Placer County Water Agency
Middle Fork American River Project
(FERC No. 2079)

FINAL

AQ 9 – GEOMORPHOLOGY
TECHNICAL STUDY REPORT – 2010

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1.0 INTRODUCTION

This report describes the geomorphology studies conducted by the Placer County Water Agency (PCWA) in accordance with the AQ 9 – Geomorphology Technical Study Plan (AQ 9 – TSP) for the Middle Fork American River Project (MFP or Project). The stakeholder-approved AQ 9 – TSP was included in Supporting Document (SD) H of the Pre-Application Document (PAD) filed with the Federal Energy Commission (FERC or Commission) on December 13, 2007 (PCWA 2007).

As described in the AQ 9 – TSP, geomorphology studies were conducted during the summer and fall of 2007 and 2008 to characterize sediment conditions in the river channels, reservoirs, and diversion pools associated with the MFP. The results of these studies were documented in the Final 2008 AQ 9 – Geomorphology Technical Study Report (AQ 9 – TSR) (PCWA 2009). A few study elements were outstanding in that report. This report completes the work required in the AQ 9 – TSP.

In 2009–2010, the outstanding study elements completed were: (1) sediment capture in Project reservoirs and diversion pools; and (2) identification of flows necessary to maintain geomorphic processes in bypass reaches and the peaking reach. This report summarizes the sediment capture field studies at the sites that were not completed in 2007 and 2008 (French Meadows Reservoir and Duncan Creek Diversion Pool). Flow necessary to maintain geomorphic processes were identified in the AQ 1 – Instream Flow Technical Study Report (AQ 1 – TSR) (PCWA 2010a). Sediment management information is summarized in the AQ 9 – TSR (2009) and the Sediment Management Plan (SMP) (PCWA 2010b). Sediment capture in Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, and the North Fork Long Canyon and South Fork Long Canyon diversion pools was characterized and quantified in the AQ 9 – TSR (2009).

This report provides a description of the study objectives, study implementation, study area, study approach, study results, and literature cited for the French Meadows Reservoir and Duncan Creek Diversion Pool sediment capture studies.

2.0 STUDY OBJECTIVE

The study objective identified in the AQ 9 – TSP that is addressed in this report is as follows:

- Characterize sediment capture in Project reservoirs and diversion pools under existing Project operations.

3.0 STUDY IMPLEMENTATION

Figure AQ 9-1 shows the AQ 9 – TSP objectives, study elements, activities, and reports completed between 2005 and 2010.

3.1 STUDY ELEMENTS COMPLETED

The following study elements were completed in 2009–2010:

Sediment Capture in Project Reservoirs and Diversion Pools

- Determined particle size composition and estimated sediment loads captured in French Meadows Reservoir and Duncan Creek Diversion Pool.

- **Identify Flows Necessary to Maintain Geomorphic Processes in Bypass Reaches and the Peaking Reach** under different flow regimes at selected instream flow study site locations using the hydraulic models developed for the AQ 1 – Instream Flow TSP (PCWA 2007). The results of this study are presented in the AQ 1 – TSR (PCWA 2010a).

3.2 DEVIATIONS FROM TECHNICAL STUDY PLAN

The sediment capture study element proceeded as described in the AQ 9 – TSP except for the following variance:

- The TSP specified collection and cataloguing 12–24 bulk samples from French Meadows Reservoir, with about 12 samples retained for particle size analysis. Due to the coarse substrate, subsurface samples could only be collected using a backhoe. PCWA collected, catalogued, and analyzed particle sizes from 6 test pits, consistent with the following permits: US Army Corp of Engineers (USACE) Nationwide Permit, Regional Water Quality Control Board (RWQCB) 401 Certification, and California Department of Fish and Game (CDFG) Streambed Alternation Agreement.

4.0 EXTENT OF STUDY AREA

The study areas included French Meadows Reservoir and Duncan Creek Diversion Pool and are shown on Maps AQ 9-1 and AQ 9-2, respectively.

5.0 STUDY APPROACH

The following describes the geomorphology study approach to determine particle size composition and volume of sediment captured in French Meadows Reservoir and Duncan Creek Diversion Pool in accordance with the AQ 9 – TSP. Particle sizes of sediment captured were determined through visual observations, sediment sampling of bed sediments, and particle size analysis. The volume of sediment captured was estimated from comparisons of topographic surface maps from different years.

5.1 FRENCH MEADOWS RESERVOIR

5.1.1 Focused Survey Location

Large areas of sediment deposition (particularly gravels) within French Meadows Reservoir were initially identified during a helicopter reconnaissance survey. The majority of sediment deposition was observed in the upper portion of the reservoir upstream of a bedrock outcrop that forms a natural constriction in the low-flow channel.

This area was the focus of the ground field studies (see Map AQ 9-1). No large gravels were observed at other locations within the exposed reservoir.

5.1.2 Particle Size Composition

Ground surveys were conducted when the reservoir was at low-pool (5,218 feet (ft) above mean sea level [AMSL]) in fall 2009 to characterize surface and subsurface particle sizes over the exposed reservoir bed (Map AQ 9-1). Sediment deposits were characterized by walking within the exposed portion of the reservoir bed up to approximately the full pool elevation (5,263 ft AMSL). Regions with similarly sized sediment deposits (e.g., sand, fine, medium or coarse gravel, cobble, and boulder) were mapped and delineated in the field into “Particle Size Regions” using a handheld Trimble “resources grade” Global Positioning System (GPS) with external antenna. For each Particle Size Region, the median particle size (D_{50}) was visually estimated using a particle size template. The homogeneity (well sorted, poorly graded) or heterogeneity (poorly sorted, well graded) of the sediment was also characterized within each Particle Size Region utilizing a Unified Soil Classification System.

Particle size composition was characterized quantitatively in a subset of the Particle Size Regions. Five representative Particle Size Regions with the most sediment deposition (based on visual observations) were selected (Particle Size Regions 3, 4, 6, 15, and 17 shown on Map AQ 9-3). Within each of the Particle Size Regions, particle sizes were characterized using pebble counts (Wolman 1954) and test pits. The locations of the test pits were recorded with the GPS and are shown on Map AQ 9-3. To determine the variability between samples within the same region, a second sample was collected. Test pits were dug using a backhoe to expose and characterize the particle size composition of the subsurface material and to document vertical sorting. All test pits were photographed to catalogue the particle sizes and depth of sediment deposited. The depths of the test pits were limited to three or four feet depth where the water table was encountered.

A representative sample was collected from each of the excavated test sediment pits for particle size analysis. The coarser material (11 mm or larger) was placed on tarps, air dried, sieved, and weighed on site. The finer material (<11 mm) was placed, then sealed in 5 gallon buckets and transported to a laboratory for particle size analysis. In the laboratory, the samples were dried, sieved and weighed to determine the particle size gradation. Sand-, silt-, and clay-sized sediments were combined and characterized as “fines”. The particle size results of the field-sieved and laboratory-sieved material were then combined into one particle size gradation representing the entire test pit sample. The pebble counts and particle size data from the test pits were plotted as frequency histograms and cumulative particle size distribution curves.

The particle size analysis was organized into six categories based on Rosgen (1998) size classifications as follows:

- <u>Sand</u> (i.e., “fines”): <2 mm, and for purposes of this analysis included material that may be silt- or clay-sized;

- Fine Gravel: ≥2 mm to <8 mm;
- Medium Gravel: ≥8 mm to <45 mm;
- Coarse Gravel: ≥45 mm to <64 mm;
- Cobble: ≥64 mm to <256 mm; and
- Boulder/Bedrock: ≥256 mm.

The results of the sediment size composition in the five representative regions were used to estimate the particle size distribution in the other Particle Size Regions. Particle Size Regions where sediment size distribution was not analyzed were matched to one of the five representative regions with the most comparable visual assessment of surface particle size. This information was applied to estimate the percentage within each Particle Size Region of: (1) sand; (2) fine, medium, and coarse gravel; and (3) cobble.

5.1.3 Estimated Sediment Loads

To estimate the overall volume of deposited sediment in the study area, pre-reservoir (1962) and post-reservoir (2007) ground surface maps were developed and compared. The difference in the topography of the two surface maps provided an estimated accrual of sediment since construction of the dam. PCWA has never conducted sediment maintenance at French Meadows Reservoir.

Pre-Reservoir Surface (1962)

The pre-dam reservoir topography was based on a 1962 topographic map, with a 1 in = 200 ft scale (1:2,400) and a 10-foot contour interval (Map AQ 9-4). Several spot elevations were also identified on the map. The resolution of this map was too coarse for direct comparison with more recent topography as total sediment accrual was estimated to be less than 10 feet throughout the study area. Therefore, a more accurate estimate of the pre-reservoir ground surface was developed. The following describes this method.

The 1962 topographic map was geo-referenced to NAD 83 California State Plane Zone 2 coordinate system. The centerline of the pre-reservoir channel on the historic map was digitized through the study area between two points where sediment deposition was likely to be minimal over time. The upper boundary endpoint was located upstream of the maximum pool elevation (5,270 ft AMSL) and the downstream boundary endpoint was located near the bedrock outcropping (5,210 ft AMSL) (boundary end points) (Map AQ 9-5). High flows through the bedrock constriction effectively scour the channel, thereby maintaining a constant elevation.

A slope for the pre-reservoir channel was calculated between the boundary end points. Elevations along the channel were assigned evenly spaced elevations to create a 3D polyline. Additional data such as spot elevations from the 1962 topographic map were also included in the pre-reservoir topographic data set. These were then used to create the pre-reservoir (1962) topographic surface map.

Post-Reservoir Surface (2007)

Recent topographic data was collected in fall 2007 of French Meadows Reservoir by Air Maps USA using aerial photogrammetric mapping techniques supported by ground control surveys during low flow conditions (5,203 ft AMSL). Elevations in areas where no sediment accrual would be expected (i.e., upper banks) were identified and compared on the 1962 and 2007 topographic maps and were use to calibrate the pre-reservoir channel alignment and elevations. Topography was developed using AutoCAD Civil 3D for the same area as was completed for the 1962 topography map (Map AQ 9-5).

Estimate of Sediment Captured

To reduce the size of the area where interpolated elevations were used for estimating the volume of sediment captured, areas with little sediment deposition were excluded from the analysis to estimate the volume of sediment captured. Indicators of near-original, pre-dam reservoir bed surface, such as *in situ* tree stumps and bedrock outcrops, were identified and located on aerial photograph field maps. Tree stumps and exposed bedrock are important benchmarks to assist in the determination of areas where minimal sediment deposition has occurred since construction of the dam (e.g., Appendix B, photo 14). On the northern side of the channel in particular, numerous tree stumps were still at grade with the existing ground surface (Appendix B, photo 13), and all except for the region immediately adjacent to the low-flow channel (Particle Size Region J) were excluded from further analysis. The remaining Particle Size Regions and corresponding particle size composition were used to estimate sediment captured and characterize the stored material within the exposed bed of the upper region of French Meadows Reservoir.

Changes in elevation since before dam construction were determined by comparing the surface maps (elevations at 82 point locations) of the remaining delineated Particle Size Regions in the 1962 and 2007 surface maps using AutoCAD Civil 3D. A geographic information system (GIS) was used to calculate the volume of sediment accrual. The surface area of each of the polygons defining the amount of sediment deposition was multiplied by their respective measured change in depth of sediment between 1962 and 2007, resulting in a total volume of sediment accrual by particle size within the area of analysis.

5.2 DUNCAN CREEK DIVERSION POOL

5.2.1 Focused Survey Location

Sediment studies to characterize particle size composition in the diversion pool focused on the upstream portion of the diversion pool that was exposed during ‘low-pool’ conditions (see Map AQ 9-2). Topography surveys from 2007 and 2010 of the diversion pool were used to estimate sediment accrual.

5.2.2 Particle Size Composition

Ground surveys were conducted in 2010 when water surface elevations were relatively low (5,261 ft AMSL) to characterize the surface and subsurface sediment particle sizes in the exposed reservoir bed. The ground surveys were conducted by walking within the exposed portion of the bed to map areas with similar types of material. Regions of similar depositional material (e.g., sand, fine, medium or coarse gravel, cobble, and boulder) were delineated visually and mapped in the field using a total station. The exposed bed of the diversion pool was delineated into four Particle Size Regions (1–4) (Map AQ 9-6). For each Particle Size Region, surface sediments were described visually and with pebble counts (Wolman 1954). A second pebble count was conducted in the largest Particle Size Region (Particle Size Region 3).

Test pits were dug using a backhoe to catalogue the subsurface particle size distribution, depth of sediment deposits, and presence of vertical sorting (Map AQ 9-6). The test pits were located in Particle Size Regions 1 and 3. They were dug to approximately one to two feet in depth where the water table was encountered. In Particle Size Region 1 (where coarsest material was observed [cobbles and boulders]), particle sizes of the subsurface material were visually estimated. Particle Size Region 3 was located within the lower portion of the exposed bed and was dominated by gravel with sand sized deposits. The same methods described above for French Meadows Reservoir were used to collect and analyze sediment size composition of the subsurface sediment from the test pits.

5.2.3 Estimated Sediment Loads

To estimate the annual volume of sediment stored in Duncan Creek Diversion Pool, the bed of the diversion pool was surveyed with a combination of total station and bathymetric surveys (below water surface) in 2007 and 2010 and compared.

2007 Surface Topography

A combination of total station and bathymetric surveys were used to develop the 2007 topography of Duncan Creek Diversion Pool. The survey was completed in October 2007 when the diversion pool water levels were low. The survey extended from the top of the dam at 5,275 ft AMSL and extended to just upstream of the impoundment's maximum storage elevation of 5,265 ft AMSL (same elevation as the dam's spillway).

Elevations were surveyed along 16 evenly spaced transects that extended across the diversion. The total station was used to survey the exposed surfaces within the diversion pool. The water surface elevation was also surveyed. Bed and hillslope elevations were also included in the survey to create a continuous topographic surface of the diversion pool.

At locations where the water was too deep for the survey with the total station, the depth from the bottom of the diversion pool to the water surface was measured with a stadia rod. When combined with the known water surface elevation, the topography under the water was developed. The survey points were interpolated in GIS software to create a continuous raster elevation surface (Map AQ 9-7).

2010 Surface Topography

Duncan Creek Diversion Pool was re-surveyed in August 2010 using the same survey methods. Map AQ 9-8 shows the 2010 topographic surface map.

Estimate of Sediment Captured

The 2007 and 2010 surface maps were compared and changes in elevation between 2007 and 2010 calculated, similar to the methods described above for French Meadows Reservoir.

6.0 STUDY RESULTS

6.1 KEY FINDINGS

French Meadows Reservoir

- Sand size material was the dominant size of sediment stored within the upper portion of French Meadows Reservoir, followed closely by medium sized gravels.
- An estimate of approximately 10,834 cubic yards of spawning sized gravel (8–64 mm) in total has been captured in French Meadows Reservoir between 1962 and 2009.

Duncan Creek Diversion Pool

- Gravel sized material (2–64 mm) was the dominant size material deposited within the exposed bed region of the Duncan Creek Diversion Pool.
- Little sediment was captured between 2007 and 2010 in Duncan Creek Diversion Pool. High flow magnitudes during this time were considerably lower than historic high flow events that delivered large volumes of sediment to the diversion pool.
- An estimate of approximately 36% of the material stored in the diversion pool was comprised of medium to coarse gravel sized (8–64 mm). Based on the average volume of sediment removed during historic removal activities, approximately 1,977 cu yds of gravel sized particles are removed during each activity.

6.2 FRENCH MEADOWS RESERVOIR

6.2.1 Particle Size Composition

The exposed reservoir bed was delineated into 34 Particle Size Regions (1–24 and A–L) based on visual estimates of surface sediments (Map AQ 9-3). The distribution of particle sizes within each Particle Size Region is provided in Table AQ 9-1. The frequency histograms and cumulative particle size distribution curves of surface and subsurface sediments within the five representative Particle Size Regions are provided in Appendix A.

Along the northern and southern sides of the low-flow channel within the reservoir, the surface sediments were visually estimated and ranged from sand- to cobble-sized material. On the northern side, the majority of the material was sand or fine gravels. Coarser material (gravel to cobble size) was observed primarily within the seasonal drainage channels (Particle Size Regions E, F and I) (Map AQ 9-3). On the southern side, six of the 23 delineated Regions were predominately sand (Appendix B, photos 14 and 15). Two of the 23 delineated Regions were cobble dominated with little or no finer material present (Appendix B, photo 16).

Particle size composition within the low-flow channel consisted primarily of cobble-sized material. Photographs of the surface material as well as the six sediment test pits are located in Appendix B, photos 1–12.

6.2.2 Estimated Sediment Loads

Tree stumps with bases at the existing ground surface without evidence of appreciable root burial or bedrock exposures were observed in large portions of the study area. Minimal sediment deposition had occurred in these areas. Most of the deposited sediments were observed on the southern side of the low-flow channel (Appendix B, photo 17). The northern side of the low-flow channel was separated from the active channel by a three to five foot high riverbank, which appears to limit sediment transport and deposition in these areas.

An estimated total of 29,523 cubic yards (cu yd) of sediment have been captured in the study area between 1962 and 2009 (average of 886 cu yd per year) (Table AQ 9-2) (Map AQ 9-9). The majority of the area analyzed had net deposition ranging from one to three feet. The largest depositional area was just upstream of the large bedrock constriction where the constriction may cause high flows to back up and deposit the sediment load. Net erosion was measured adjacent to the present low-flow channel. Sediment accrual is likely episodic, with greater amounts of sediment transported in years with very high flows and much smaller amounts of material transported in years with very low flows.

Of the total volume of sediment captured, approximately 32% was sand, followed by 27% medium gravels (Table AQ 9-2). Approximately 15%, 14%, and 10% of the total volume of sediment is comprised of cobble, fine gravel, and coarse gravel, respectively. Boulder/bedrock represented the smallest fraction of sediment (2%). The volume of combined medium (8–45) and coarse (45–64 mm) sized gravels (typically used for spawning) comprised approximately 37% of the regions analyzed. The medium and coarse gravel sized sediment stored in the exposed bed of the reservoir equates to approximately 250 cu yd per year.

The sediment load contribution to French Meadows Reservoir estimated in the analysis is less than for typically low-yielding watersheds in California. The average annual sediment load contribution to California streams that are considered to carry a low sediment load is approximately 80 tons/sq mi/yr (Leopold 1994). The drainage area to French Meadows Reservoir is 47 sq mi. Based on an annual sediment load of 886 cu yds/year, the contribution per square mile from the upstream watershed is 19 cubic yards/sq mi/year. Sediment loads entering into French Meadows Reservoir may be low compared to values in the literature due to low gradients upstream of the reservoir (approximately 1%) where sediments likely deposit prior to reaching the reservoir.

Potential Sediment Deposition Downstream of Study Area

Sediment could potentially be stored in French Meadows Reservoir downstream of the surveyed area. However, it is unlikely that any large accumulations of gravel deposits of spawning size or other particle sizes exists below the study area. A brief discussion of the potential for sediment deposition downstream of the constriction is provided below.

- When the reservoir pool water surface elevation is low, high flow events could potentially transport gravels past the bedrock constriction. An analysis was performed to determine the frequency when the reservoir pool elevation was lower than the elevation of the downstream bedrock constriction (5,218 ft AMSL) on the same days that high flow events have occurred. Flows could transport sediments further downstream of the study area when these conditions occurred. Modeled average daily flow data for Middle Fork American River and recorded reservoir pool elevations for French Meadows Reservoir were available from 1975–2007 (PCWA 2010). The 5-year flow[1] was equaled or exceeded during 14 days. Of these days, the reservoir was lower than the elevation of the downstream bedrock constriction for a total of 3 days during the period of record (Figure AQ 9-2).
- One area of almost entirely sand size particles was observed downstream of the constriction during reconnaissance surveys. Based on a comparison of the 1962 and 2009 topographic maps any sedimentation within this area was less than ten feet (due to the resolution of the 1962 topographic map).
- No large tributaries flow into French Meadows Reservoir downstream of the study area that would contribute a large amount of additional sediment to the reservoir. A topographic map of the reservoir shows several small first order and two second order intermittent drainages that may deliver minimal amounts of sediment into the reservoir.

6.3 DUNCAN CREEK DIVERSION POOL

6.3.1 Particle Size Composition

Duncan Creek splits into two channels prior to entering into the diversion pool. The majority of the flow enters the diversion pool from the main channel along the western

[1] The 5-year recurrence interval flow (Q5) was selected to represent a flow that would scour the upstream channel and transport sediments.

edge of the diversion pool during periods of low flow. The coarsest material (predominately cobble and gravel with some boulders) was observed along the upstream segment of this channel as it flowed into the diversion (Appendix C, photos 1 and 2). As the channel gradient decreases and the channel widens as it flows into the diversion pool, the dominant size of the bed material decreased to medium gravel (8–45 mm) sized deposits (Appendix C, photos 4 and 6).

The bed material within the smaller secondary channel entering the diversion pool was dominated by gravel intermixed with cobble sized material (Appendix C, photos 11 and 12). Sand sized material was observed along the lower portions of the exposed bed and in the shallow portions of the diversion pool that were outside the influence of the inflowing channel (Appendix C, photos 13 and 14).

The particle size distributions of the surface (pebble counts) and subsurface samples (test pits) within the exposed portion of the diversion pool were different (Table AQ 9-3 and Appendix C, photos 1–14). Sand size particles comprised approximately one-fourth of the subsurface deposits, with a fairly even distribution of particles sizes between the sand and cobble ranges. In comparison, the results of the pebble counts indicated the majority of the material was medium gravel sized (Appendix D). The data from the pebble counts collected within the four Particle Size Regions and test pit samples (in Particle Size Region 3) were plotted as frequency histograms and cumulative particle size distribution curves (Appendix D).

6.3.2 Estimated Sediment Loads

Very little sediment accumulated in the diversion pool between 2007 and 2010 (Map AQ 9-10). The net change in sediment volume between 2007 and 2010 based on topographic surveys was an estimated loss of 411 cu yd or 0.15 feet (1.8 inches) change in depth averaged over the area of the diversion pool. The elevation change within the majority of the impoundment was less than ±1 feet.

Two high flow events that caused spills occurred between 2007 and 2010. The magnitude of these flows had the potential to deliver sediments from the upstream watershed, as well as scour the diversion pool. The maximum daily average flow measured was 785 cfs in May 2009 (USGS Gage No. 11427700). The magnitude of this flow was between the two-year recurrence interval (408 cfs) and 5-year recurrence interval (928 cfs). A flow of 380 cfs occurred in February 2009. However, these flow magnitudes were considerably lower than previous high flow events that delivered large volumes of sediment to the diversion pool and required sediment removal (at least 1,930 cfs, which is greater than a 10-year recurrence interval (Figure AQ 9-3)). On average, sediment removal activities have occurred once every 7.3 years after very large flow events.

It was not possible to estimate sediment load and capture in the diversion pool because no sediment accrual was measured between 2007 and 2010. However, using the results of the test pit sediment sampling from Particle Size Region 3, the percentage of medium to coarse gravel (8–64 mm) in subsurface sediments was estimated (Map AQ

9-6). Averaging the results of the test pit samples, approximately 36% of material that is captured is medium to coarse gravel-sized. Historical records of sediment removal activities (1997–2009) contained information on the total volume of sediment removed (PCWA 2010b). During this time period, sediment removal occurred three times, with an average volume of 3,035 cu yds of sediment and 1,977 cu yds of gravel size particles (8–64 mm) removed during each activity.

7.0 REFERENCES

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TABLES

Table AQ 9-1. Particle Size Composition Summary for French Meadows Reservoir.

Particle Size Region[1]	Sand <2 mm	Fine Gravel 2-8 mm	Medium Gravel 8-45 mm	Coarse Gravel 45-64 mm	Cobble 64-256 mm	Boulder/Bedrock >256 mm
1	31%	24%	38%	4%	3%	0%
2	25%	13%	21%	11%	30%	0%
3 [1]	17%	20%	30%	8%	25%	0%
4 [1,2]	26%	18%	37%	12%	7%	0%
5	25%	13%	21%	11%	30%	0%
6[1]	14%	11%	29%	19%	21%	6%
7	100%	0%	0%	0%	0%	0%
8	14%	11%	29%	19%	21%	6%
9	6%	8%	22%	7%	57%	0%
10	85%	5%	5%	5%	0%	0%
11	14%	11%	29%	19%	21%	6%
12	17%	20%	30%	8%	25%	0%
13	14%	11%	29%	19%	21%	6%
14	31%	24%	38%	4%	3%	0%
15 [1]	6%	8%	22%	7%	57%	0%
16	85%	5%	5%	5%	0%	0%
17 [1]	31%	24%	38%	4%	3%	0%
18	10%	0%	0%	0%	90%	0%
20	100%	0%	0%	0%	0%	0%
21	31%	24%	38%	4%	3%	0%
22	100%	0%	0%	0%	0%	0%
23	100%	0%	0%	0%	0%	0%
24	5%	5%	5%	5%	80%	0%
A	5%	5%	5%	5%	80%	0%
C	100%	0%	0%	0%	0%	0%
D	100%	0%	0%	0%	0%	0%
E	6%	8%	22%	7%	57%	0%
F	6%	8%	22%	7%	57%	0%
G	6%	8%	22%	7%	57%	0%
H	25%	13%	21%	11%	30%	0%
I	6%	8%	22%	7%	57%	0%
J	17%	20%	30%	8%	25%	0%
K	14%	11%	29%	19%	21%	6%
L	100%	0%	0%	0%	0%	0%

[1]Particle size distribution determined from particle size analyses. Refer to text for description of estimation of particle size distributions for the other Particle Size Regions.
[2]Average of duplicate samples.

Table AQ 9-2. Estimated Volume of Sediment Accrual in French Meadows Reservoir.

Particle Size Region[1]	Accumulated Sediment Volume cubic yards	Sand <2 mm	Fine Gravel 2-8 mm	Medium Gravel 8-45 mm	Coarse Gravel 45-64 mm	Cobble 64-256 mm	Boulder/Bedrock >256 mm
1	581	180	139	221	23	17	0
2	235	59	30	49	26	70	0
3	3536	601	707	1061	283	884	0
4	2514	654	452	930	302	176	0
5	177	44	23	37	19	53	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	5069	710	558	1470	963	1065	304
9	1971	118	158	434	138	1124	0
10	5439	4623	272	272	272	0	0
11	1462	205	161	424	278	307	88
12	1412	240	282	424	113	353	0
13	1710	239	188	496	325	359	103
14	4891	1516	1174	1859	196	147	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
21	526	163	126	200	21	16	0
J	0						
Total (cubic yards)	**29523**	**9352**	**4271**	**7876**	**2959**	**4571**	**495**
Percent of Total		**32%**	**14%**	**27%**	**10%**	**15%**	**2%**

[1]The Particle Size Regions that were identified as having gravel deposits are summarized in this table. Refer to Map AQ 9-9.

Note: 0 cubic yards of accumulated sediment indicate Particle Size Regions where erosion of sediment was calculated.

Table AQ 9-3. Particle Size Composition Summary for Duncan Creek Diversion Pool.

Particle Size Region[1]	Sand <2 mm	Fine Gravel 2-8 mm	Medium Gravel 8-45 mm	Coarse Gravel 45-64 mm	Cobble 64-256 mm	Boulder/Bedrock >256 mm
Surface Pebble Count						
1	0%	2%	33%	15%	49%	1%
2	0%	11%	54%	13%	22%	0%
3a[2]	0%	13%	77%	7%	3%	0%
3b[2]	4%	15%	74%	4%	3%	0%
4	0%	15%	50%	17%	18%	0%
Bulk Sample						
3a (Pit #2)	33%	11%	10%	20%	26%	0%
3b (Pit #1)	20%	20%	26%	15%	19%	0%

[1]Particle Size Region refers to defined areas located on Map AQ 9-4.

[2]Due to the large area of Particle Size Region 3, a second sample was collected.

FIGURES

MAPS

APPENDIX A

Histograms and Cumulative Particle Size Distribution Curves for the Bulk Sample and Pebble Count Locations at French Meadows Reservoir

APPENDIX B

Site Photographs of French Meadow Reservoir Sediment Study Area

APPENDIX C

Histograms and Cumulative Particle Size Distribution Curves for the Bulk Sample and Pebble Count Locations at Duncan Creek Diversion Pool

APPENDIX D

Site Photographs of Duncan Creek Diversion Sediment Study Area