GEO-1 EROSION AND SEDIMENTATION TECHNICAL MEMORANDUM

KERN RIVER NO. 3 HYDROELECTRIC PROJECT
FERC PROJECT NO. 2290

PREPARED FOR:

SOUTHERN CALIFORNIA EDISON®

Energy for What's Ahead®

KERNVILLE, CALIFORNIA

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LIST OF ACRONYMS AND ABBREVIATIONS

FERC	Federal Energy Regulatory Commission
GSD	ground sample distance
KR3	Kern River No. 3
LiDAR	Light Detection and Ranging
NAIP	National Agricultural Imagery Program
Project	Kern River No. 3 Hydroelectric Project (FERC Project No. 2290)
SCE	Southern California Edison

1.0 INTRODUCTION

This Technical Memorandum provides the methods and findings from reconnaissance-level desktop and field assessments of erosion and sedimentation associated with the *GEO-1 Erosion and Sedimentation Study Plan* in support of Southern California Edison's (SCE) Kern River No. 3 (KR3) Hydroelectric Project (Project) relicensing, Federal Energy Regulatory Commission (FERC) Project No. 2290. The GEO-1 Study Plan was included in SCE's Revised Study Plan (RSP) submitted on July 1, 2022 (SCE, 2022). In the October 12, 2022, Study Plan Determination (SPD) (FERC, 2022), FERC approved the GEO-1 Study Plan without modification.

During a desktop review from May to June 2023, aerial imagery, topographic data from 2008 to 2009 Light Detection and Ranging (LiDAR) imagery, and available operation and maintenance records were reviewed. A field survey was conducted from July 25 to 26, 2023, to document erosion from Project-related sources. All field sampling efforts and data analyses are complete and summarized below.

2.0 STUDY GOALS AND OBJECTIVES

The objectives of the study, as outlined in GEO-1 Erosion and Sedimentation (SCE, 2022), include the following:

- Reconnaissance-level inventory and assessment of erosion and sedimentation to identify the extent to which Project facilities—including structures—are contributing to erosion.
- Inform the assessment of potential effects of erosion and sedimentation caused by Project operations and/or run-off from Project-related facilities and/or other hard surfaces.

3.0 STUDY AREA AND STUDY SITES

The study area includes lands and waters within and adjacent to the FERC Project Boundary for the purposes of characterization and data collection relevant to understanding potential effects of Project operation and maintenance activities on erosion and sedimentation (Figure 3-1). Survey locations include the following areas and locations, which are shown on Figure 3-1:

- Project spillways, including KR3 Powerhouse Spillway and Cannell Creek Siphon and Spillway;
- KR3 Powerhouse and surrounding Project-related buildings, parking areas, and access road;
- Project diversions, including Fairview Dam, Salmon Creek Diversion Dam, and Corral Creek Diversion Dam;
- Fairview Dam Sandbox facility;
- Exposed sections of the KR3 Conveyance Flowline segments; and
- Project spoil piles sites.

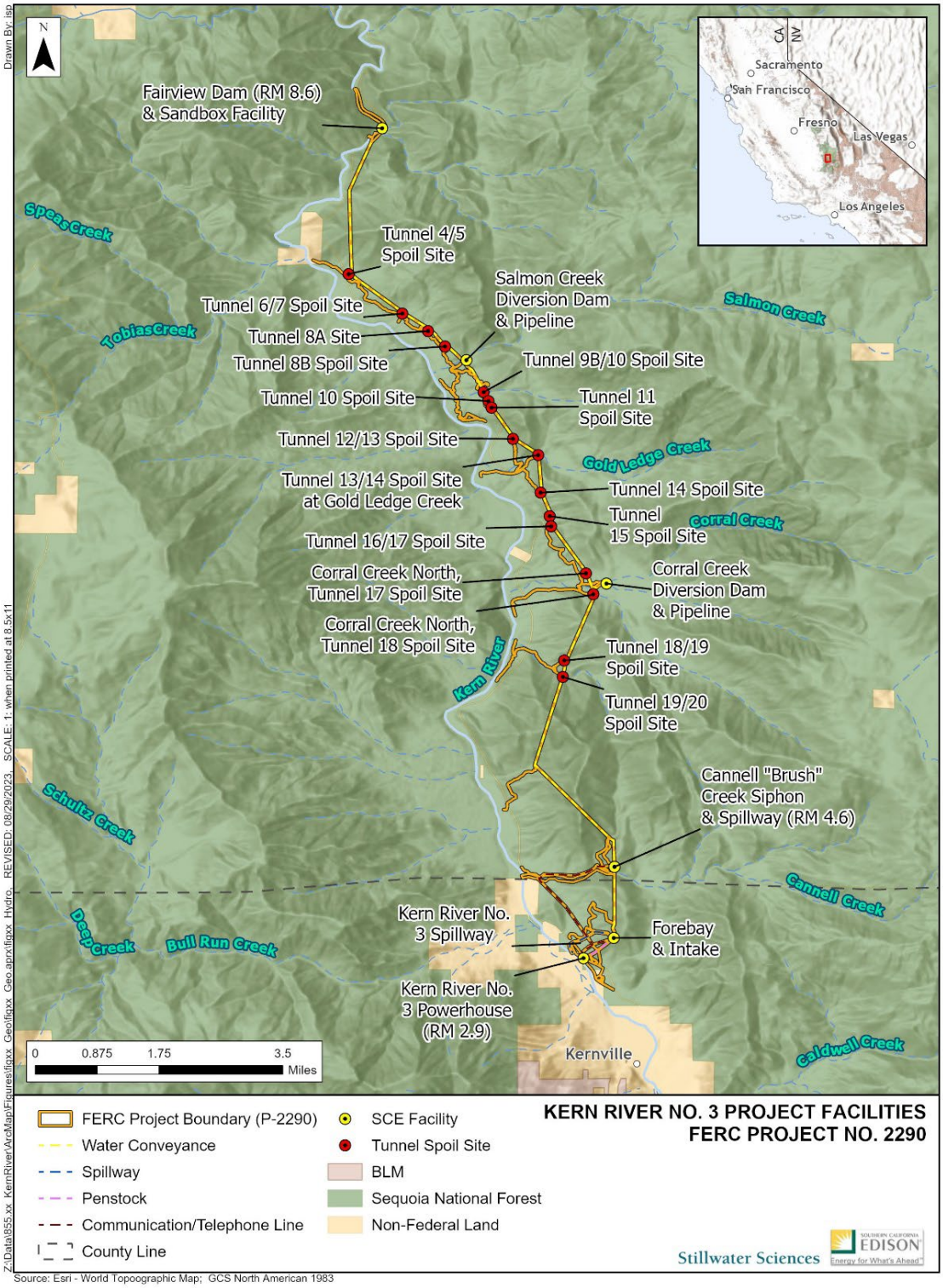

Figure 3-1. Erosion and Sedimentation Study Area.

4.0 METHODS

Study implementation followed the methods described in SCE's RSP Package (SCE, 2022), as amended by FERC in its SPD (FERC, 2022).

Study Plan Variances

There are no variances from the GEO-1 Study Plan, as amended by FERC in its SPD (FERC, 2022).

4.1. DESKTOP REVIEW AND GEOMORPHIC INTERPRETATION

Desktop reviews of maps, geological and soils data, hydrological records, and available construction operation and management records were conducted to provide information about potential locations, causes, and relative severity of erosion and sedimentation at Project facilities.

Topographic maps, digital aerial imagery, 2020 unmanned aerial vehicle imagery and videos, and 2008 to 2009 LiDAR data (USACE, 2019) were reviewed to provide the geomorphic context for the Project Area and to identify areas of past and active erosion in the vicinity of Project structures. Aerial imagery data included the following sources: (1) 2005 National Agricultural Imagery Program (NAIP) digital ortho(-graphic) imagery at 1-meter ground sample distance (GSD), (2) 2008 and 2014 Kern County digital ortho imagery at 0.33-meter GSD, and (3) 2022 NAIP digital ortho imagery at 0.6-meter GSD. Digital aerial imagery was downloaded from the U.S. Geological Survey Earth Explorer website.[1] Digitized historical single-frame aerial images were evaluated but were not available at adequate resolutions to make meaningful comparisons. The Google Earth historical imagery feature was also used to help determine the approximate timing of erosion and sedimentation events.

4.2. FIELD SURVEYS AND ANALYSIS

Field surveys were performed to document erosion from Project-related sources and the potential for sediment delivery to watercourses. Field methods were adapted from relevant guidance documents about erosion inventory and sediment control in California and the Pacific Northwest (CDFG, 2010; USFS, 2012; Weaver et al., 2014). Documentation of erosion condition at sites included (1) feature location mapped using submeter global navigation satellite system (GNSS), (2) photography of Project structures and conditions, (3) narrative description of erosion processes, (4) estimates of the volume of eroded material and delivery potential, and (5) estimates of historical erosion rates and potential future erosion. Erosion volumes were visually estimated or recorded with measurements of average dimension (length, width, depth) where appropriate.

Erosion and sedimentation conditions were assessed for each site based on data collected during field surveys. Sediment delivery volumes were estimated, and future erosion potential was categorized based on the potential for sediment delivery to streams

[1] Available at: https://earthexplorer.usgs.gov/. Accessed: June 2023.

or reservoirs. A geographic information system map was prepared to show the locations of all features identified during the inventory (Figure 3-1).

5.0 DATA SUMMARY

5.1. DESKTOP REVIEW AND GEOMORPHIC INTERPRETATION

The desktop review of existing topographic data and aerial imagery indicates erosion and sedimentation related to Project features are likely small scale and remained stable from 2005 to 2022, the period for which historical data were reviewed. Legacy spoil piles from drilling the KR3 Conveyance Flowline are visible in all photo sets and appear largely unchanged between 2005 to 2022. One notable exception is a failed road crossing and graded pad constructed from legacy spoils within an unnamed tributary channel where the Tunnel 9B/10 section daylights and crosses the channel (Figure 3-1). Based on historical imagery, the failure occurred sometime between April 2010 and April 2013 and continues to be a site of active erosion (Table 5.1-1).

The KR3 Powerhouse Forebay Spillway channel was identified as an area of concern for potential active erosion and sedimentation based on communication with Stakeholders. The KR3 Powerhouse Forebay Spillway channel is formed in native hillslope soils and colluvium from direct surface discharge released at the end of the KR3 Conveyance Flowline immediately before the flowline enters the KR3 Powerhouse penstock (Figure 3-1). Over time, water released into the spillway has carved a distinct channel through the hillslope colluvial mantle down to underlying bedrock (Figures A-56 to A-63). The channel averages 40 to 50 feet wide and 10 to 15 feet deep over the entire length of the spillway channel, based on LiDAR measurements. KR3 Powerhouse Forebay Spillway channel enters the Kern River floodplain approximately 1,300 feet upstream of the KR3 Powerhouse. The channel planform pattern and degree of incision appears largely unchanged from 2005 to 2022, based on aerial imagery analysis.

Similar to the KR3 Powerhouse Forebay Spillway channel, the Cannell Creek Siphon and Spillway discharges directly onto the hillslope and has channelized a watercourse through native material that has remained largely unchanged since 2005, based on aerial imagery analysis.

Table 5.1-1. Significant Sources of Erosion and Sedimentation at GEO-1 Study Sites

Site	Photographs (Appendix A)	Volume (CY)	% Delivery	Description
Fairview Dam Sandbox Facility [a]	A-1 to A-4	N/A	N/A	Significant erosion of (non-Project) Mountain Highway 99 road fill prism and basal area surrounding intake flume of the Fairview Dam Sandbox Facility occurred during significant March 2023 flood event as a result of failed culvert.
	A-5 to A-6	<1	100	Minor surface rilling and road fill prism failure at small access road leading to parking area located at the southwestern area of the Fairview Dam sandbox. See results from Appendix A, *Project and Shared Access Roads*, in the *LAND-1 Road Condition Assessment Interim Technical Memorandum* (Attachment R of this Initial Study Report).
Tunnel 6/7 Spoil Site	A-10 to A-13	3	60	Small failure located along the distal margin of the graded pad area of the Tunnel 6/7 Spoil Site caused by concentrated surface drainage (Figure A-13).
Tunnel 9B/10 Spoil Site	A-22 to A-25	N/A	N/A	Failed road crossing immediately downstream of an exposed section of Tunnel 9B/10 Spoil Site. Legacy material from tunnel excavation was likely placed directly in the watercourse and the road crossing was built with spoil material. Based on review of satellite imagery, the failure occurred sometime between April 2010 and April 2013. An unnamed tributary continues to erode the spoil material. See Section 5.5, Erosion Concerns and Impassable Road Sections, in the *LAND-1 Road Condition Assessment Interim Technical Memorandum* (Attachment R of this Initial Study Report).
Corral South Tunnel 18 Spoil Site	A-48 to A-49	1-2	100	Surface erosion and direct delivery of sediment to watercourse at Corral South Tunnel 18 Spoil Site. Legacy spoil pile placed directly within watercourse; subsequent channelization through legacy spoil pile develops steep banks and active erosion of the toe and spoil pile margins.
Tunnel 19/20 Spoil Site	A-52 to A-53	N/A	N/A	Legacy spoil material placed directly in watercourse where exposed tunnel section crosses unnamed drainage swale. Spoil material is actively being reworked and captured by run-off, and the disrupted surface drainage patterns are forcing run-off across road. A small gulley is forming within the inboard ditch of the access road (Figure A-53). See results from Appendix A, *Project and Shared Access Roads*, in the LAND-1 Interim Tech Memo).
KR3 Spillway Channel	A-56 to A-63	N/A	N/A	Spillway channel formed in native hillslope colluvial mantle. Majority of erosion and sedimentation occurred shortly after operations began in 1921 according to historical records. Spillway channel banks continue to actively erode but at low rates. Numerous knickpoints were observed but are generally stable.

Site	Photographs (Appendix A)	Volume (CY)	% Delivery	Description
KR3 Powerhouse	A-64 to A-68	1-2	100	Scour and bank erosion along KR3 Powerhouse retaining wall and access road. Large volumes of sediment and debris from March 2023 flood accumulated within Kern River floodplain and powerhouse maintenance storage yard.

CY = cubic yard; KR3 = Kern River No. 3; N/A= data not available

Notes:

[a] The western portion of Fairview Dam was inaccessible during the July 25 to 26, 2023, field surveys due to high flows in the North Fork Kern River; however, the western abutment is built into bedrock, and based on results of Task 1, there were no visible signs of erosion around the western abutment of the dam.

5.2. TASK 3: FIELD SURVEYS AND ANALYSIS

Field staff surveyed Project sites July 25 to 26, 2023, to document Project-related erosion and sedimentation conditions. Table 5.1-1 presents volume estimates and feature descriptions at sites where field staff observed more significant erosion and sedimentation. Appendix A presents an annotated photo log with field photographs for all GEO-1 Study sites visited.

6.0 STUDY SPECIFIC CONSULTATION

No study specific consultation is required for this study, and no consultation has been conducted to date.

7.0 OUTSTANDING STUDY PLAN ELEMENTS

All Study Plan elements have been completed as outlined in SCE's RSP (SCE, 2022) filing and FERC's SPD (FERC, 2022). No further work is currently planned for this study.

8.0 REFERENCES

CDFG (California Department of Fish and Game). 2010. *California Salmonid Stream Habitat Restoration Manual.* Fourth edition. Wildlife and Fisheries Division.

FERC (Federal Energy Regulatory Commission). 2022. *Study Plan Determination for the Kern River No. 3 Hydroelectric Project*. Accession No. 20221012-3024. October 12.

SCE (Southern California Edison). 2022. *Kern River No. 3 Hydroelectric Project, Revised Study Plan*. Filed with FERC on July 1. Accessed: August 2023. Retrieved from: sce.com/sites/default/files/custom-files/Webfiles/Revised_Study_Plan_KR3_20220701.pdf

USACE (U.S. Army Corps of Engineers). 2019. Kern Canyon Lidar Collection, CA 2008. Towill, Inc. Distributed by OpenTopography. Accessed: May 30, 2023. Retrieved from: https://doi.org/10.5069/G9X34VM8.

USFS (U.S. Forest Service). 2012. "National Best Management Practices for Water Quality Management on National Forest System Lands (FS-990a)." Volume 1: *National Core BMP Technical Guide*. April 2012. Accessed: September 2023. Retrieved from: https://www.fs.usda.gov/sites/default/files/FS_National_Core_BMPs_April2012_sb.pdf.

Weaver, W., E. Weppner, and D. Hagens. 2015. *Handbook for Forest, Ranch, and Rural Roads.* Prepared for the Mendocino County Resource Conservation District.

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APPENDIX A
GEO-1 FIELD SURVEY ANNOTATED PHOTO LOG

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Figure A-1. Erosion of (non-Project) Mountain Highway 99 at Fairview Dam Sandbox Facility initiated by failed culvert crossing (view looking upstream).

Figure A-2. Erosion of (non-Project) Mountain Highway 99 at Fairview Dam Sandbox Facility initiated by failed culvert crossing (view looking downstream).

Figure A-3. Close-up view of erosion and debris along inboard edge of Fairview Dam Sandbox Facility near the failed (non-Project) Mountain Highway 99 culvert location.

Figure A-4. Erosion and debris near access gate to Fairview Dam Sandbox Facility.

Figure A-5. Minor surface rilling and road fill prism failure cut into access road to Fairview Dam Sandbox Facility (view looking upslope).

Figure A-6. Minor surface rilling and road fill prism failure cut into access road to Fairview Dam Sandbox Facility (view looking toward river channel, behind vegetation).

Figure A-7. Historical tunnel spoil material placed in drainage swale at Tunnel 4/5 Spoil Site (view looking into channel from downstream margin of spoil pile).

Figure A-8. Minor surface rilling cut into native decomposed granite hillslope at Tunnel 4/5 Spoil Site. Material potentially historical tunnel spoil material; sediment delivery captured by Tunnels 5-8A Access Road and spoil pile pad.

Figure A-9. Adjacent view to Figure A-8 image of minor surface rilling.

Figure A-10. Tunnel 6/7 Spoil Site showing exposed tunnel section built through drainage swale; upslope side filled to top of tunnel with sediment (view looking upslope from below tunnel).

Figure A-11. Tunnel 6/7 Spoil Site showing exposed tunnel section built through drainage swale; upslope side filled to top of tunnel with sediment (view looking downslope from above tunnel).

Figure A-12. Minor surface erosion at exposed tunnel section from disrupted drainage patterns.

Figure A-13. Small failure in outboard edge of spoil pile fill pad at Tunnel 6/7 Spoil Pile Site; erosional feature located near the farthest downstream edge of spoil pile.

Figure A-14. Sediment and debris accumulation at Tunnel 8A Site (view looking up drainage channel from road crossing).

Figure A-15. Recently replaced culvert at Tunnel 8A Site (view looking downstream). Figure A-14 Image photographed from center of road (see witness post for reference).

Figure A-16. Tunnel 8B Spoil Pile Site showing stable spoil pile pad surface.

Figure A-17. Downslope margin of tunnel 8B spoil pile.

Figure A-18. Downstream side of Salmon Creek Diversion Dam with coarse colluvium from minor rockfall erosion along Left (south) channel margin (view looking upstream).

Figure A-19. Upstream side of Salmon Creek Diversion Dam with sand and debris accumulation above Diversion intake structure (view from right bank toward left bank, north to south).

Figure A-20. Right Bank (north side) immediately downstream of the exposed flume crossing at Salmon Creek with little-to-no active erosion in historical spoil material.

Figure A-20. Left bank (south side) immediately downstream of the exposed flume crossing at Salmon Creek with little-to-no active erosion in historical spoil material.

Figure A-22. Failed road crossing at Tunnel 9B/10 Spoil Site (view looking upstream from historical road–stream crossing location).

Figure A-23. Failed road crossing at Tunnel 9B/10 Spoil Site (view looking across channel at right bank [north side]).

Figure A-24. Failed road crossing at Tunnel 9B/10 Spoil Site (view looking across channel at left bank [south side]).

Figure A-25. Close-up view of failed road Crossing at Tunnel 9B/10 Spoil Site (view looking across channel at left bank [south side]).

Figure A-26. Overview of Tunnel 10 Spoil Site (view looking downstream from top of exposed tunnel section).

Figure A-27. Access road cut through historical coarse spoil pile material at Tunnel 10 Spoil Site (view looking upstream from left bank [south side]). Small section of exposed tunnel visible (circled in yellow), near location of Figure A-26 Image.

Figure A-28. Small gully formed in road-cut embankment in historical spoil pile at Tunnel 10 Spoil Site; sediment delivered to road surface.

Figure A-29. Minor rilling cut into road surface at Tunnel 10 Spoil Site.

Figure A-30. Tunnel 11 Spoil Site with minor surface erosion along outboard edge of roadbed built on spoil pile pad (view looking upslope).

Figure A-31. Coarse Tunnel 11 spoil material with stable spoil edge with Little-to-no active erosion of spoil pile (view looking downslope).

Figure A-32 Outer edge of Tunnel 12/13 Spoil Site with little-to-no active erosion (view looking downslope with Kern River in foreground).

Figure A-33. Close-up view of access road built on top of Tunnel 12/13 spoil material (Figure A-32 image immediately adjacent to right side of Figure A-33 image).

Figure A-34. Access road built on Tunnel 13/14 Spoil Site at Gold Ledge Creek (view looking upstream and showing left bank [south side] of spoil material).

Figure A-35. Spoil Material Exposed along right bank (north side) of Gold Ledge Creek at Tunnel 13/14 Spoil Site; low-to-moderate erosion activity accelerated by cattle crossing trails down embankment (view looking across creek).

Figure A-36. Moderate erosion of coarse spoil material placed in steep drainage swale at Tunnel 14 Spoil Site; sediment delivered directly to watercourse.

Figure A-37. Close-up view of erosion into Tunnel 14 spoil material.

Figure A-38. Tunnel 15 Spoil Site (view looking upslope from access road).

Figure A-39. Stable outboard edge of Tunnel 15 spoil pile with little-to-no active erosion; Kern River visible in background (view looking downslope).

Figure A-40. Spoil material and access road at Tunnel 16/17 Spoil Site with little-to-no active erosion.

Figure A-41. Spoil material and access road at Tunnel 16/17 Spoil Site (view from immediately adjacent to right side of Figure A-40).

Figure A-42. Spoil material and large pad at Corral North Tunnel 17 Spoil Site. Aggregate stockpile adjacent to exposed tunnel structure in foreground likely imported material for road maintenance.

Figure A-43. Coarse spoil material at Corral North Tunnel 17 Spoil Site, located at head of broad, low-gradient upland valley swale, little-to-no active erosion.

Figure A-44. Concrete footings of elevated flume with minor erosion and sedimentation at Corral Creek crossing.

Figure A-45. Gunite erosion control/bank stabilization along upstream edge of Corral Creek crossing flume.

Figure A-46. Minor sand and debris accumulation on the upstream face of Corral Creek Diversion Dam.

Figure A-47. Small gully erosion along Corral Creek Diversion Tunnel, approximately 300 feet upslope of point where diversion empties into exposed tunnel structure.

Figure A-48. Moderate erosion of left bank (south side) of Corral South Tunnel 18 Spoil Site; sediment delivered directly to the watercourse.

Figure A-49. Additional view of moderate erosion along left bank (south side) of Corral South Tunnel 18 Spoil Site (view immediately adjacent to left of Figure A-48 image).

Figure A-50. Tunnel 18/19 Spoil Site with moderate surface erosion of spoil caused by disrupted surface drainage patterns from exposed tunnel section (view from downstream).

Figure A-51. Semi-active erosion of Tunnel 18/19 Spoil Site along watercourse margin; exposed tunnel section that disrupts surface drainage pattern visible in background behind vehicle (view upstream).

Figure A-52. Spoil material and debris at Tunnel 19/20 Spoil Site with moderate erosion of spoil material on both margins of watercourse.

Figure A-53. Active erosion of inboard ditch along access road to Tunnel 19/20 Spoil Site.

Figure A-54. Cannel Creek Siphon Spillway (view looking downslope).

Figure A-55. Cannel Creek Siphon Spillway Channel (view looking upslope).

Figure A-56. KR3 Powerhouse Forebay Spillway channel with incision in bedrock and vertical/overhanging banks.

Figure A-57 Tension crack in vertical/overhanging bank of KR3 Powerhouse Forebay Spillway channel (tension crack located at the bottom edge of Figure A-57 image).

Figure A-58. Knickpoint in KR3 Powerhouse Forebay Spillway channel; few loose or separated blocks in knickpoint face indicate relatively stable feature.

Figure A-59. Second knickpoint in KR3 Powerhouse Forebay Spillway channel.

Figure A-60. Top of KR3 Powerhouse Forebay Spillway channel (looking downstream; location of knickpoint in Figure A-59 image indicated by yellow circle).

Figure A-61. KR3 Powerhouse Forebay Spillway channel where it empties into the Kern River floodplain (looking downstream).

Figure A-62. KR3 Powerhouse Forebay Spillway channel where it empties into the Kern River floodplain (looking upstream).

Figure A-63. KR3 Powerhouse Forebay Spillway channel where it empties into the Kern River floodplain (looking upstream).

Figure A-64. Small berm constructed of sediment and debris from the March 2023 flood event deposited at the KR3 Powerhouse maintenance yard.

Figure A-65. Scour along base of retaining wall at KR3 Powerhouse access gate.

Figure A-66. Potential erosion of road prism fill near KR3 Powerhouse access road and gate.

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