POTENTIAL RESOURCE ISSUE:

- Stable channel form and fluvial processes.

PROJECT NEXUS:

- Project operations modify the flow regime in the bypass river reaches and capture sediment in diversion pools, potentially resulting in changes to channel morphology and fluvial processes.

POTENTIAL LICENSE CONDITIONS:

- Channel riparian maintenance flows.
- Sediment Management Plan.

STUDY OBJECTIVES:

- Document sediment conditions in the bypass river reaches.
- Characterize sediment capture in diversion pools.
- Develop information to assist in the identification of flows necessary to maintain geomorphic processes in the bypass river reaches.
- Identify sources of sediment (major gullies, areas of vegetation and soil loss, and hillslope destabilization and erosion), including documentation of erosion resulting from spills from Project forebays and historic flume failures.

EXTENT OF STUDY AREA:

- The study area will include the bypass river reaches, comparison river reaches, and Project flowlines/flumes and Project forebay spill channels (Table AQ 5-1).
- It should be noted that the majority of lands along the bypass reaches are privately owned and outside the FERC Project boundary. For the purposes of the geomorphic studies described herein, SCE will take the following steps to obtain approval to conduct field studies on private property:
  - Provide notification to landowner of Project relicensing and request authorization to enter property to conduct the field studies.
  - If authorization is obtained, SCE will complete field studies as described in this technical study plan.
  - If authorization is not obtained, SCE will limit field studies to only those lands where landowners have provided access.

STUDY APPROACH:

The following describes the geomorphology study approach which includes data collection and analyses for: (1) evaluating sediment conditions in the bypass river reaches; (2) evaluating sediment capture in Project diversions; (3) identifying flows necessary to maintain geomorphic processes; and (4) identifying sediment sources and Project-related erosion areas.

Sediment Conditions in the Bypass River Reaches

The amount of fine sediment in pools and the particle size composition and fine sediment content of spawning gravels will be determined in the bypass river reaches, as described below.

Fine Sediment in Pools

A quantitative analysis of fine sediment in pools, V* (Hilton and Lisle, 1993), will be conducted.

- Conduct quantitative visual estimates of residual fine sediment in 5 to 10 pools, V* (Hilton and Lisle, 1993), at each of the sampling locations in the bypass river reaches and in comparison river reaches (Table AQ 5-1). Pools with V* values that are relatively low (less than 0.1) can be reasonably approximated by visual estimation (Hilton and Lisle, 1993). If there are problems completing the V* estimates (for example, due to excessive pool depths or V* values exceed 0.1), then this will be immediately communicated to the resource agencies for further consultation.
    - Visual estimates of V* will be made using a snorkel and mask. The visual surveys will be supported by a combination of photographic documentation of pool bottom sediments and sketch maps, and measurements of the surface area and depth of any fine sediment patches observed.

Particle Size Composition and Fine Sediment Content of Spawning Gravels

- Determine particle size distribution and fine sediment content of spawning gravels in the bypass river reaches and comparison reaches using bulk sampling techniques (McNeil and Ahnell, 1960). The locations are listed in Table AQ 5-1.
    - Collect bulk samples using a modified McNeil sampler (i.e., bottomless bucket) to depths that approximate that of a trout egg pocket. Coarse sediments will be sieved and weighed on-site. Finer sediments will be packaged for transport from the field site and later dried, sieved, and weighed.
    - One "side-by-side" replicate pair of bulk samples will be taken in each of the study sites to provide a measure of the variability in particle size composition within the same gravel deposit to characterize an expected range of natural variability.
- Plot particle size composition of spawning gravel samples as cumulative distribution curves and histograms. Statistically analyze the particle size composition as represented by the D50, D16, and D84.
- Compare particle size composition and fine sediment content to standards from the scientific literature (Kondolf, 1988 and 2000) and, where applicable, to the relevant comparison streams.

Sediment Capture in Project Diversions

The capture of sediment in Project diversion pools (Kaweah No. 1 and Kaweah No. 2 diversion pools) will be evaluated based on a review of existing sediment management information and data collected from field studies, as described below.

- Obtain information on sediment management practices implemented at Project diversions.
    - Summarize existing sediment management conducted by SCE Operations and Maintenance personnel.

  - o Obtain historic information, as available, pertaining to volume of sediments excavated and frequency of maintenance, for each facility.

- Determine the particle size composition of captured sediments using sub-surface bulk sampling and sieving/particle size analysis.

Identify Flows Necessary to Maintain Geomorphic Processes in Bypass River Reaches

Information regarding flows that are necessary to maintain geomorphic processes in the bypass reaches will be developed by comparing impaired and unimpaired hydrologic regimes and evaluating sediment transport conditions under different flow regimes in the bypass river reaches, as outlined below.

Compare Impaired and Unimpaired Hydrologic Regimes

- Compare impaired and unimpaired hydrologic regimes (high-flow magnitude, duration, and frequency) in bypass river reaches using methods outlined in Guidelines for determining flood flow frequency: Bulletin 17B of the Hydrology Subcommittee, Interagency Advisory Committee on Water Data (USGS 1982) and Flood Frequency Analyses, Manual of Hydrology (Dalrymple 1960).
  - o Determine unimpaired flood flow frequency from existing gaging records.

Evaluate Initiation of Sediment Transport Conditions under Different Flow Regimes at Selected Quantitative Study Sites

- Identify initiation of sediment transport flows at the geomorphic and riparian quantitative transects and instream flow transects using the hydraulic models developed for the AQ 1 – Instream Flow Technical Study Plan (TSP).
  - o Collect stage-discharge data at high flows at geomorphic and riparian transects in select reaches to calibrate the hydraulic model.
    - ▪ For purposes of the sediment transport assessment, the range of flows used for stage-discharge calibration will be extended into higher discharges than typically required for aquatic habitat instream flow modeling. Stage data (i.e., water surface elevations) will be collected either by field observations during high flows (e.g., flagging water surface elevation on the banks, or from pre-installed staff gages) or by installation of automated pressure transducers that provide continuous water depth measurements.
  - o Coordinate hydraulic modeling for sediment transport with the AQ 1 – Instream Flow TSP. The sediment transport modeling will be based on the hydraulic modeling described in the AQ 1 – Instream Flow TSP. The study sites on the bypass river reaches and comparison river reaches proposed for the AQ 1 – Instream Flow TSP will be evaluated for sediment transport conditions in this study (Table AQ 5-1).
  - o Derive channel hydraulic conditions, including flow depth, velocity, energy slope, and bed shear stress, from the models for a range of high flows.
    - ▪ Bed shear stress, which is calculated as a depth-slope product, will be obtained as an output from the AQ 1 – Instream Flow TSP modeling. Bed shear stress (τ) will be expressed as an average force (lbs/sq. ft.) over the transect width.

    - Determine the shear stress required to initiate motion for a given particle size from the Shield's criterion that defines the critical shear stress (τ^*_{ci}, the shear stress threshold at which incipient motion occurs). The bed shear stress obtained from the model and the Shield's criterion will be used to determine the particle sizes that are mobilized over the range of flows. Shield's relationship for critical shear stress is defined as, $\tau^*_{ci} = \beta (\gamma_s - \gamma) d_{50}$. Where: β = Shield's parameter (a dimensionless variable) γ, γ_s = specific weight of the fluid and sediment, respectively, and d_{50} = median particle diameter.
    - A range of commonly accepted values from the geomorphic and engineering literature will be documented and used for Shield's parameter (β). A range of critical shear stress and corresponding range of discharge values at which initiation of motion occurs for a given particle size will be presented.
  - Determine particle sizes in the channel from pebble counts performed for the Rosgen Level II channel classification, and/or bulk sediment samples, or from data collected as part of the AQ 1 – Instream Flow TSP.

<u>Identify Sources of Sediment and Document Project Related Erosion</u>

- The location and relative abundance of sediment recruitment to channels from hillslope mass-wasting and bank erosion processes in the bypass river reaches will be documented. Significant sediment recruitment, mass wasting, and/or bank erosion sites will be mapped via aerial reconnaissance, ground survey, and/or aerial photography.
- Historic and/or ongoing erosion resulting from spills at the Project forebays, existing canal and flume releases, or historic flume failures will be mapped via aerial reconnaissance, ground survey, and/or aerial photography.

SCHEDULE:

Date	Activity
November 2017–August 2018	Conduct sediment survey and hydrology analysis
September–October 2018	Complete data analysis
March–October 2018	Conduct sediment transport field surveys in coordination with instream flow surveys
November 2018–June 2019	Analyze data and prepare draft report
June 2019	Distribute draft report to the stakeholders
July–September 2019	Stakeholders review and provide comments on draft report (90 days)
October–December 2019	Resolve comments and prepare final report
December 2019	Distribute final report in Final License Application

REFERENCES:

Dalrymple, Tate. 1960. Flood frequency analyses, Manual of Hydrology: Part 3. U.S. Geological Survey Water Supply Paper 1543-A.

Hilton, Sue, and Thomas E. Lisle, 1993. Measuring the fraction of pool volume filled with fine sediment. Res. Note PSW-RN-414. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Kondolf, G.M. 1988. Salmonid spawning gravels: A geomorphic perspective on their size distribution, modification by spawning fish, and criteria for gravel quality. PhD thesis. Johns Hopkins University, Baltimore.

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McNeil, W.J. and W.H. Ahnell. 1960. Measurement of gravel composition of salmon stream beds. University of Washington Fish. Res. Inst. Circ. No.120.

U.S. Geological Survey (USGS). 1982. Guidelines for Determining Flood Flow Frequency: Bulletin 17B of the Hydrology Subcommittee, Interagency Advisory Committee on Water Data.

Wolman, M.G. 1954. A method of sampling coarse bed material. American Geophysical Union, Transactions, 35: 951-956.

TABLES

Table AQ 5-1. V*, Bulk Spawning Gravel, and Sediment Transport Hydraulic Model Locations.

River/Reach	Bypassed Reach	Reaches Upstream of Project Facilities or Comparison Reaches	Initiation of Motion Sediment Transport Modeling Site	Number of Bulk Spawning Gravel Samples	Number of V* Pools
Kaweah River					
Kaweah River Upstream of Kaweah No. 3 Powerhouse		●	Yes	4	10
Kaweah River Downstream of Kaweah No. 3 Powerhouse and Upstream of the East Fork Kaweah River Confluence	●		Yes	4	10
Kaweah River Downstream of East Fork Kaweah Confluence and Upstream of Kaweah No. 1 Powerhouse	●		Yes	4	5
Kaweah River Downstream of Kaweah No. 1 Powerhouse and Upstream of Kaweah No. 2 Powerhouse	●		Yes	4	5
Kaweah River Downstream of Kaweah No. 2 Powerhouse	●		Yes	4	10
East Fork Kaweah River					
East Fork Kaweah River Upstream of the Kaweah No. 1 Diversion		●	Yes	4	10
East Fork Kaweah River Downstream of the Kaweah No. 1 Diversion	●		Yes	4	5
East Fork Kaweah River Upstream of Confluence with Kaweah River	●		Yes	4	5

Table AQ 5-2. Geomorphology Study Detailed Site Information[1].

Geomorphic Reach	Site Name	River Mile Location of Site	UTM-Coords at Beginning of Site (Downstream River Mile) (Zone 10N, NAD83)	Number of						Comments
				Mesohabitats (Cross-sections)					Special Purpose Cross-sections	
				Total	HGR	LGR	RUN	POOL		
Kaweah River										
Kaweah River Upstream of Kaweah No. 3 Powerhouse	K9.5	9.5	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
Kaweah River Downstream of Kaweah No. 3 Powerhouse and Upstream of the East Fork Kaweah River Confluence	K8.7	8.7	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
Kaweah River Downstream of East Fork Kaweah Confluence and Upstream of Kaweah No. 1 Powerhouse	K7.3	7.3	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
Kaweah River Downstream of Kaweah No. 1 Powerhouse and Upstream of Kaweah No. 2 Powerhouse	K6.9	6.9	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
Kaweah River Downstream of Kaweah No. 2 Powerhouse	K4.3	4.3	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
East Fork Kaweah River										
East Fork Kaweah River Upstream of the Kaweah No. 1 Diversion	EFK5.2	5.2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
East Fork Kaweah River Downstream of the Kaweah No. 1 Diversion	EFK3.8	3.8	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
East Fork Kaweah River Upstream of Confluence with Kaweah River	EFK0.7	0.7	TBD	TBD	TBD	TBD	TBD	TBD	TBD	

[1]All information is tentative. Information to be determined in the field and completed in coordination with interested resource agencies.