United States (<http://www.usinflationcalculator.com/>).

1 GRAVEL AUGMENTATION: 546,000 CUBIC YARDS OVER YEARS 1-15

Gravel augmentation costs from five recently implemented restoration sites on the Lower Tuolumne River were used as references to estimate future costs of placing 564,000 yd³ of gravel in the next 15 years, at priority sites identified in the Lower Tuolumne River Coarse Sediment Management Plan (CSMP, McBain and Trush, 2004). The five restoration sites were Bobcat Flat Phase 1 Gravel Augmentation Project (2005), Bobcat Flat Phase 2 Gravel Augmentation Project (2011), Duck Slough Restoration Project (2016), M.J. Ruddy Floodway Restoration Project (2004), and SRP 9 Restoration Project (2001). Each reference site included placement of gravel to restore bar and riffle features, and in some cases to isolate historic gravel mining pits from the mainstem channel. Costs for Bobcat Flat reflect actual incurred costs documented by the Tuolumne River Conservancy. Costs for the MJ Ruddy project were from an engineer’s estimate based on the final design. Costs for the SRP 9 project were based on the winning contractor bid. If more precise cost estimates are needed, actual costs from TID engineering staff can be requested for the M.J Ruddy and SRP 9 projects, as TID was the implementing agency for both. As a result of analyzing costs associated with these five sites, reconnaissance-level cost estimates for 564,000 yd³ of gravel placement at future sites on the Lower Tuolumne River were based on an average 2018 unit cost of \$33.94 (Table 1).

Estimates of historic unit costs to place a cubic yard of gravel augmentation varied somewhat from site-to-site due to the differences between the sites, variability in project features, and whether gravel was imported from off-site or processed from on-site sources. Gravel for the Bobcat Flat Phase 1, Bobcat Flat Phase 2, and Duck Slough projects was acquired on-site from the floodplain adjacent to the river, separated by size class, washed, mixed for a desired grain size distribution, and placed in the river. Gravel for MJ Ruddy and SRP 9 was delivered from nearby gravel quarries.

The cost of gravel was included as a line item in the MJ Ruddy project cost estimate. Because the California Department of Fish and Wildlife (CDFW) provided the gravel to the SRP 9 project, it was not listed in the SRP 9 winning bid. Therefore, the cost of the CDFW gravel was added to the winning bid cost for SRP9 project implementation to obtain a total unit implementation cost.

Table 1. Cost summary of recent gravel placement projects on the Lower Tuolumne River.

Site	Bobcat Flat Phase 1	Bobcat Flat Phase 2	Duck Slough	MJ Ruddy	SRP 9	Average
Total Earthwork Volume (yd ³)	14,300	17,500	9,000	211,000	165,080	
Historic Unit Cost (\$/yd ³)	\$24.28	\$28.59	\$36.25	\$19.26	\$31.08	
Year	2005	2011	2016	2004	2001	
Assumed Total Inflation (%)	28%	11%	4%	32%	41%	
2018 dollars Unit Cost (\$/yd ³)	\$31.03	\$31.71	\$37.70	\$25.42 (low)	\$43.83 (high)	\$33.94
Indirect Costs included?	X	X	X	X	X	
Earthwork Costs included?	X	X	X	X	X	
On-Site Material Processing?	X	X	X			
Gravel Purchase and Delivery?				X	X	

Additional line items, such as rock slope protection, temporary crossings, and revegetation, were not included in the unit gravel placement cost estimates. These line items were reviewed to identify which features would be included in future gravel augmentation, and should therefore be included in the historical cost analysis. Indirect costs, such as implementation construction management, erosion control, waste management, sanitation, and other miscellaneous expenses were included in the unit costs. Implementing agency overhead costs were included as a separate line item outside of implementation costs. Total earthwork volumes were tabulated using the available cost estimates and project data. Historic unit gravel implementation costs were estimated by dividing the sum of all relevant project line items (indirect costs, earthwork, on-site material processing, and/or rock delivery) by the total volume of gravel fill.

Unit costs include costs of either gravel purchase and delivery or on-site processing. For simplicity, no discount was applied to the gravel augmentation unit cost for any future gravel acquired from the CDFW quarry at Snelling, as costs to load, transport (from Merced River), and stage gravel are expected to be slightly less but still commensurate with actual costs from the reference sites, even when the gravel is provided at no cost.

Costs at each future site, expected year of implementation, and total costs (in 2018 dollars with and without 30% contingency) are presented in Table 2. Future gravel placement sites shown in Table 2 are based on the recommended sites in Table 17 of the CSMP (McBain and Trush 2004). Because the sites in the CSMP totaled only 539,471 yd³, necessary volumes for each CSMP site were scaled up by a factor of 4.5%, such that the total fifteen-year placement volume matched the 564,000 yd³ recommended in the agency REA recommendations. On average, 37,600 yd³ would have to be placed each year over the course of 15 years to meet the 564,000 yd³ total. A possible bundling and sequencing of gravel augmentation sites was prepared in Table 2 by comparing the cumulative site placement volumes with the average annual volume (37,600 yd³/yr). For example, CSMP Site 1 (8,677 yd³) and CSMP site 2 (18,070 yd³) were bundled into the same implementation year because the total volume (26,747 yd³) was close to the average annual volume of 37,600 yd³/yr.

Table 2. Summary of locations and 2018 costs to place all 564,000 yd³ of gravel recommended by resource agencies, using average unit cost value of \$33.94/yd³ in Table 1 for 2018 dollars.

CSMP Site No.	Year	Site Name	Adjusted Gravel Augmentation Fill Total* (yd ³)	Implementation Cost Based on Average Unit Cost (2018 \$)
1	1	Riffle A3/4 Complex	8,677	\$290,000
2	1	Riffle A5/6 La Grange Pool	18,070	\$610,000
6	2	Riffle 3A Complex	20,909	\$710,000
10	3	Basso Pool	49,908	\$1,690,000
14	4	Riffle 12 Complex	67,955	\$2,310,000
22	5	FOTT RM 43 Site (Bobcat Flat)	16,048	\$540,000
26	6	Riffle 24 (TLSRA)	2,091	\$70,000
5	6	New La Grange Bridge Backwater (Riffle 1C)	28,228	\$960,000
8	6	Riffle 5A Complex	4,977	\$170,000
9	7	Riffle 5B Complex	3,719	\$130,000
11	7	Riffle 7 Complex	3,009	\$100,000
12	7	Riffle 8	9,795	\$330,000
13	8	Zanker Pool	38,797	\$1,320,000
18	9	FOTT RM 44.5 Site (Riffles 16, 17A, 17D)	36,232	\$1,230,000
27	10	SRP 4	34,387	\$1,170,000
29	11	Riffle 28B/Roberts Ferry Bridge Pool	46,461	\$1,580,000
3	12	Riffle A7 Complex3	3,946	\$130,000
4	12	Riffle 1A/B Complex3	16,841	\$570,000
15	12	Riffle 13 A/B Complex	20,517	\$700,000
17	13	Riffle 14/15 Complex	30,014	\$1,020,000
19	13	RM 44 Pool	16,210	\$550,000
20	14	SRP 3	21,863	\$740,000
21	14	Riffle 18	21,748	\$740,000
7	15	Riffle 4A Complex	3,361	\$110,000
16	15	Riffle 13C and Backwaters	9,405	\$320,000
23	15	Riffle 23A	5,398	\$180,000
24	15	RM 42.4	5,232	\$180,000
25	15	Riffle 23B	10,074	\$340,000
28	15	RM 40.5 Pool/Riffle 27	10,128	\$340,000
ROUNDED TOTALS =			564,000	\$19,000,000
ROUNDED TOTALS INCLUDING 30% CONTINGENCY =				\$25,000,000

*Lower Tuolumne River CSMP Table 17 volumes multiplied by 4.5% for total volume to equal 564,000 yd³

2 GRAVEL AUGMENTATION: 1,400,000 CUBIC YARDS OVER YEARS 16-25

The cost of additional placement of 1,400,000 yd³ for SRPs 5, 6, 7, 8, and 10 in year 16-25 at a unit cost of \$33.94 totals \$48,000,000 in 2018 dollars. Costs by year are summarized in Table 3.

Table 3. Projected future cost to place 1,400,000 yd³ of gravel recommended by resource agencies for SRP's 5, 6, 7, 8, and 10 during Years 16-25, using average unit cost value of \$33.94/yd³ in Table 1 for 2018 dollars.

Year	Site	Assumed Gravel Augmentation Fill (yd³)	Implementation Cost Based on Average Unit Cost (2018 \$)
16	Future Site 1	140,000	\$ 4,750,000
17	Future Site 2	140,000	\$ 4,750,000
18	Future Site 3	140,000	\$ 4,750,000
19	Future Site 4	140,000	\$ 4,750,000
20	Future Site 5	140,000	\$ 4,750,000
21	Future Site 6	140,000	\$ 4,750,000
22	Future Site 7	140,000	\$ 4,750,000
23	Future Site 8	140,000	\$ 4,750,000
24	Future Site 9	140,000	\$ 4,750,000
25	Future Site 10	140,000	\$ 4,750,000
ROUNDED TOTALS =		1,400,000	\$48,000,000
ROUNDED TOTALS INCLUDING 30% CONTINGENCY =			\$62,000,000

3 PERMITTING

Permitting costs were calculated at 5% of gravel augmentation and contingency costs. Estimated permit costs to implement 564,000 yd³ of gravel augmentation over a period of 15 years is \$1,200,000. Estimated permit costs to implement 1,400,000 yd³ of gravel augmentation over 10 years at SRPs 5, 6, 7, 8, and 10 is \$3,000,000. If the two actions were permitted concurrently as a single action, the permitting costs of the 1,400,000 yd³ would not be necessary, or the total cost would be lower due to efficiency. If they were to be done separately, then an assumption of a \$4 million permitting cost would be reasonable. All cost estimates above are in 2018 dollars.

4 DESIGN

A considerable amount of data collection, analysis, hydrodynamic modeling, surveying, and drafting will be required by engineering and engineering contractors to adequately design each gravel augmentation project, create bid documents, and provide field support. The level of effort for this broad category of design for civil works projects is generally commensurate with the scale of implementation effort. Design costs are calculated at 15% of the sum of gravel augmentation, contingency, and permitting costs. Estimated design costs to implement 564,000 yd³ of gravel augmentation over 15 years is \$4,000,000. Estimated design costs to implement 1,400,000 yd³ of gravel augmentation over 10 years at SRPs 5, 6, 7, 8, and 10 is \$10,000,000 (2018 dollars).

5 MONITORING AND REPORTING

Monitoring and reporting will be required as a condition of permit compliance, and the cost estimate assumes annual monitoring and reporting will cost approximately \$100,000/year in 2018 dollars. The \$100,000/year cost estimate includes two weeks of travel and field time for six technical staff and two weeks of reporting annually. The total monitoring cost for year 1 through year 15 associated with the gravel augmentation of 564,000 yd³ is \$1,400,000 in 2018 dollars (rounded to \$2,000,000 in cost summary). The total monitoring cost for year 16 through year 25 associated with filling SRP's 5, 6, 7, 8, and 10 with 1,400,000 yd³ of gravel augmentation is \$1,000,000 in 2018 dollars.

6 OWNER'S CONTRACT ADMINISTRATION

Owner's contract administration costs were calculated at 10% of the sum of gravel augmentation, contingency, permitting, detailed design, and monitoring costs. Estimated owner's contract administration costs to implement 564,000 yd³ of gravel augmentation over a period of 15 years is \$3,000,000. Estimated owner's contract administration costs to implement 1,400,000 yd³ of gravel augmentation over a period of 10 years at SRPs 5, 6, 7, 8, and 10 is \$8,000,000 (2018 dollars).

7 COST SUMMARY

Cost summaries for each of the gravel augmentation phases recommended by the resource agencies in their REA comments (564,000 yd³ in Years 1-15 and 1,400,000 yd³ in Years 16-25) have been compiled independently and include implementation, 30% construction contingency, permitting, detailed design, monitoring and reporting, and owner's contract administration. The cost estimate for implementing 564,000 yd³ of gravel over a fifteen-year period is \$35,000,000 in 2018 dollars, or \$46,000,000 in inflation-adjusted dollars (Table 4). The cost estimate for implementing 1,400,000 yd³ of gravel over a later ten-year period is \$84,000,000 in 2018 dollars, or \$160,000,000 in inflation-adjusted dollars (Table 5). The total future cost for placing 1,964,000 yd³ of gravel is estimated to be \$206,000,000, including inflation.

Table 4. Cost summary of implementing 564,000 yd³ of gravel augmentation over a fifteen-year period using 2018 dollars and future dollars (applying the average implementation unit cost estimate and accounting for inflation).

Task	Rounded Cost
Unit Cost for gravel augmentation implementation	\$33.94/yd ³
Implementation Cost	\$19,000,000
Contingency	\$6,000,000
Permitting	\$1,200,000
Detailed Design	\$4,000,000
Monitoring and Reporting	\$1,500,000
Owner's Contract Administration	\$3,000,000
Rounded Up TOTAL in 2018 Dollars:	\$35,000,000
Inflation-Adjusted Total*:	\$46,000,000

*Assumes 3.22% annual inflation from Year 1-15 using annual volumes shown in Table 2

Table 5. Cost summary of implementing 1,400,000 yd³ of gravel augmentation over a ten-year period using 2018 dollars and future dollars (applying the average implementation unit cost estimate and accounting for inflation).

Task	Rounded Cost
Unit Cost for gravel augmentation implementation	\$38.94/yd ³
Implementation Cost	\$48,000,000
Contingency	\$14,000,000
Permitting	\$3,000,000
Detailed Design	\$10,000,000
Monitoring and Reporting	\$1,000,000
Owner's Contract Administration.	\$8,000,000
TOTAL in 2018 Dollars:	\$83,000,000
Inflation-Adjusted Total*:	\$160,000,000

**Assumes 3.22% annual inflation from Year 16-25 using an average annual volume of 140,000 yd³/year (1,400,000 yd³/10 years)*