

Case Study 7. Woodrock Guard Station Geoweb Ford

Location

Central Wyoming. Bighorn National Forest. West Fork of the South Tongue River. 20 miles southwest of Sheridan, off Forest Highway 26 (East Fork South Tongue River Road).

Crossing Description

This unvented ford is on a perennial brook trout stream where fish passage is a concern. The ford was constructed in 1997 with Geoweb (high density polyethylene geocell) cellular confinement material backfilled with gravel to form a natural looking armored driving surface. A constructed boulder and cobble cascade armors the structure’s downstream edge (figure A35). The site is in a broad meadow with an active flood plain and soft, compressible soils. Although traffic use is light, continued consolidation of the road approaches has caused the ford to spread laterally. The forest plans to replace this ford with an open-bottom arch matching bankfull width.



Figure A35. A boulder cascade was constructed at the downstream edge of the ford to control scour caused by placing the Geoweb very slightly above streambed elevation.

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Setting

The West Fork South Tongue River valley is a wide, moderately sloping valley in the Bighorn Mountains (Section M331-B) at 8,440 feet. The Bighorn Mountains are composed of a highly weathered granitic batholith capped by limestone on the east and west. It is a cold continental climate, with fir and pine forests mixed with shrub-steppe vegetation.

Why Was This Structure Selected?

The Geoweb structure was a relatively inexpensive way to provide a hardened surface through the creek for recreational traffic while allowing for fish passage. It was also expected to be easy to construct.

Crossing Site History

Before the Geoweb was placed in 1997, this crossing was a natural ford; that is, there was no designed structure. The replacement was done as a watershed improvement project to stop bank erosion caused by waves from vehicles driving through, and to confine vehicles to a single crossing area.

Road Management Objectives

This road is maintained for high clearance vehicles (maintenance level 2) and is closed in winter. Traffic use is considered light recreational. The road accesses a campground and is used by all-terrain vehicles, recreational vehicles and 4-wheel drive trucks with trailers.



Figure A36. Ford is used by vehicles ranging from ATV's to motor homes.

Stream Environment

Hydrology: The West Fork South Tongue River is perennial with summer flows about 1-foot deep. Peak flows occur during snowmelt and are usually sustained for 1 to 2 weeks. The runoff regime is fairly moderate, and catastrophic floods are very unusual. However, this is not a low-energy stream; slope was estimated at 2 to 3 percent in the vicinity of the crossing.

Average annual precipitation is approximately 20 inches. Ice plugging is a frequent problem with culverts in this area.

Channel Description: The stream is moderately entrenched in a flood plain about 40 to 50 feet wide, and the bankfull channel is 25 feet wide and 2 feet deep. It is probably a Rosgen B3 or B4 channel with some medium and large boulders. The wider valley surface is a grassy terrace about 2-feet above the flood plain (see figure A37). Streambank material is a highly organic sandy loam, and bank stability is generally high due to root masses of willow, bog birch, sedge, and grass. The crossing has widened significantly since the structure was installed, apparently due to the compaction of the moist sandy loam valley soils.

Aquatic Organisms: The West Fork is a brook trout fishery.

Water Quality: Maintaining good water quality was one of the reasons the ford was originally armored. However, waves caused by vehicles driving through the fairly deep water wash the approaches, and the road is not surfaced well enough to prevent erosion and transport of material into the stream. Because vehicles are driving directly through the water and sediment is being produced, the forest intends to replace this ford with a culvert.

Structure Details

Structure: To construct this ford, large rocks were removed from the existing crossing and it was excavated to a depth equal to the height of the Geoweb, 6 inches. This was done during low flow, but without diverting flow, so compaction was probably not achieved. The geotextile and Geoweb were stretched out, anchored with rebar and hooking clips, forming a 16 foot by 48 foot layer, and the cells were filled to the top with 1½-inch to 4-inch crushed rock. To prevent undercutting, the upstream edge was bent down into a deeper trench that was later filled with large rock. Four to 6 inches of clean 1½-inch to 4-inch rock cover most of the ford.

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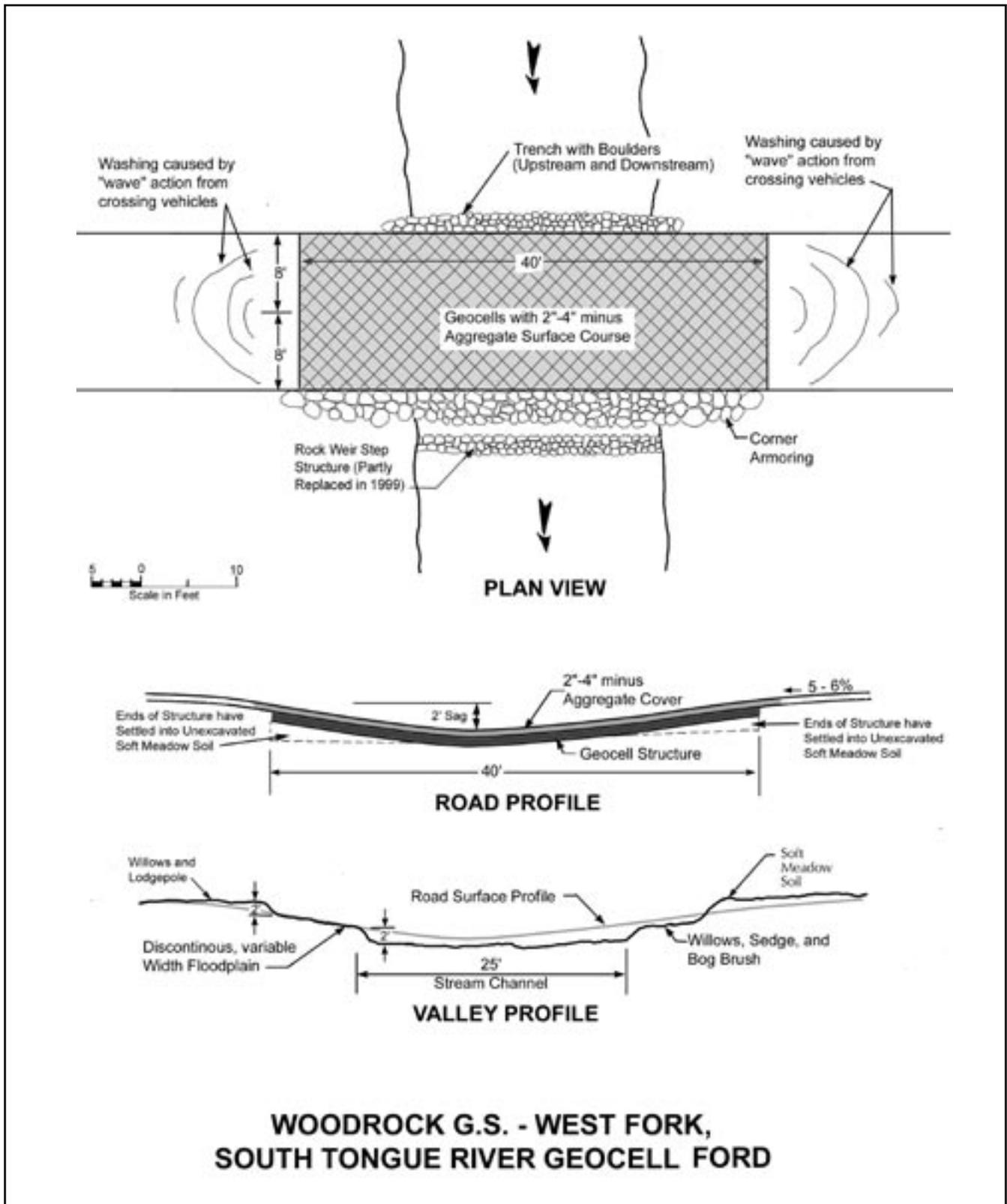


Figure A37. Plan view with valley and road profiles.

The original intent was to install the Geoweb to the elevation of the 100-year flood. As can be seen in figure A38, although the Geoweb originally extended higher, it has settled under traffic loads and probably does not fully cover the bankfull cross section. The stream widens out substantially at the crossing.



Figure A38. Soil compression on the approaches to the ford causes the stream to widen and lowers the elevation of the ends of the Geoweb mat. Currently the geocell mat protects only part of the crossing during high flows.

The intent was to set the surface of the filled Geoweb cells at the level of the finished streambed, matching stream slope. However, this is very difficult to do without diverting streamflow. The downstream edge of the Geoweb protruded an inch or two, so a rock energy dissipator was placed there. Scour occurred despite this, and in 1999 a larger boulder cascade control was constructed. This support structure creates a berm that backs water up on the crossing so that vehicles drive through deeper water than would otherwise be necessary.

Bank stabilization and approaches: The road approaches slope into the crossing at about 5 to 6 percent. Even though 10 cubic yards of rock have been added to the approaches to raise the road grade, figure A38 shows that it is substantially wider than the natural channel. Riprap is placed downstream where the approaches cut into the streambanks.

Cost: \$3,050 in 1997.

Safety: There is no signing for this structure, but the valley is wide and flat on the approach to the structure, making it easily visible.

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Flood and Maintenance History

There have been no major floods since the Geoweb was installed. As noted above, scour due to the fact that the Geoweb did not perfectly match stream grade necessitated construction of a boulder weir that now backwaters the ford. Erosion and consolidation of the approaches required the addition of rock, but compaction continued, and the crossing shape could not maintain itself. The boulder weir helps to retain the gravel surfacing necessary to protect the surface, but in many places, tire action appears to spin the gravel out of the top of the cells allowing the material to degrade (figure A39).



Figure A39. Geoweb exposed, probably by tire action.

Summary and Recommendations

Geocell fords are attractive for low-traffic and light-vehicle uses because they are inexpensive and quick to install. However, they require the same attention to foundation leveling and compaction as heavier structures do. In this case, construction without diverting the stream may have been responsible for the difficulty with matching stream slope, which then required building a downstream weir and backwatering the structure. The risk of losing the crossing shape because of traffic compressing the soft flood-plain soils also was not recognized. Those soils should have been compacted or overexcavated and replaced with firm material.

The final elevation of the geocells plus cover material is critical to the design. Initially the site should be overexcavated to the depth of the cells plus the anticipated depth of cover aggregate. Four to 6 inches of coarse, clean cover aggregate is recommended. Since this material will likely be removed during high flows, some cover aggregate will periodically have to be replaced.

Carefully weigh the speed and economy of installation against the drawbacks specific to this structure type. The geocells are damaged by traffic if not protected by a layer of gravel, and after high flows the gravel surfacing will need maintenance or replacement (see also figure A41 below). Generally, this design is not preferred for streams that experience high velocity flows or substantial traffic volume. The forest plans to replace this structure with one that will keep vehicles out of the water.

Harold Golden, fisheries biologist, and Phil Fessler, engineer, Bighorn National Forest provided information for this case study.

See also Pence, Lester M. (1987). A plastic ford—you've got to be kidding. USDA Forest Service Engineering Program, Engineering Field Notes v19 (January-February):27-33

Similar Structures in Other Locations

The Ashley National Forest has a successful temporary geocell (similar to Geoweb) installation on Little Brush Creek (figure A40). The material used for this ford is called "TerraCell". The mats are 8-foot by 20-foot by 6-inches deep. Two mats were installed lengthwise across the stream.

The crossing accesses a road planned for storage within a few years, so the structure needed to last only 3 to 5 years. Traffic is mostly administrative and recreational, and is primarily 4-wheel-drive vehicles such as light duty trucks, all-terrain vehicles, and sports utility vehicles. As the photo shows, after only one year, some of the 4-inch minus surfacing had been lost from the geocells on one side of the structure, and the material was deteriorating. Rock was added during the summer of 2002. Nonetheless, in 2004 the site was in a similar condition (figure A41). More material has eroded out from the geocells on one side of the ford and the channel has widened locally.

The native (darker red) cobbles and gravels deposited on the crossing in figure A40 show the structure provides free downstream passage for debris and bed material. There is no reason to believe the ford would block fish and other aquatic species at the site going upstream. The forest is satisfied with the ford as a temporary crossing.

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Figure A40. Little Brush Creek geocell ford in June 2002.



Figure A41. Looking upstream at erosion of one side of the ford in August 2004, 3 years after construction. Probably tire action and high flows have combined to pluck material out of the cells or undermine them. The ford is still intact and the geocells are covered by native bed material in the active channel.

Alex Gouley and Dan Abeyta of the Ashley National Forest, Utah provided photos and information about the Little Brush Creek geocell installation.

The Humboldt-Toiyabe National Forest used Geoweb for a ford on the Duck Valley Reservation (Plocher 2001). A 10-foot wide by 30-foot long geocell structure was constructed using 8-inch-wide and 8-inch-deep cells. The site was dewatered, surveyed, and a geotextile filter layer and Geoweb mat installed, backfilled, and covered with local screened stream channel material. A smooth, firm foundation was established before placement of the geotextile layer and the Geoweb. The ends of the structure were keyed in by excavating a trench to a depth of 16 inches (two cell heights) along the upstream and downstream edge of the structure and burying the geocells in the trench.

Once the Geoweb was properly stretched, oriented, and anchored in place with rebar, the cells were backfilled with an angular 1½- to 5-inch screened aggregate. Then the crossing was covered with 3 to 5 inches of screened 3- to 8-inch open-graded gravel free of fines.

The site is reportedly functioning well today, though no specific performance or maintenance information has been provided. The site is being monitored for sediment reduction to determine the effectiveness of the improved ford compared to the natural road crossing as part of the U.S. Environmental Protection Agency Nonpoint Source Pollution Prevention Program.

References

Kostrubala, Thaddeus. 2003. Skull Creek Project 2002 Report, Shoshone-Paiute Tribes-Duck Valley Indian Reservation, Tribal Environmental Protection Program, End-of-Year Report to the U.S. Environmental Protection Agency, Grant C9-9891001-0. January 24, 2003.

Plocher, Krishna. 2001. Skull Creek Geoweb Crossing-Duck Valley Reservation. Humboldt-Toiyabe National Forest Construction Report, October 10, 2001.

