Case Study 21. Capps Low-Water Bridge

Location

North central California. El Dorado National Forest, Placerville Ranger District. North Fork Cosumnes River. Meiss Cabin Road, Primary Forest Route 52.

Crossing Description

This low-water bridge was constructed in 1998 as an Emergency Relief for Federally Owned Roads (ERFO) project (figure A132). It replaced a vented concrete slab ford that plugged and caused substantial channel and flood plain damage during the 1997 flood. Because the old ford blocked sediment transport during high flows, it had caused dramatic channel aggradation and flood plain erosion. To reestablish channel stability at the site, the designers decided to bridge the entire flood plain, and to provide for overflow in case of debris jamming. The bridge has 13 concrete piers set on bedrock and the deck is square steel tubing with two smooth steel plate runways.

Figure A132. Looking downstream at the Capps low-water bridge. July 2002.

Setting

Sierra Nevada Section (M261-E). Rocks are mixed granitic, volcanic, and metasedimentary. Ponderosa pine and mixed conifer forest. Riparian vegetation includes cottonwood, alder, willow, dogwood, and cedar.

Why Was This Structure Selected?

The forest considered relocating the road, but nearby archeological resources and private property eliminated relocation as a feasible alternative.

This crossing structure was expected to accomplish the following objectives.

- Remove the sediment transport blockage associated with the old crossing structure and allow stream processes to restore a more nearly natural channel size, shape, and substrate.
- Provide room for the channel to migrate within the flood-prone area.
- Provide passage for aquatic organisms.
- Reduce the need for maintenance.

Crossing Site History

Historically, this road was a stagecoach route across the Sierra divide. It forded the North Fork Cosumnes River at this location, and probably widened the channel by breaking the banks down. Sediment deposited in the widened channel and flood flows were diverted across the rutted flood plain. With time, the flood plain progressively lowered in elevation as floods washed more material away.

Subsequent ford improvements did not solve the problem. The structure that existed prior to the 1997 flood of record was a concrete slab with an 8-foot-wide concrete box culvert, which filled with bed material and needed annual cleaning even during normal years. During floods, the ford plugged and flow spread over the flood plain, eroding and changing channel location, and washing out the road approaches. To reopen the road after floods, onsite stream-deposited material was routinely heaped up into a turnpike across the eroded flood plain, topped with an aggregate base, and either paved or oiled. This practice, combined with erosion during floods, explains why the flood-plain surface at the crossing site is several feet lower than in adjacent sections upstream and downstream of the site. Because of the widened section, sediment deposition was a serious problem, and the channel became so embedded it seemed to be paved. The vented ford washed out in 1997, during the flood of record (figure A133).

Figure A133. Capps ford after the 1997 flood. Flood flows spread out across the entire valley and road is washed out on far side.

Road Management Objectives

Forest Route 52 is maintained for passenger cars (maintenance level 3), and is used for recreation, timber haul, administrative access, and access to private land. Occasional closures due to severe weather are acceptable, but dependable summer seasonal access is required. There is little or no winter use.

Stream Environment

Hydrology: Large floods occur on the North Fork Cosumnes River during rain-on-snow events. The approximately 15 square mile watershed was mined in California's gold rush days, and early roads followed the intermittent streams up each tributary draw. (Crossing structures on these tributaries are described in case study 13.) Current roads are located on both sides of many of these draws, and are in only moderate condition. Loose bed material is readily available to all these streams because of these disturbances, and when flows rise, bedload transport can be very high. Blocking sediment transport with a ford is a particularly bad idea in this system.

Channel Description: At the crossing site, the channel is best described as a Rosgen C3 because of channel widening and flood plain modifications due to the crossing. It is a B3 or B4 upstream and downstream (figure A134), with some bedrock-controlled sections. Bankfull width is between 20 and 30 feet. The low terrace adjacent to the natural sections of the river has been lost at the crossing site, and the bridge crosses a 300-foot flood plain that is about 2 to 3 feet lower than the ground adjacent to the stream elsewhere. Even in undisturbed upstream reaches, abandoned channels and side channels are evident across the valley bottom. Clearly the stream is dynamic and prone to shifting across the valley floor.

Figure A134. Downstream view of Capps bridge showing cobble bars and debris in channel.

Because the previous structure obstructed sediment transport, bed material at the site was much finer than in up- and downstream reaches. Cobble-embeddedness was very high. The new structure has allowed fines to migrate through, opening up the cobble bed again, and improving fish habitat.

Aquatic Organisms: This structure provides passage for all species, at all life stages. By providing for free downstream transport of bed material and wood, the structure is also working to maintain downstream and onsite stream habitats. Foothill yellow-legged frogs, tree frogs, western pond turtles, and trout are among the aquatic species that are likely to use these habitats.

Water Quality: This structure was designed to restore channel functions and it helps maintain good water quality by reducing channel and bank erosion.

Structure Details

Structure: The Capps low water bridge is 224 feet long, with 13 piers spaced on 16-foot centers. The piers are up to 12 feet deep to reach

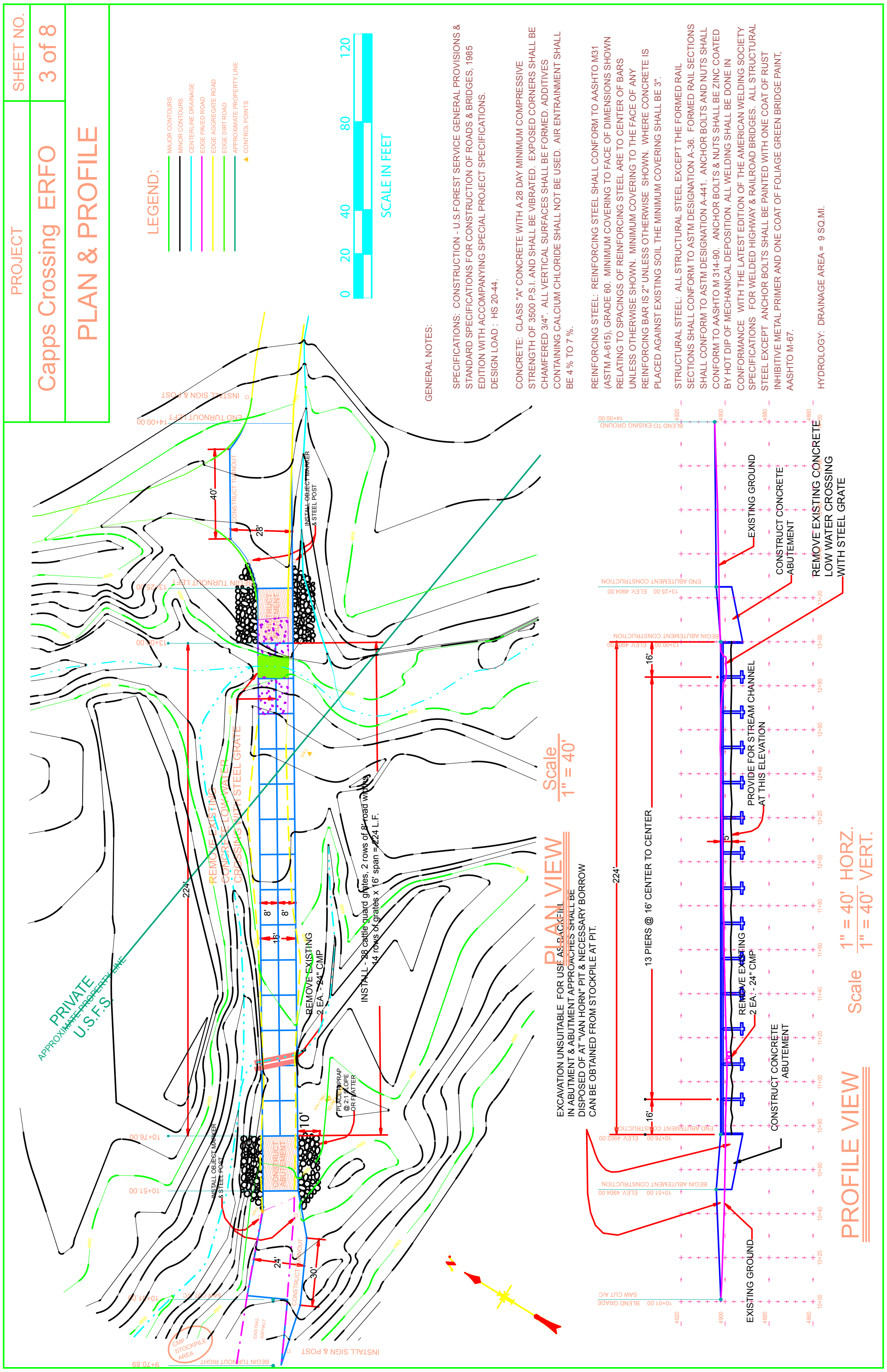


Figure A135—Site plan and cross section for Capps Crossing replacement project. A full size drawing may be found on the CD included in the back of this publication.

bedrock. The deck consists of 16-foot-long sections of box iron grating 16 feet wide. Steel beams support the rectangular steel tube decking. The 25-foot-long concrete abutments slope down to the deck at 8 percent (figure A135).

Bank stabilization and approaches: Riprap placed at the two abutments provides protection against scouring. Near the abutment in the active channel, large long rocks were placed at an angle to help turn flow toward the middle of the stream, away from the abutment and banks. Other than the riprap, the banks will be allowed to stabilize naturally.

Cost: $300,000 in 1997.

Safety: Early cold weather in this area makes icing a hazard while the road is still open. Wooden guard rails were added to keep vehicles from sliding off the roadway (figure A136). Safety signing is limited to type III object markers on the ends of the bridge.

Flood and Maintenance History

On January 1 2006, the bridge underwent a flood estimated to have an 85-year return interval. Large amounts of debris were caught under and on the bridge, and sediment accumulated around the structure as a result. Perhaps due to sediment accumulation upstream of the bridge during the flood, flow spread over the entire flood plain and has concentrated into two principal channels, one on either side of the flood plain. Maintenance work will include debris removal and in-channel work to confine low-flow to a single channel and remove some sediment deposits.

Figure A136. Note concrete abutment with riprap, grating with tire runways, and wood curbs.

Summary and Recommendations

This site presents challenges for crossing structures because historic disturbances in the drainage—combined with recent floods—mean that very large amounts of boulder and cobble-sized material are available for transport during high flows. The bridge is an appropriate structure type for this disturbed site because it minimizes interruption of sediment and debris transport and should permit the channel to stabilize over time.

This low-water bridge is a solid heavy duty structure that is expected to sustain flooding well. In retrospect, forest personnel believe it would have been advisable to space the piers at a distance equivalent to the current active channel width to minimize the potential to block floating wood debris.

Ken Pence, engineering technician (retired); Cheryl Mulder, zone hydrologist; David Jones, engineer; and Richard Adams, facilities engineer from the Eldorado National Forest provided information for this case study.

Similar Structures In Other Locations

The Eldorado National Forest had experience with low-water bridges before constructing one at the Capps crossing in 1997. A very similar structure has been in existence since 1971 where the Jones Wreckum road crosses Jones Fork of Silver Creek. Originally, the crossing was probably an unimproved ford. It accesses private property.

The site is at about the same elevation as Capps, and has a similar runoff regime. According to Steve Brink, the designer, flow at this site fluctuates from 15 feet wide and 1-foot deep to 180 feet wide and 5-foot deep (Brink 1974, 2000). Crossing objectives were to support log haul and recreation, provide for free fish passage during low flows, protect good trout spawning habitat up- and downstream, and avoid flow obstructions that might cause channel shift. This bridge was designed to pass 80 percent of the estimated 100-year flow under the deck. It was overtopped the first winter without damage or any need for maintenance. It has since been overtopped at least three times, and the only maintenance on record is removal of woody debris.

The bridge rests on 10 concrete spread footings placed 5 feet below the streambed surface. The approach slabs have cutoff walls 5 feet below the streambed and were riprapped. The deck consists of twenty 8-foot by 16-foot cattleguards.

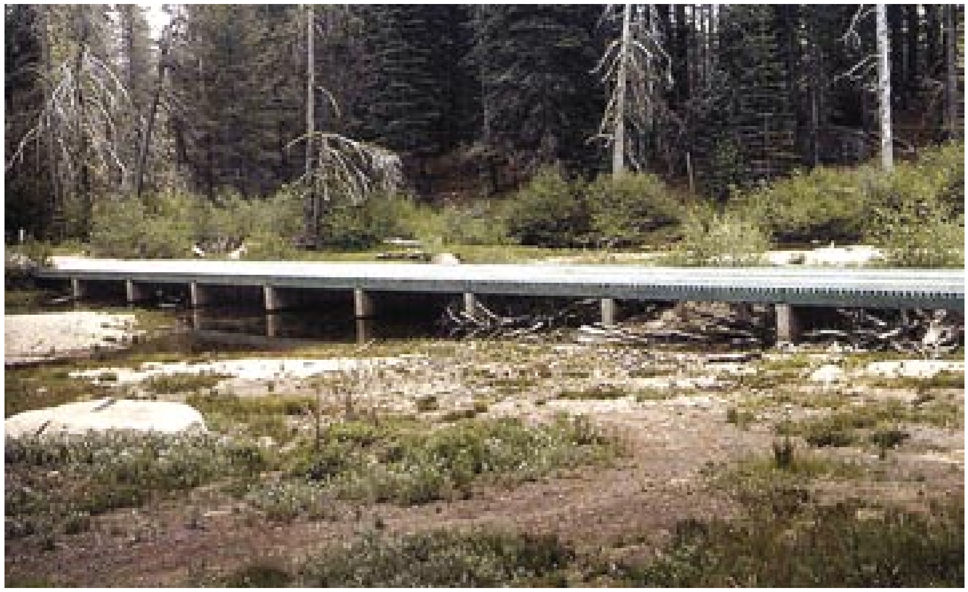
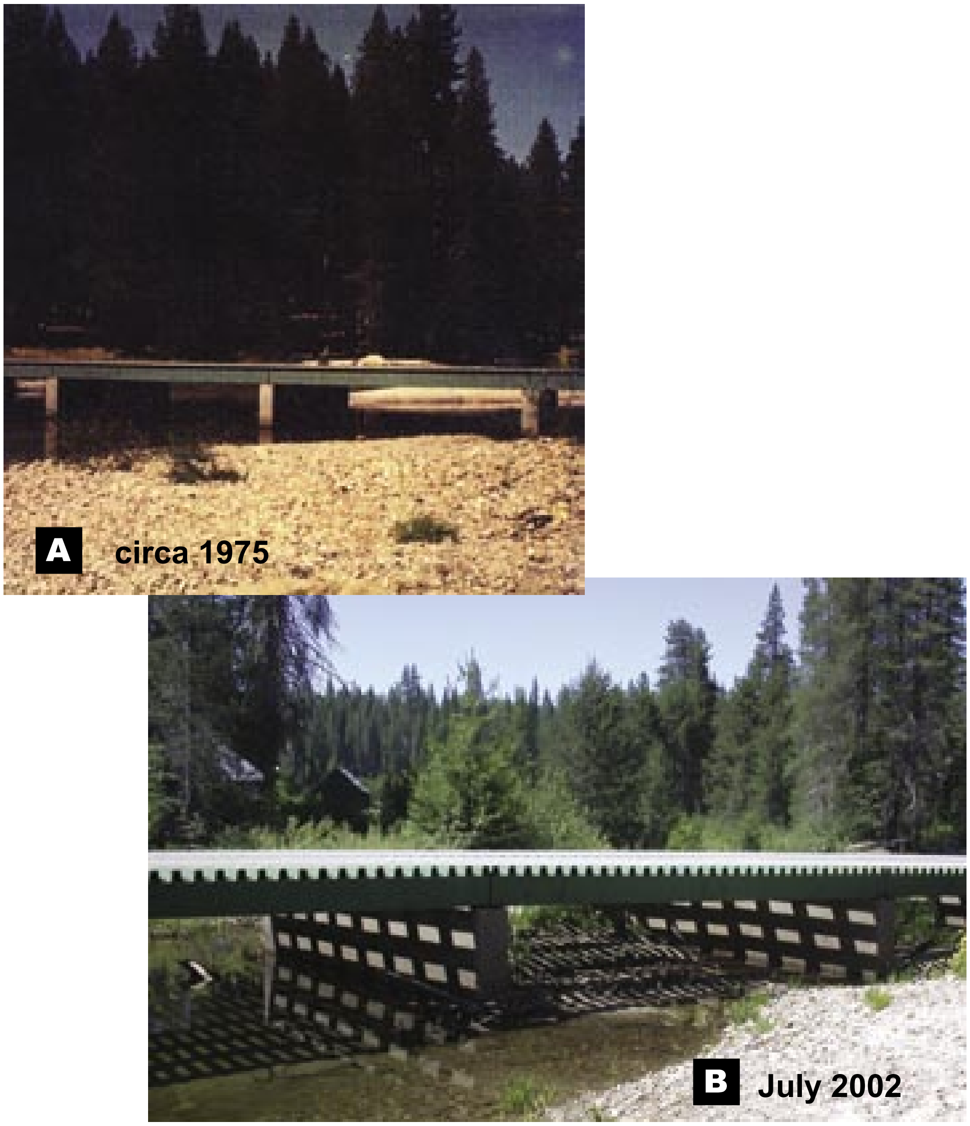


Figure A137. Looking downstream at Capps bridge with debris trapped under deck, 1988.

This reach is flatter than Capps, bed material is finer (coarse gravels about 1 to 1½ inch), and the channel appears to be more stable. The bridge is located just upstream of a right-angle bend in the river and crosses the point bar leaving enough space for natural adjustments in sediment storage. Woody debris trapped under the bridge on the point bar side has not been removed, and has contributed to sediment accumulation (figure A137). Both upstream and downstream bars have enlarged since the 1970s (figures A138a, A138b). Nonetheless, comparing current channel conditions to Brink's 1974 description, the channel does not seem to have changed much, indicating that the stream is functioning naturally and is stable. None of the pier footings are exposed.



Figures A138a and A138b. Looking downstream at the Jones Wreckum Bridge. A138a. Bridge inspection photo.