Case Study 2: Twenty-mile Creek Rock Fords

Location

Washington. Okanagan National Forest. Methow Valley Ranger District. Chewuch river basin, East Chewuch Road.

Crossing Description

The Twenty-mile Creek alluvial fan is a very active depositional zone at the edge of the main Chewuch River valley. In addition to the main channel descending the fan, there are several distributary channels, which are expected to move around frequently. The East Chewuch Road crosses all these channels on the lower part of the fan. The hardened rock fords on distributary channels are inexpensive, low maintenance, and easy to replace if the channels do move. These channels lead to spawning habitat for steelhead at the fan head, and fish have been observed successfully passing on their way upstream. The fords approximate natural channel size and shape and have not required major maintenance since construction in 1999. An old concrete vented ford, believed to block adult steelhead, crosses the main channel.

Figure A4. Hardened rock ford on East Chewuch Road.

Setting

Eastern Cascades (M242-C). Continentally glaciated mountains with steep canyons that end in alluvial fans as they enter the flatter valleys or the larger rivers. Silver fir and Douglas fir communities.

Appendix A—Case Study 2

Why Was This Structure Selected?

The dynamic conditions of this alluvial fan site require structures that are easily maintained and inexpensive to replace. Downstream water quality is protected better by a crossing that can pass large debris and rocks than by a culvert prone to plugging. The structure conforms to channel shape and slope, permitting the channel to maintain its natural form and function. The structures allow fish passage during the spawning migration.

Crossing Site History

The original structure in the main fan channel was an 8-foot culvert that was washed downstream in a 1972 flood. At that time, the fan was functioning normally, and bedload and debris deposition at the fanhead frequently caused the main flow to shift location, such that the crossing was at times useless. After the washout, the main channel was straightened and leveed to avoid overflows and to fix the channel in place (figure A5), and the crossing was replaced with a vented ford. The channel modification increased water velocity and the pipe on the ford plugged (figure A6) causing water to divert down the road (figure A7). The modification also impaired the natural water and sediment storage functions of the fan, causing more rapid water and sediment delivery to the Chewuch River during floods. This contributed to a reduction in water quality and, possibly, quantity during low summer flow, which is critical for downstream irrigation and fish habitat.

Figure A5—Twenty-mile creek was channelized near the top of the alluvial fan. Note levee at right of photo.

To reduce sediment input to the Chewuch, and to increase water storage on the fan, the district in cooperation with the Pacific Watershed Institute undertook a channel restoration project in 1999. The levees were breached, and flow was allowed to disperse into several distributary channels down the fan, more closely simulating natural flow patterns. To permit fish passage up the secondary channels, culverts were replaced with the hardened fords described here.

Figure A6—Vented ford plugged with boulders.

Figure A7—Plugged culvert causes water diversion down road before construction of rock fords.

Appendix A—Case Study 2

Road Management Objectives

East Chewuch Road has an aggregate surface and is used principally for hunting, dispersed camping, and recreational driving as part of a recreational loop road. It is gated during spring runoff when the steelhead are migrating. The road is maintained for high-clearance vehicles that can negotiate the moderately steep approaches to the low-water crossings and the large riprap in the bottom of the fords. Constructing the dips resulted in a change of design vehicle from passenger cars to higher clearance vehicles.

Stream Environment

Hydrology: Twenty-mile Creek is a perennial tributary to the Chewuch River with a watershed area of 5.5 square miles. Peak flows occur during spring snowmelt runoff, and less frequently during summer thunderstorms. Since the restoration project, summer flows in the main channel sometimes sink into the fan, while a couple of the secondary channels maintain perennial flow.

Channel Description: Twenty-mile Creek begins as a low gradient channel in high-elevation meadows. It descends through a steep canyon before dropping much of its bedload on the alluvial fan. Before the restoration project described above, the slope of the main fan channel exceeded 3 percent, bankfull width was 30 to 40 feet, and the substrate was small to large boulders arranged in cascades and large steps. Fines were being swept through the system and deposited in the mainstem Chewuch River. After the levees were breached and distributary channels began functioning again, the main channel has gained sinuosity, reduced slope, and is retaining more fines. The distributaries are slightly to moderately entrenched (figure A8). They are about 15 feet wide or less, with slopes of around 3 to 4 percent in the vicinity of the road.

Figure A8—Looking upstream along a distributary channel (hardened dip in foreground).

Aquatic Organisms: Two Upper Columbia Basin endangered species—spring chinook salmon and steelhead trout—as well as redband trout (a sensitive species) use this stream for spawning and juvenile rearing. Resident bulltrout (threatened), west slope cutthroat, and redband are thought to use 20-mile Creek for foraging.

Water Quality: Alluvial fans are dynamic systems, where streamflow infiltrates at the fan head, storing water for later slow release during the summer. Bed material and woody debris also deposit on the fan, causing channel locations to change during high flows. The objective of the restoration project was to reestablish these natural channel processes and alluvial fan functions. The desired end result was to reduce sediment transport to the main stem, increase water storage and summer release, and maintain or enhance fish passage and habitat diversity. Successful accomplishment of these goals should improve water quality in the Chewuch River by reducing sediment and floodwater inputs, and by increasing cool water releases in summer.

Appendix A—Case Study 2

Structure Details

Structure: These rock dips are designed to mimic channel dimensions and slope so that water and sediment are transported through the crossing and so that fish can move up through them. The vertical curve is also designed to prevent stream diversion down the road during the 100-year flood (figure A9a). The dips are outsloped at 3 to 5 percent, similar to the slope of the channels. Riprap on the ford surface (a dense mix of Class III and V riprap) is sized to stay in place during the 100-year flood. Although the U.S. Army Corps of Engineers Hydrologic Engineering Center – River Analysis System (HEC-RAS) was not used for this design, it has been used for subsequent ones to make sure the riprap, boulders, and ford width and depth are sized appropriately for the velocity in the stream.

A line of embedded rounded boulders is placed on the downstream shoulder of the ford to maintain the dip shape and to help hold the riprap of the ford surface material in place. The boulders are spaced to trap smaller material from the road but not so close together that they would be a fish passage barrier.

Because the culvert that had been at this site had caused some downcutting downstream, boulders were placed there to trap sediment and raise the channel bed to its original elevation (figure A9b). Again, the rock was sized to mimic the larger rocks in the natural stream channel. The approach appears to be working well.

Cost: Total cost in 1999 (including installation) for the 2-dip project was $18,275.

Safety: No information provided.

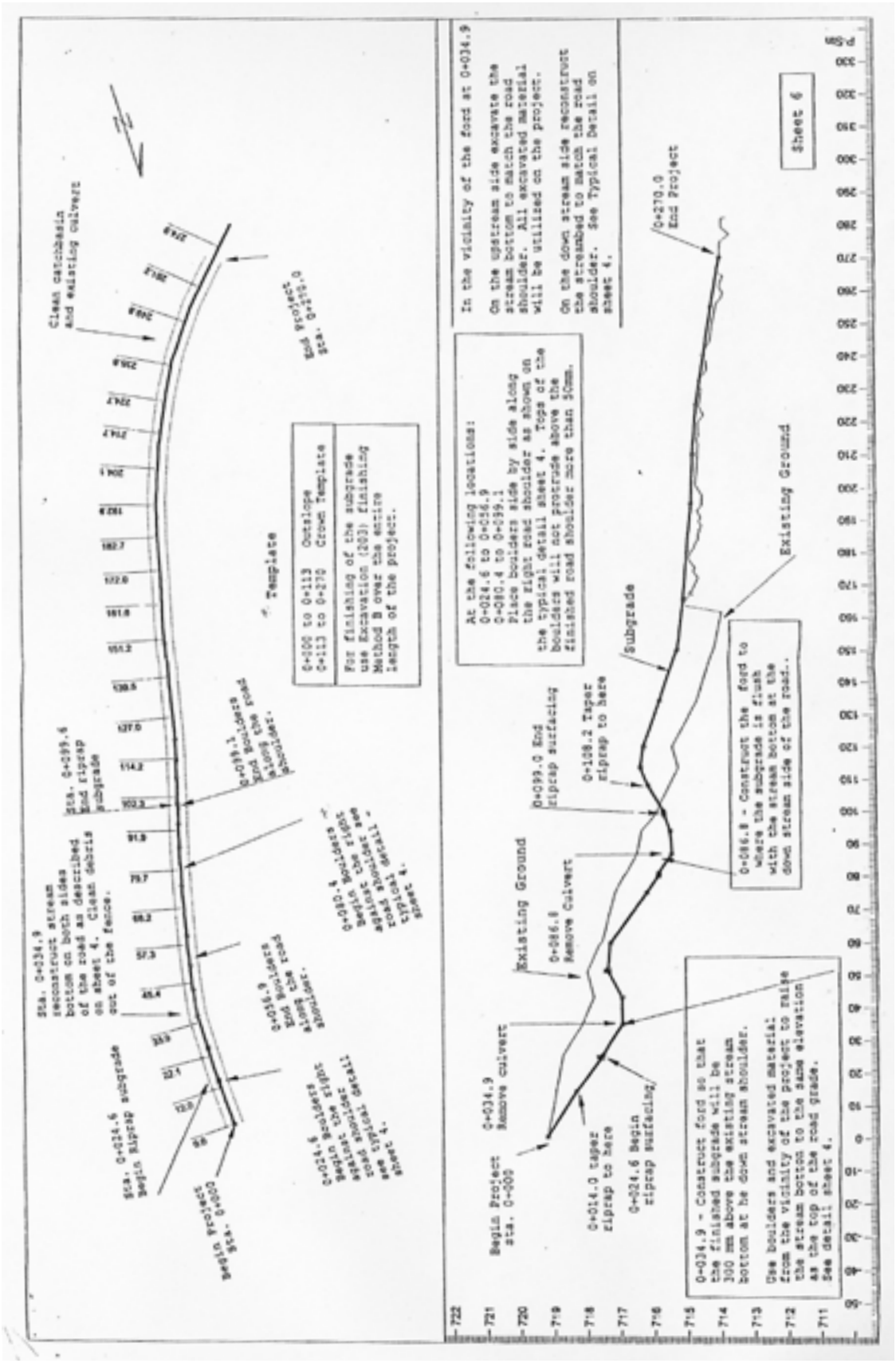

Figure A9a—Ford profile. A full size drawing may be found on the CD included in the back of this publication.

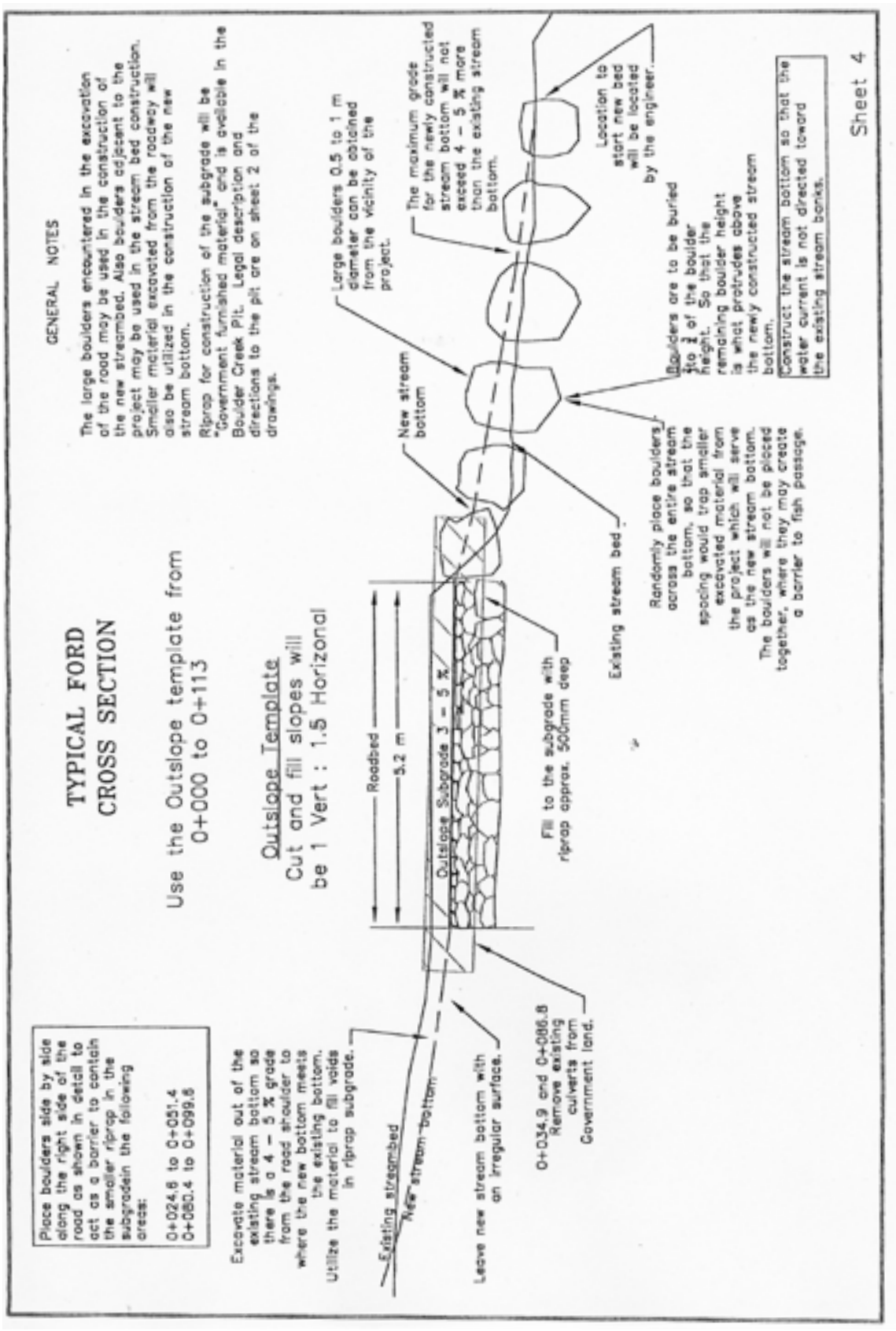

Figure A9b—Cross-section drawings. A full size drawing may be found on the CD included in the back of this publication.

Flood and Maintenance History

The structures were built in 1999. They have not experienced a major event and maintenance has been limited to minor reshaping of the approaches. No sediment has required clearing from the roadway. Fish are spawning in the ford, which means the road must remain closed for longer periods in the spring (2 to 3 months).

Figure A10. Hardened dip on East Chewuch Road.

Summary and Recommendations

This example shows the importance of looking at offsite watershed conditions when designing road crossings. Previous channel straightening and confinement with levees had caused significant channel erosion that plugged the vented-ford crossing. Some of the alluvial fan functions that support high water quality and maintain fish habitat were also lost. Restoration required breaching the levees and allowing flow down distributary channels. The rock dips on the distributary channels are a simple, inexpensive way to provide vehicle access in summer without creating a barrier to fish passage. Fish passage is maintained by mimicking natural channel width and slope and by using rock surfacing that is rough enough to keep flow velocities within the range fish can negotiate. Rock dips are also appropriate here because they can be rebuilt easily should channel location change due to depositional patterns at the fan head.

Recommendations from the design engineer:

1. Work with your local hydrologist to estimate stream flows and velocity and do a run with HEC-RAS.

2. Changing this road from one maintained for passenger cars to one maintained for higher clearance vehicles required an adjustment both for public and administrative traffic. In cases such as this, good communication with all affected parties should be considered an essential part of project planning and implementation.

Jennifer Molesworth, fishery biologist on the Methow Valley Ranger District, and David McCormack, engineer on the Okanagan National Forest provided information and photos for this case study.