Case Study 12. Grubbs Concrete Slab Vented Ford

Location

North central California. Plumas National Forest. Mount Hough Ranger District. Grizzly Creek. 3 miles west of Bucks Lake, CA. Forest Road 23N92Y, just off the Oroville-Quincy Highway (FH119).

Crossing Description

This partially vented ford is a massive concrete slab that was constructed in 1986 on a 55-foot-wide high-energy perennial stream. The channel is not steep at this site (approximately 2 percent), but it is immediately downstream of steeper, unstable terrain, and it moves boulders up to about 1½ feet in diameter during floods. The ford consists of a 65-foot long reinforced concrete slab about 1-foot above channel grade with one opening for fish passage: an embedded 3-foot-wide concrete-walled box covered with a cattleguard grating (figure A73). The opening frequently plugs with debris and boulders, and upstream fish passage is questionable most of the time. The downstream edge of the structure is protected against scour with gabions. The structure withstood the major 1996 flood with no damage.

Figure A73. Grubbs crossing on Grizzly Creek, May 2002.

Setting

Sierra Nevada Section (M261-E). Northern end of the Sierra Nevada in granitic and strongly metamorphosed volcanic and sedimentary rocks. Elevation 4,950 feet. Vegetation is Douglas fir-mixed conifer, with willow, cottonwood, and alder along the creek.

Appendix A—Case Study 12

Why Was This Structure Selected?

A slab ford with vent was selected at this site for three main reasons: stream power and bedload movement are high during storm events, and the previous structure was not strong enough; fish passage is a concern; and the crossing receives little use. The site's broad, shallow profile makes it a good location for a ford.

Crossing Site History

The previous crossing structure was a vented ford constructed in 1984 to provide access across the stream during a timber sale. It was a gabion-type structure fabricated from surplus pieces of welded wire from a retaining wall, and had two corrugated metal pipes as vents. It was too weak for the dynamic forces of the stream at this site, and was destroyed in 1986 (figure A74).

Figures A74a and b. The original gabion vented ford. (a) as built and (b) after the 1986 storm.

Road Management Objectives

This road accesses a block of private land and a small piece of USDA Forest Service land, and is closed with a gate on the far side of the crossing. Use is a mix of occasional logging traffic during a timber sale, USDA Forest Service administrative traffic, and some private use. The road is native surfaced and is maintained for commercial vehicles (maintenance level 2).The typical annual average daily traffic count is 0, although during a timber sale, average daily traffic can be 20 to 50.

The structure is inundated for several weeks during annual spring peak flows. During the season of use (summer to fall), traffic interruptions are expected one or two times per year, for approximately 12 to 48 hours.

Stream Environment

Hydrology: Grizzly Creek is a perennial tributary of the North Fork of the Feather River that drains about 5 square miles. Average annual precipitation is 75 to 80 inches. Winter snow is generally heavy in this area and spring runoff peaks early and moves large (up to 18-inch) boulders. Grizzly Creek is spring-fed in its alpine headwaters and has a strong base flow. Summer low flows are on the order of 30 cubic feet per second. The design storm flow (Q_{100}) is estimated at 1,900 cubic feet per second. Flood debris deposited on the crossing slab showed that the most recent 100-year flood (1997) totally inundated the entire channel several feet deep (figure A78). Peak flow velocities were estimated at 8 to 10 feet per second.

Channel Description: At the site, channel slope is 2 to 2½ percent, and the substrate is a well-graded mixture of gravels, cobbles, and boulders to a maximum size of about 18 inches. The bankfull channel is about 55 feet wide, and is slightly entrenched (figure A75). Streambanks are fairly stable, and riparian vegetation includes willow, alder, fir, and cottonwood.

Figure A75. Grizzly Creek downstream of the ford, May 2002.

Aquatic Organisms: This section of stream provides habitat for nonthreatened rainbow trout, as well as nongame fish. Fish passage is a key issue at this location, but little is known about how successfully fish move across the structure. Accelerated water velocities across the smooth concrete probably inhibit fish moving upstream and the vent is normally plugged. Young fish have been seen moving downstream across the slab.

Water Quality: Water quality in the stream is naturally excellent and maintaining it is an important objective. This massive concrete structure is a good structure type for water quality protection, because it does not chronically contribute sediment to the stream, and it can sustain the largest floods without failing.

Structure Details

Structure: This structure was designed and rebuilt by the Plumas National Forest under a public works contract as part of the 1986 storm damage repair program. Two concrete "boxes" were poured, each 30 feet long by 14 feet wide, with a 4-foot-deep cutoff wall extending across the entire channel, tying the two boxes together. The core was backfilled with gravel and an 8-inch-thick concrete slab was poured to form the driving surface on both sides.

Between the two concrete boxes, a 3-foot-wide embedded box culvert was constructed for fish passage (figure A76). A steel Irvine Type "HV" bridge decking with welded metal grating bridges the box to connect the driving surfaces.

Figure A76. A 3-foot wide gap left between the two sides of the ford forms a narrow concrete-floored vent.

The project took approximately 3 months to construct and required a total of 42 cubic yards of reinforced concrete and 35 cubic yards of gabions.

Bank and bed stabilization and approaches: The ford slopes into the channel at 7 to 9 percent (figure A77). Four-foot-deep concrete cutoff walls were constructed along both edges of the roadway for scour prevention. The downstream edge was also armored with two rows of gabions. The upper row sits on a concrete sill attached to the wall of the structure, and the lower row sits directly on the streambed.

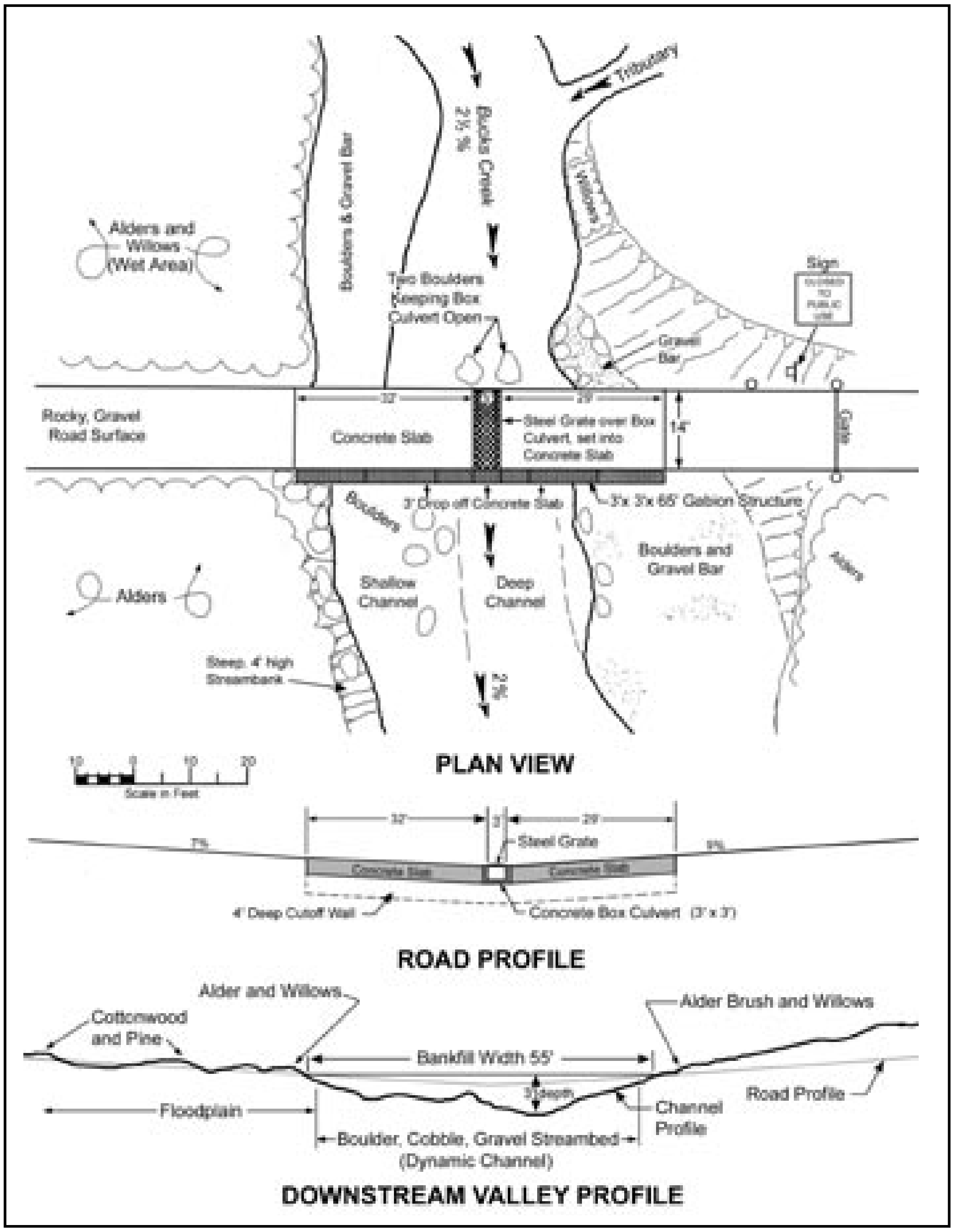

Figure A77. Site plan view and cross-section sketch.

Cost: Total new construction cost in 1987 was $44,500.

Safety: The structure has no safety measures other than object markers at each end of the ford. The ford sees limited use most of the time, and because the driving surface is close to the streambed, safety concerns are minimal. The ford is on a straight section of the road and the water depth is relatively easy to see.

Flood and Maintenance History

This massive reinforced concrete structure survived the major 1997 flood event with no damage (figure A78). Minor maintenance is frequently required to remove rocks and boulders off the slab and from the concrete box. Boulders moving in the channel during high flows are not much smaller than the box width, and in conjunction with small debris they tend to keep the box plugged most of the time. Some of the downstream gabions will need replacement soon due to damage and abrasion of the wire.

Figure A78. After a major storm, medium and large boulders and large root wads cover the ford, but the structure is undamaged.

Summary and Recommendations

The Grubbs low-water crossing is a relatively massive concrete structure capable of withstanding major storm flows and major bedload movement (figure A79). This type of structure is necessary for a ford in a very dynamic stream environment. There has been little downstream scour, probably due to coarse streambed material. However, the entire structure should be lowered approximately 1 foot to conform more closely to the channel bottom elevation. Also, the embedded box intended for fish passage is too narrow given the size of the bed load moving in the channel; it plugs frequently, and requires maintenance to clean the vent. After 20 years, the gabions are worn and need repair.

Figure A79. Grubbs ford immediately after construction in 1986. The vent appears to be a velocity barrier when it is not plugged.

This high stream power, high-value fishery site is a very difficult location for a low-water crossing. Any structure here will have to sustain high floods transporting large boulders, and it should pass fish and other aquatic organisms most of the year. Both objectives could be accomplished using a high-VAR ford with embedded concrete boxes approximating the bankfull channel width.

Gordon Keller, geotechnical engineer on the Plumas National Forest, provided information and photos for this case study.