

APPENDIX A

TYPICAL DIAGRAMS FOR ROAD AND STREAM CROSSING REMOVAL

The following pages contain typical diagrams of a variety of prescriptions used to treat roads and stream crossings. The illustrations are before-and-after representations of the earthmoving work that is performed as part of road and stream crossing removal. For clarity, vegetation and mulch are not shown on the diagrams. Bedrock, as illustrated on the diagrams represents undisturbed material that may include solid rock, weathered rock, or undisturbed soil. Organic soil as illustrated on the diagrams may or may not be present, depending on local conditions.

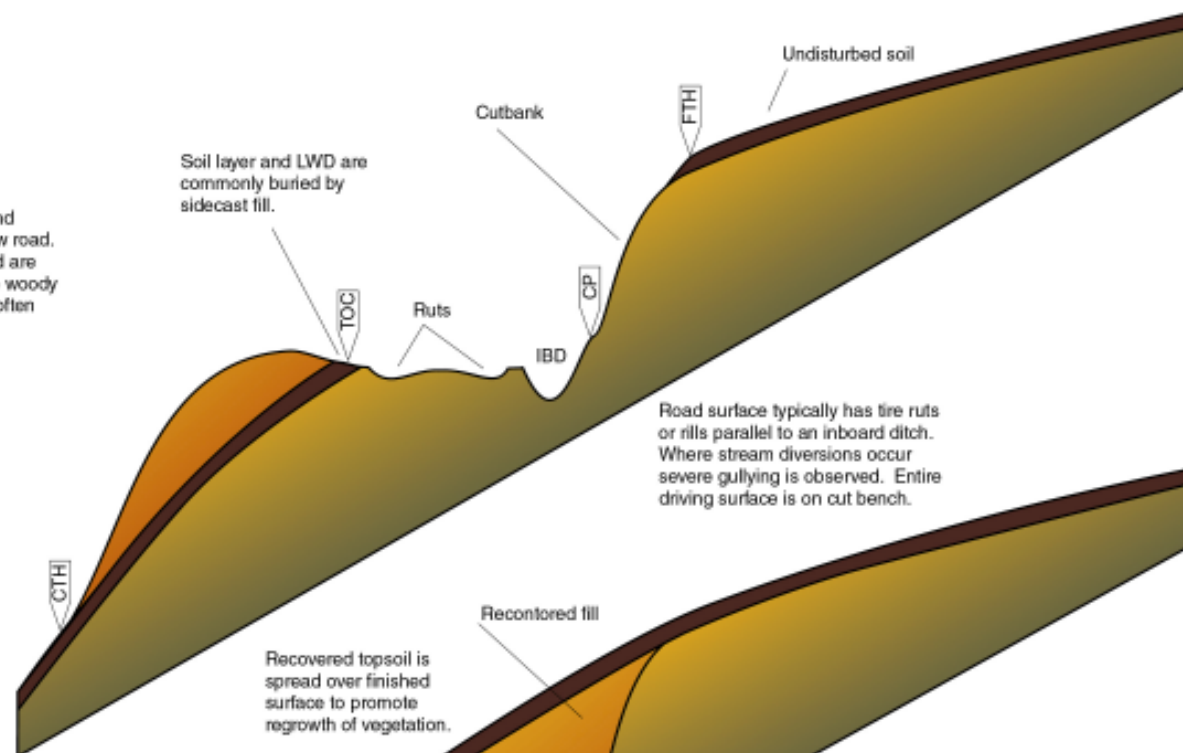
Full-Cut Bench Road Recontour - Convex Slope

Cross Section Cutaway

Typical Diagram

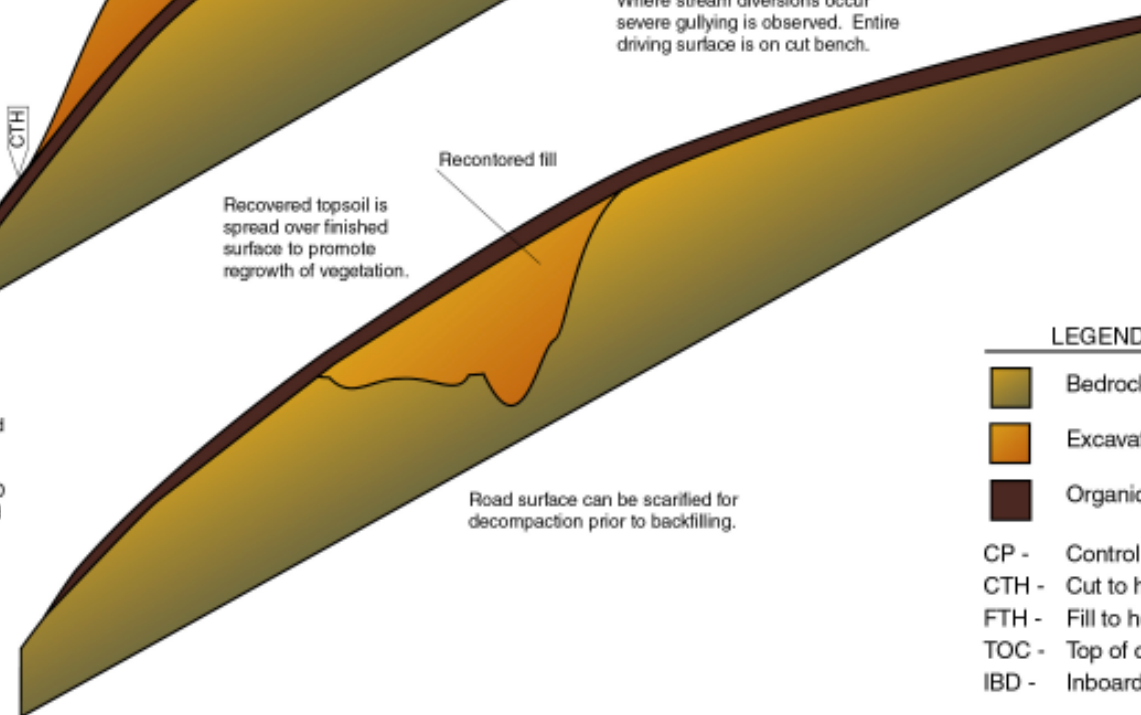
Before treatment

Road fill is sidecast downslope and steepens slope immediately below road. Outboard berms are common and are usually composed of fill and large woody debris (LWD). A layer of LWD is often present along the base of the fill.



After treatment

Road fill is recovered from the outboard fill and replaced into the cut bench. Topsoil is preserved and should be redistributed on finished surfaces. LWD (not shown) should be evenly scattered over the finished work area.



LEGEND

- Bedrock
- Excavated Fill
- Organic soil

- CP - Control point
- CTH - Cut to here
- FTH - Fill to here
- TOC - Top of cut
- IBD - Inboard ditch

Cut/Fill Bench Road Recontour - Convex Slope

Cross Section Cutaway

Typical Diagram

Before treatment

Road fill is sidecast over soil layer and steepens slope below road. The outer 1/2 to 1/3 of the road is built on fill. Outboard berms are common and are usually composed of fill and large woody debris (LWD). LWD is present under and throughout fill.

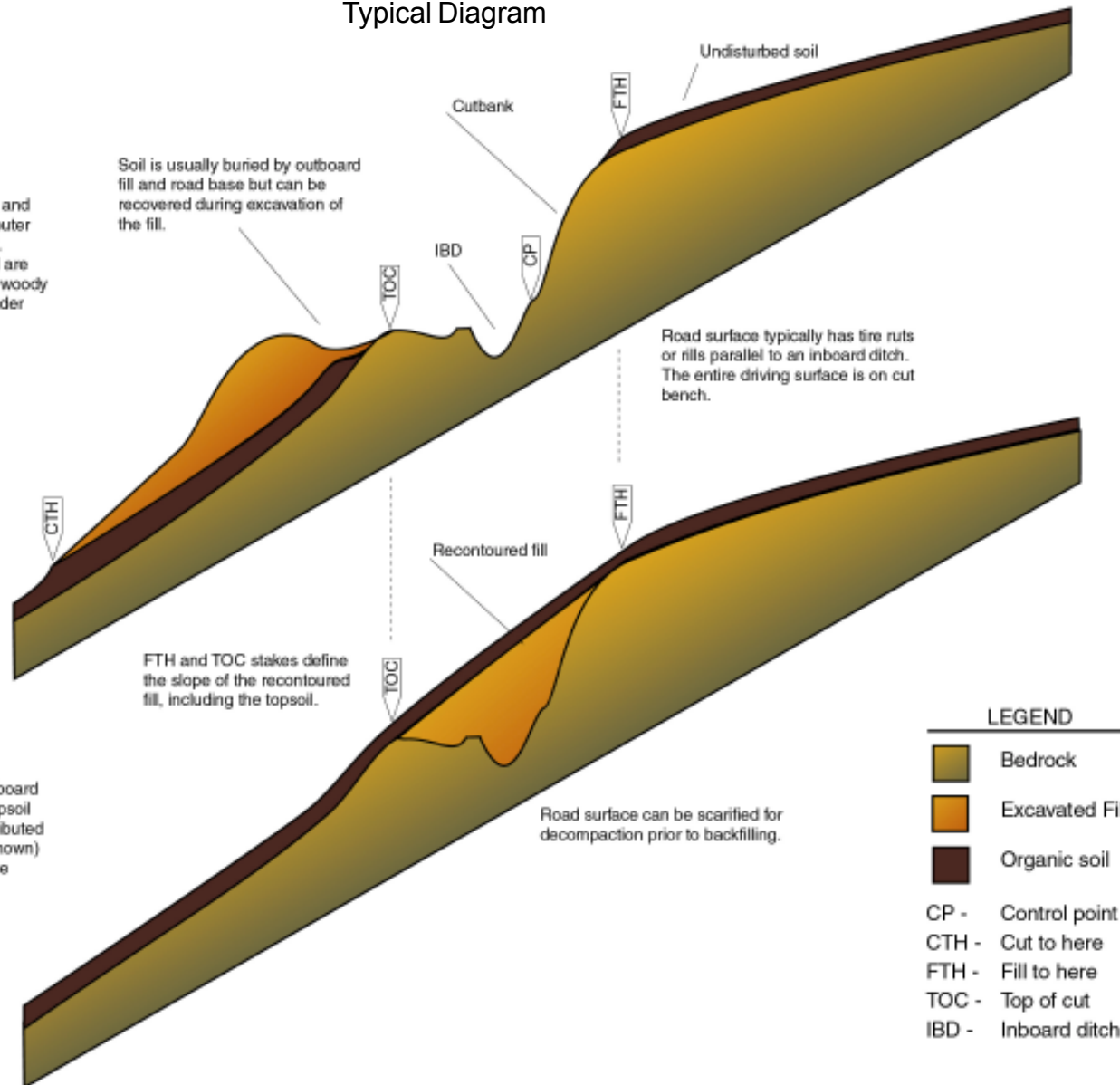
Soil is usually buried by outboard fill and road base but can be recovered during excavation of the fill.

Road surface typically has tire ruts or rills parallel to an inboard ditch. The entire driving surface is on cut bench.

After treatment

Road fill is recovered from the outboard fill and replaced into cut bench. Topsoil is preserved and should be redistributed on finished surfaces. LWD (not shown) should be evenly scattered over the finished work area.

Road surface can be scarified for decompaction prior to backfilling.



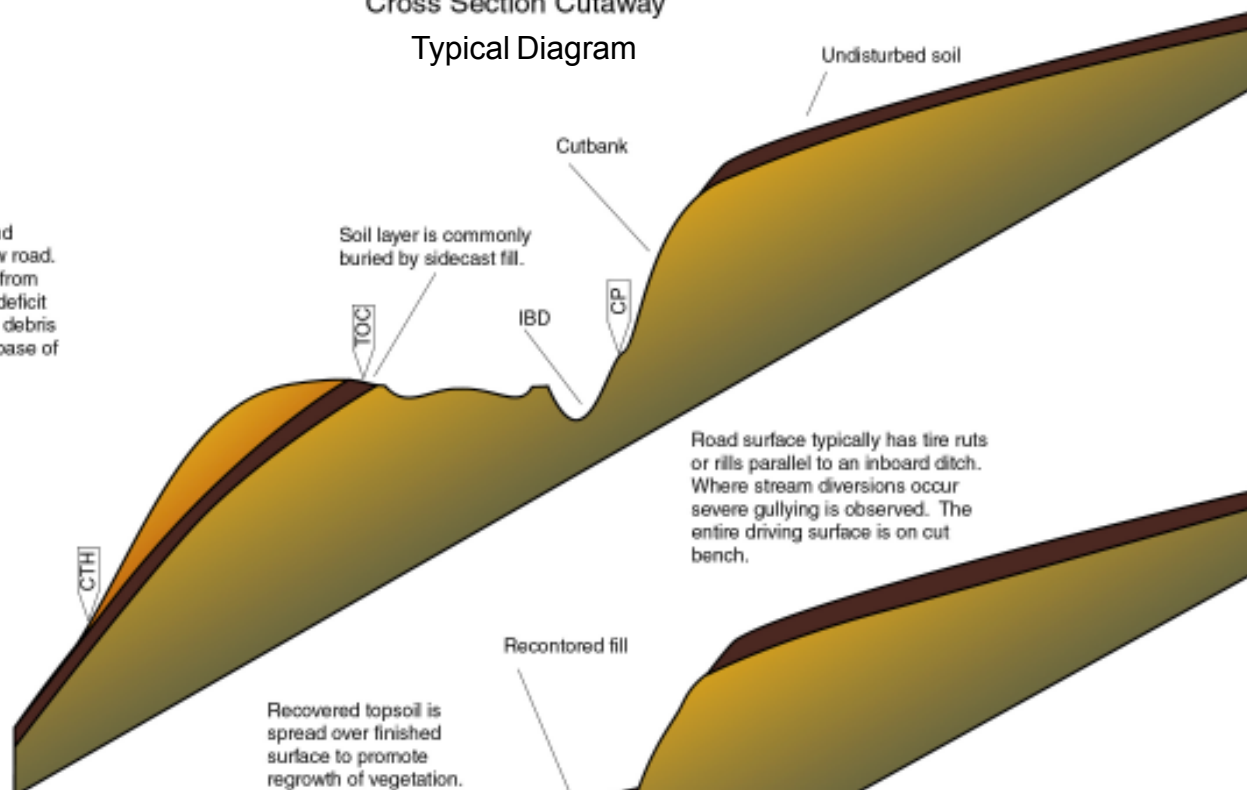
Full-Cut Bench Partial Road Recontour (Decommission)- Convex Slope

Cross Section Cutaway

Typical Diagram

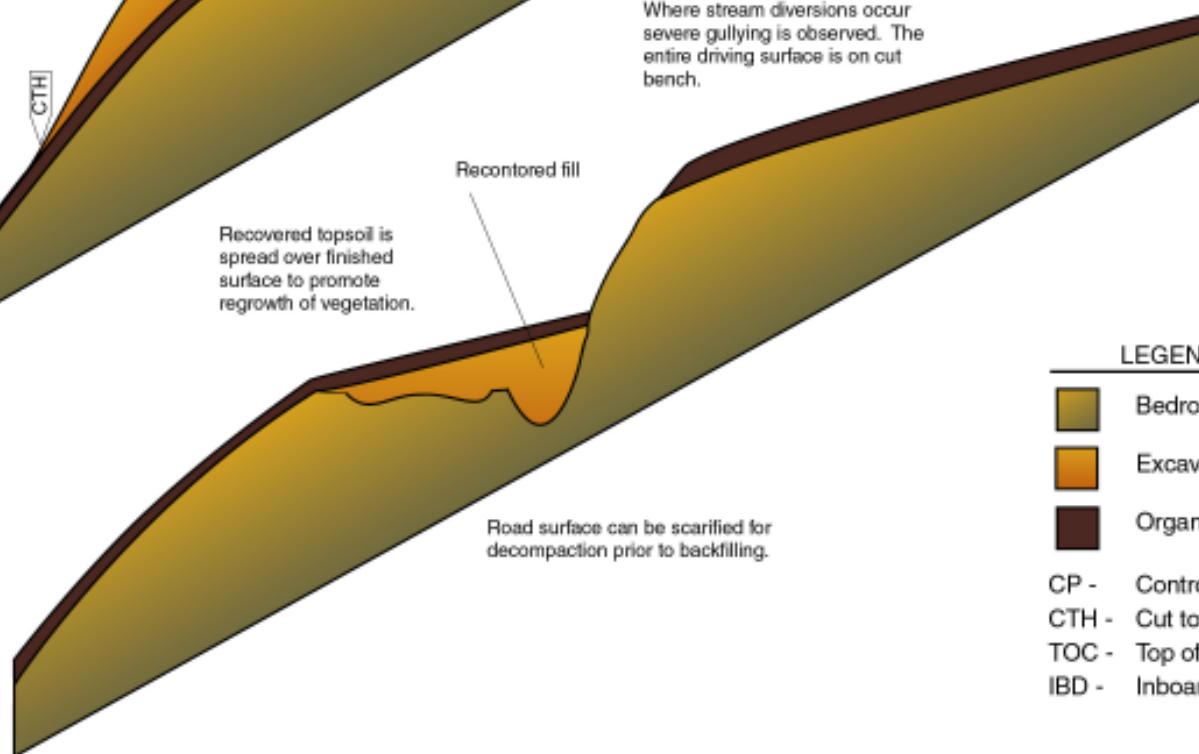
Before treatment

Road fill is sidecast downslope and steepens slope immediately below road. Where material has been eroded from road alignment, a recoverable fill deficit may exist. A layer of large woody debris (LWD) is often present along the base of the fill.



After treatment

Road fill is recovered from the outboard fill and replaced into the cut bench. Available fill should be used to evenly outslope road surface. Cutbank should be backfilled as high as needed to provide sheet drainage. Topsoil is preserved and should be redistributed on finished surfaces. LWD (not shown) should be evenly scattered over the finished work area.



LEGEND

	Bedrock
	Excavated Fill
	Organic soil
CP -	Control point
CTH -	Cut to here
TOC -	Top of cut
IBD -	Inboard ditch

Full-Cut Bench Road Recontour Import Terraform - Convex Slope

Cross Section Cutaway

Typical Diagram

Before treatment

Road fill is sidecast downslope and steepens slope immediately below road. Where material has been eroded from road alignment, a fill deficit may exist. A layer of large woody debris (LWD) is often present along the base of the fill. The soil layer is commonly buried by sidecast fill.

Road surface typically has tire ruts or rills parallel to an inboard ditch. Where stream diversions occur severe gulying is observed. Entire driving surface is on cut bench.

Cutbank

Undisturbed soil

FTH

IBD

CP

TOC

Where fill deficits occur, the cutbank can, in some cases, be lowered by removal of material from above. Topsoil should be stockpiled for later redistribution on the finished surface.

Lowered cutbank

Recontored fill

Recovered topsoil is spread over finished surface to promote regrowth of vegetation.

After treatment

Road fill is recovered from the outboard fill and replaced into the cut bench. Available fill should be used to evenly outslope road surface. Cutbank should be backfilled as high as possible or lowered to fully recontour road bench. Topsoil is preserved and should be redistributed on finished surfaces. LWD (not shown) should be evenly scattered over the finished work area.

Road surface can be scarified for decompaction prior to backfilling.

LEGEND

- Bedrock
- Excavated Fill
- Organic soil

- CP - Control point
- CTH - Cut to here
- FTH - Fill to here
- TOC - Top of cut
- IBD - Inboard ditch

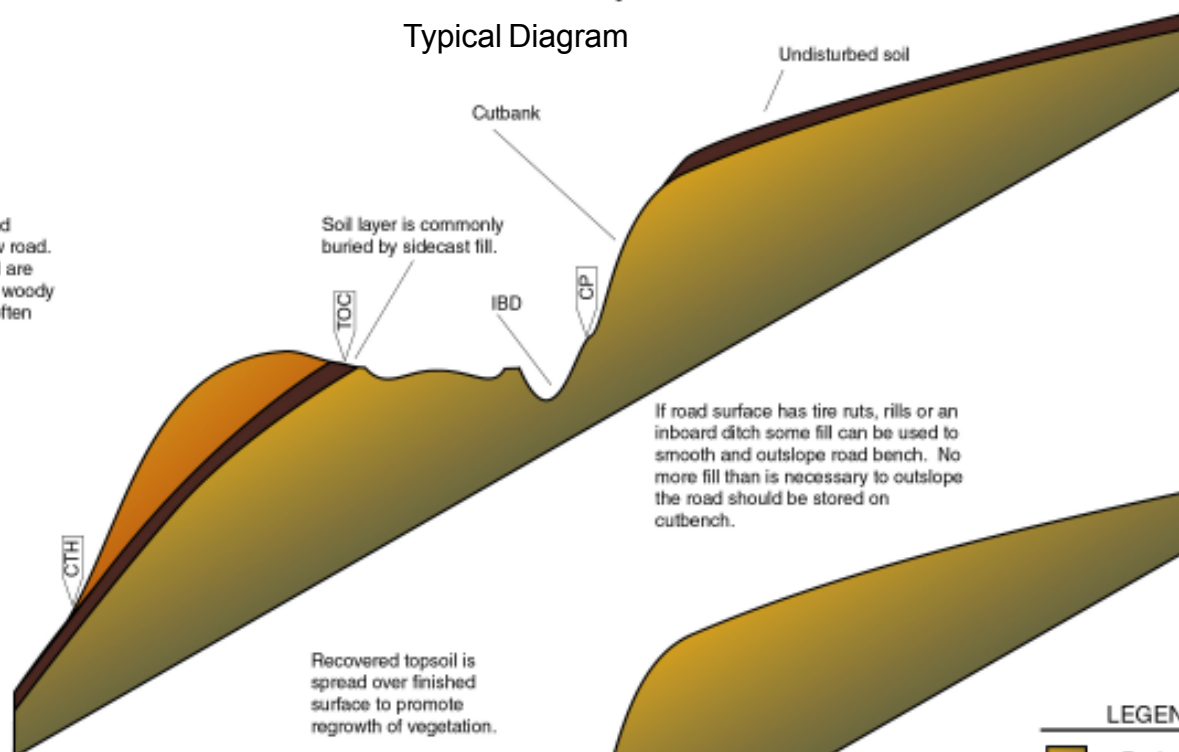
Export-Outslope Road Treatment - Convex Slope

Cross Section Cutaway

Typical Diagram

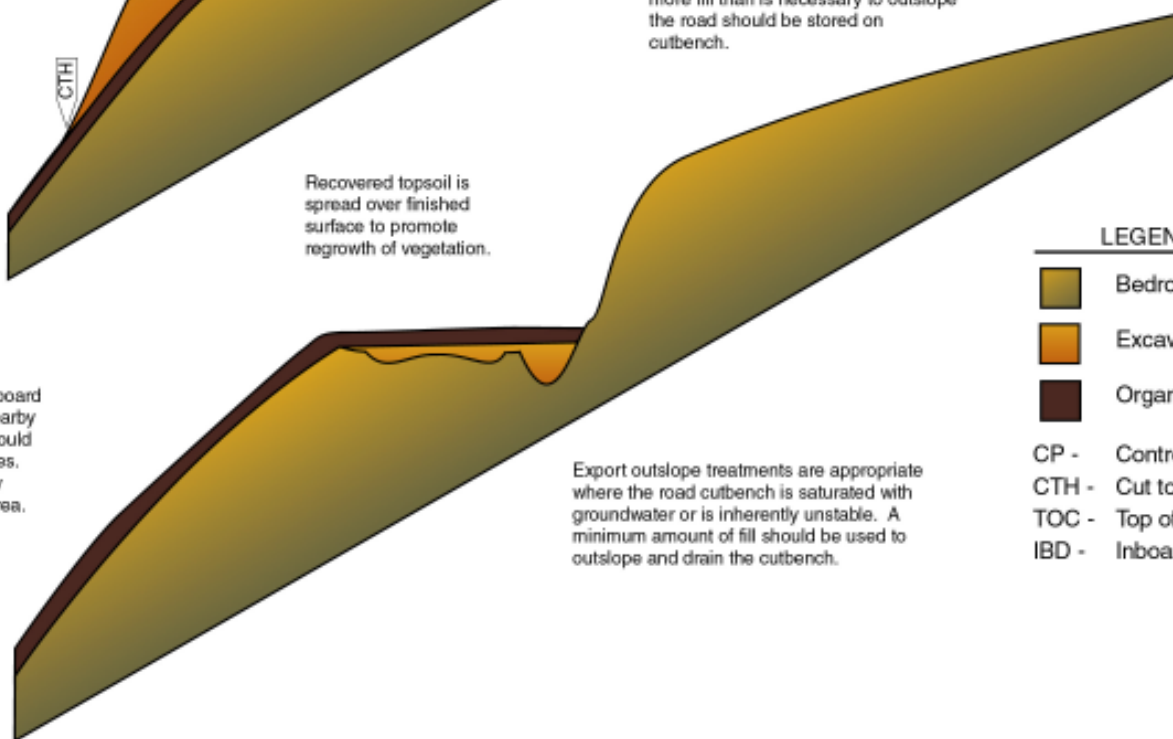
Before treatment

Road fill is sidecast downslope and steepens slope immediately below road. Outboard berms are common and are usually composed of fill and large woody debris (LWD). A layer of LWD is often present along the base of the fill.



After treatment

Road fill is recovered from the outboard fill and moved offsite to another nearby fillsite. Topsoil is preserved and should be redistributed on finished surfaces. LWD (not shown) should be evenly scattered over the finished work area.



LEGEND

-  Bedrock
-  Excavated Fill
-  Organic soil
- CP - Control point
- CTH - Cut to here
- TOC - Top of cut
- IBD - Inboard ditch

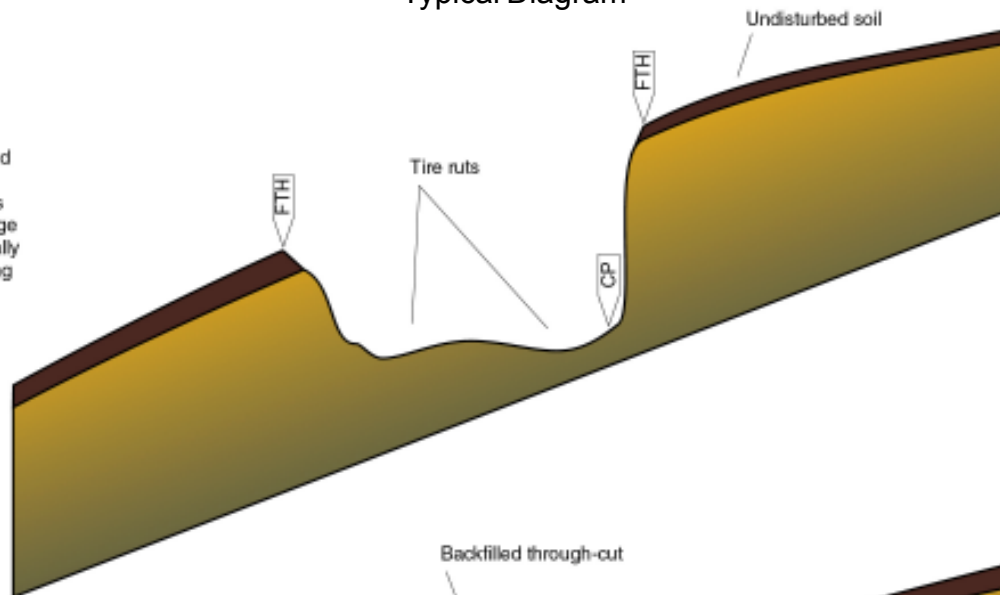
Through-Cut Road Recontour - Convex Slope

Cross Section Cutaway

Typical Diagram

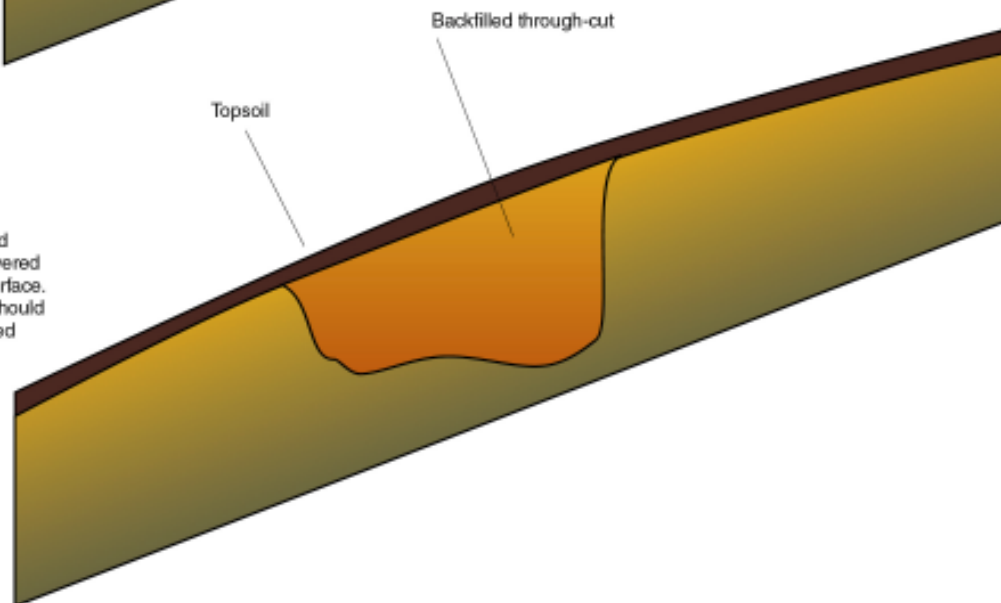
Before treatment

When roads continuously erode and are regraded sideslope through-cuts form. Sideslope through-cuts are also constructed to supply large quantities of fill when needed locally for road repairs or stream crossing fill.



After treatment

Fill is recovered from local area and used to backfill through-cut. Recovered soil is spread evenly on finished surface. Large woody debris (not shown) should be evenly scattered over the finished work area.



LEGEND

- Bedrock
- Excavated Fill
- Organic soil
- CP - Control point
- FTH - Fill to here

Turnpike Road Recontour - Swale/Valley Profile

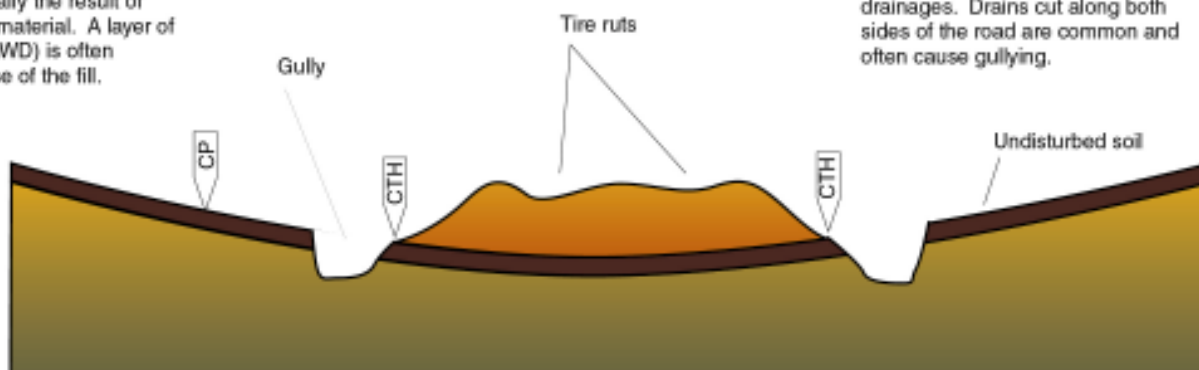
Cross Section Cutaway

Typical Diagram

Before treatment

Road fill is pushed downslope usually from a through-cut section immediately above turnpike. Outboard berms are common and are usually the result of compaction of the fill material. A layer of large woody debris (LWD) is often present along the base of the fill.

Elevated turnpikes can run parallel to swale axes or across broad drainages. Drains cut along both sides of the road are common and often cause gullying.

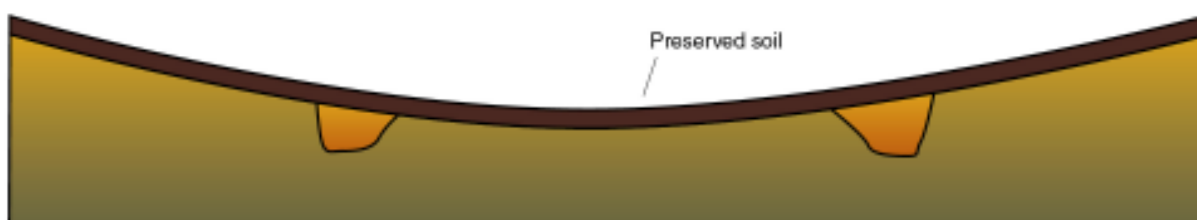


Turnpikes can be built directly on top of organic soil or can be built up on mineral soil.

After treatment

Turnpike fill is recovered and transported to a local site in need of fill. Topsoil is preserved as the excavation proceeds and should be left on finished surfaces. LWD (not shown) should be evenly scattered over the finished work area.

Turnpike is removed to original grade and drains or gullies are filled with available fill material.



LEGEND

-  Bedrock
-  Excavated Fill
-  Organic soil
- CP - Control point
- CTH - Cut to here

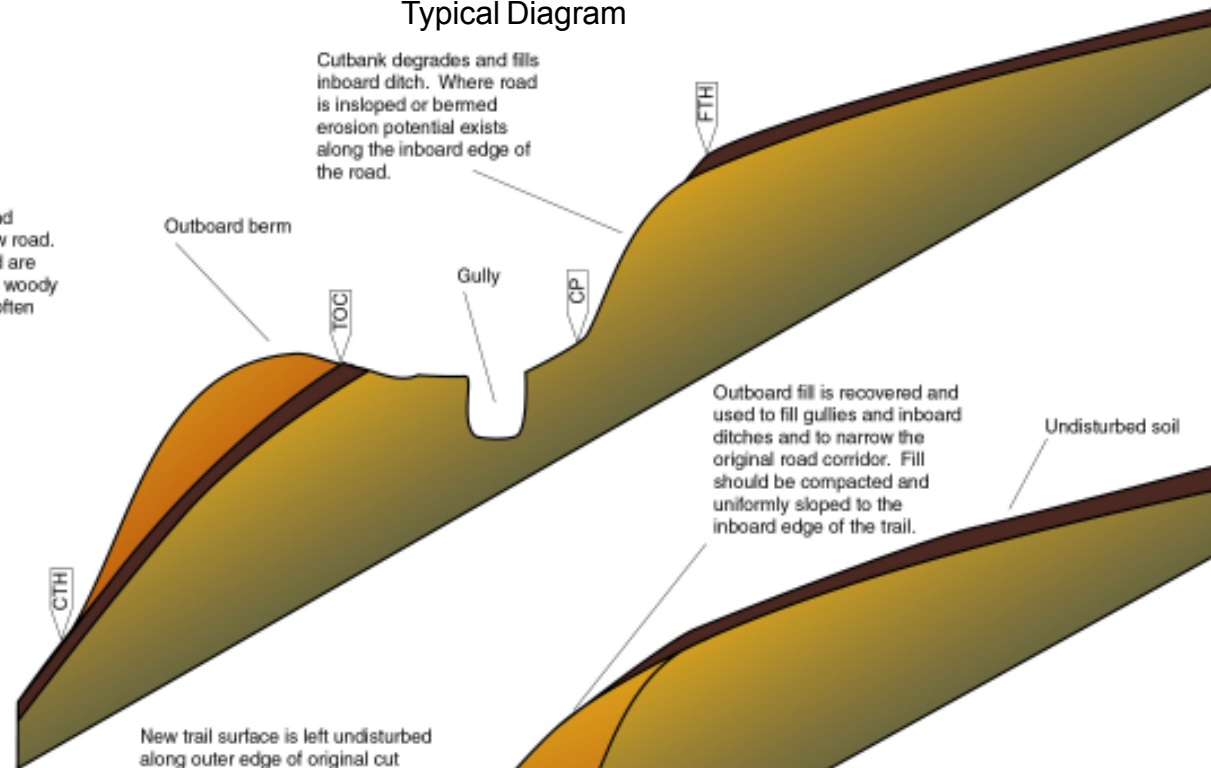
Road to Trail Conversion - Convex Slope

Cross Section Cutaway

Typical Diagram

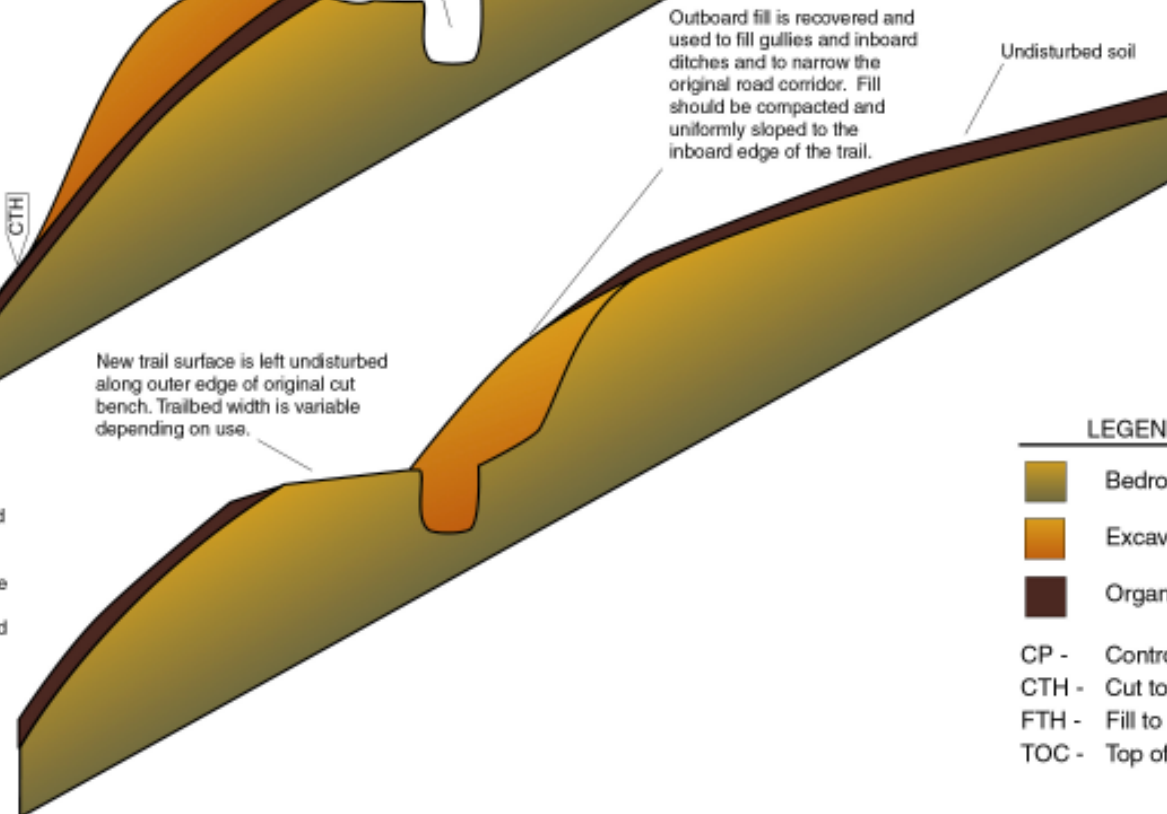
Before treatment

Road fill is sidecast downslope and steepens slope immediately below road. Outboard berms are common and are usually composed of fill and large woody debris (LWD). A layer of LWD is often present along the base of the fill.



After treatment

Road fill is recovered from the outboard fill and replaced into the cut bench. Topsoil is preserved and should be redistributed on finished surfaces above and below the trail. LWD (not shown) should be evenly scattered upslope and downslope of the trail bench.



LEGEND

- Bedrock
- Excavated Fill
- Organic soil

- CP - Control point
- CTH - Cut to here
- FTH - Fill to here
- TOC - Top of cut

Through-Cut Road Recontour - Ridgetop Profile

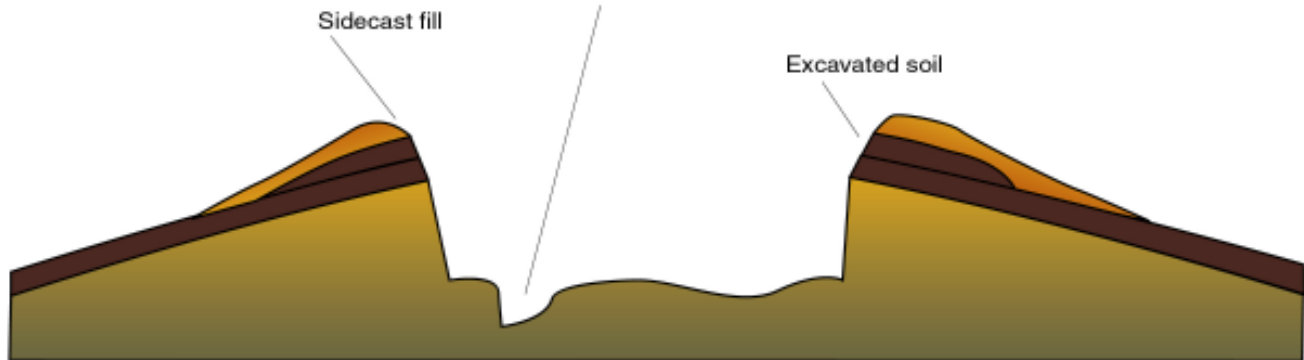
Cross Section Cutaway

Typical Diagram

Before treatment

Roads constructed along ridgelines are commonly through-cuts with berms of fill and soil along both sides.

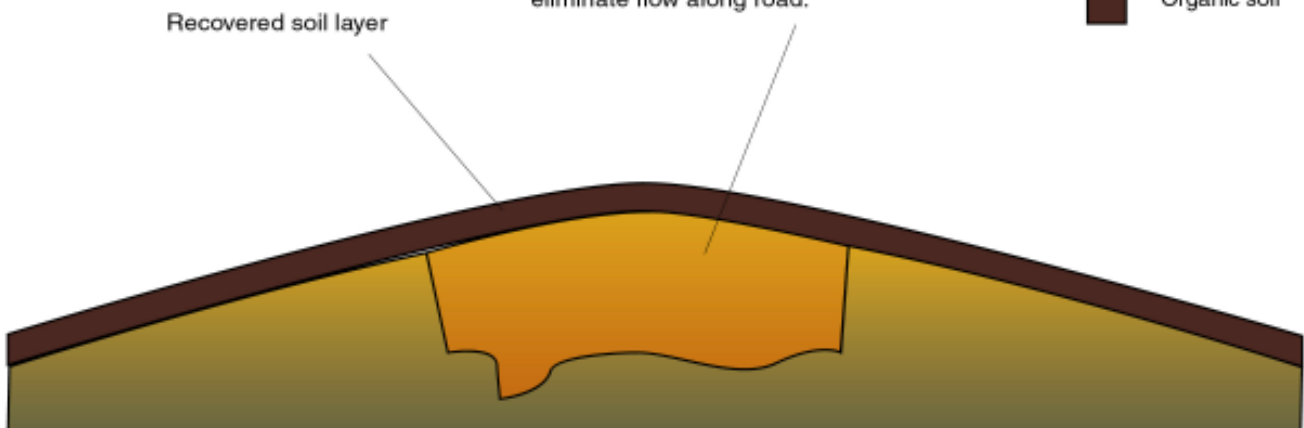
Through-cuts confine flow along the road and cause severe gully erosion on compacted road surfaces.



After treatment

Fill and soil are recovered from the edges of the road and used to recontour the ridge. Large woody debris is spread evenly on the work area.

Road is backfilled and crowned to promote drainage downslope and eliminate flow along road.



LEGEND

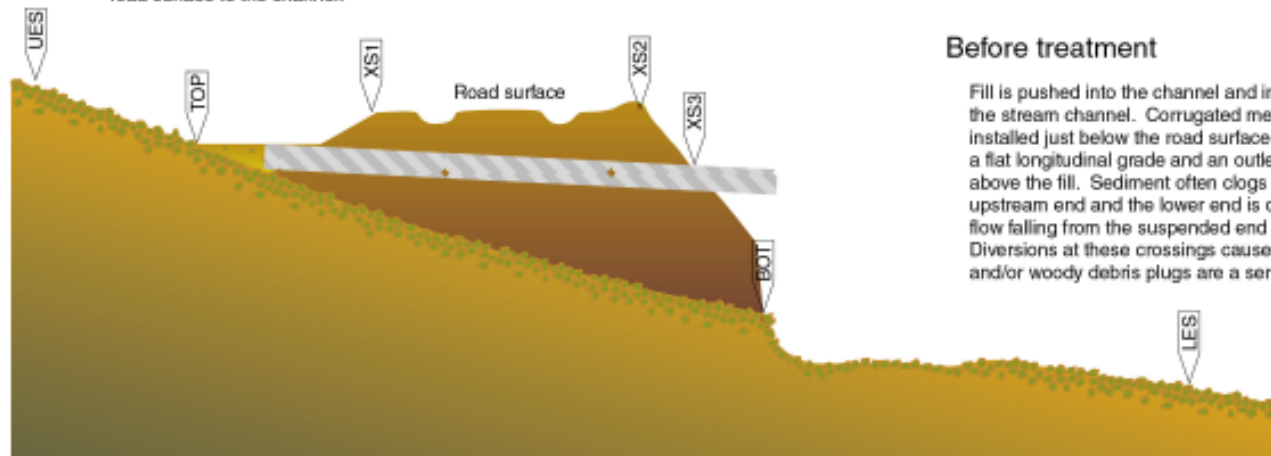
	Bedrock
	Excavated Fill
	Organic soil

Culvert Stream Crossing Excavation

Longitudinal Profile Cutaway

Typical Diagram

The outboard edge cross section (XS2) is usually the deepest cross section from the road surface to the channel.

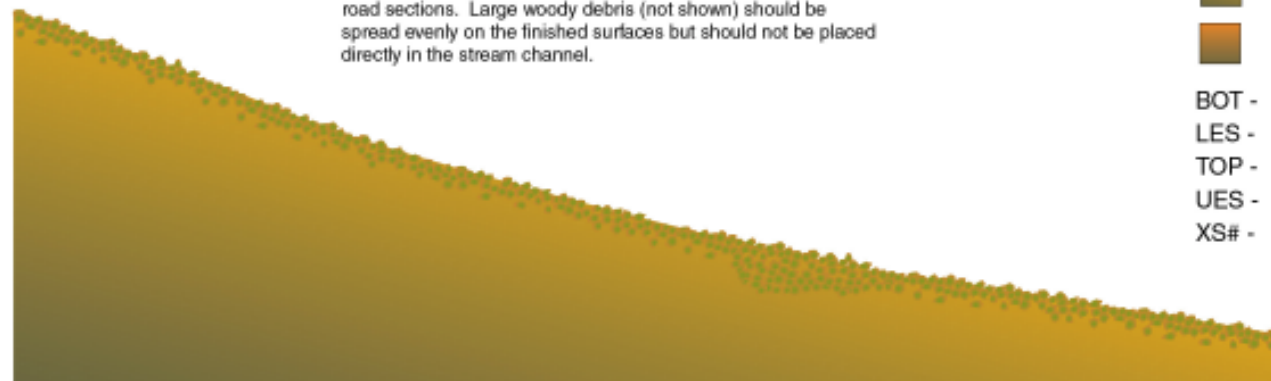


Before treatment

Fill is pushed into the channel and inner gorge to cross the stream channel. Corrugated metal pipe (CMP) installed just below the road surface is typically set with a flat longitudinal grade and an outlet hanging well above the fill. Sediment often clogs the pipe at the upstream end and the lower end is deeply scoured by flow falling from the suspended end of the culvert. Diversions at these crossings caused by sediment and/or woody debris plugs are a serious erosion threats.

After treatment

Fill and culverts are excavated from the channel to re-expose the channel armor along the stream. Soil is not redistributed along the axis of the stream. Fill is used locally to recontour adjacent road sections. Large woody debris (not shown) should be spread evenly on the finished surfaces but should not be placed directly in the stream channel.



LEGEND

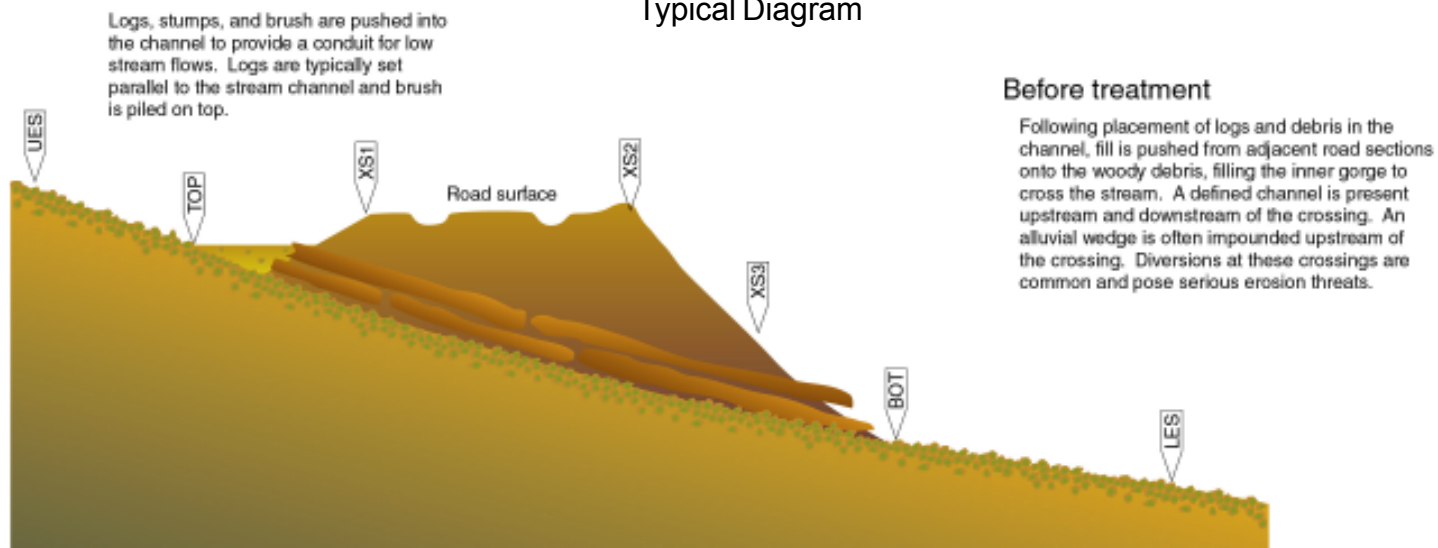
- Bedrock
- Excavated Fill

- BOT - Bottom of cut
- LES - Lower end stake
- TOP - Top of cut
- UES - Upper end stake
- XS# - Cross section

Humboldt Stream Crossing Excavation

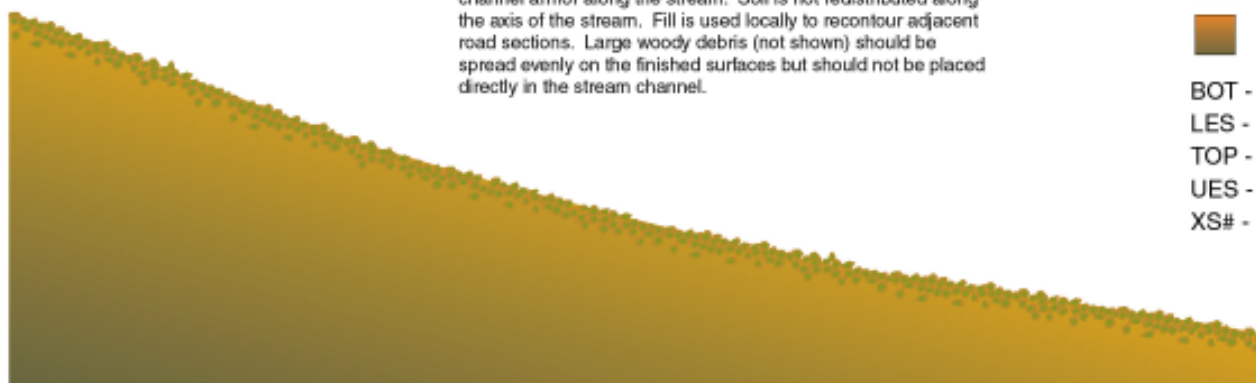
Longitudinal Profile Cutaway

Typical Diagram



After treatment

Fill and logs are excavated from the channel to re-expose the channel armor along the stream. Soil is not redistributed along the axis of the stream. Fill is used locally to recontour adjacent road sections. Large woody debris (not shown) should be spread evenly on the finished surfaces but should not be placed directly in the stream channel.



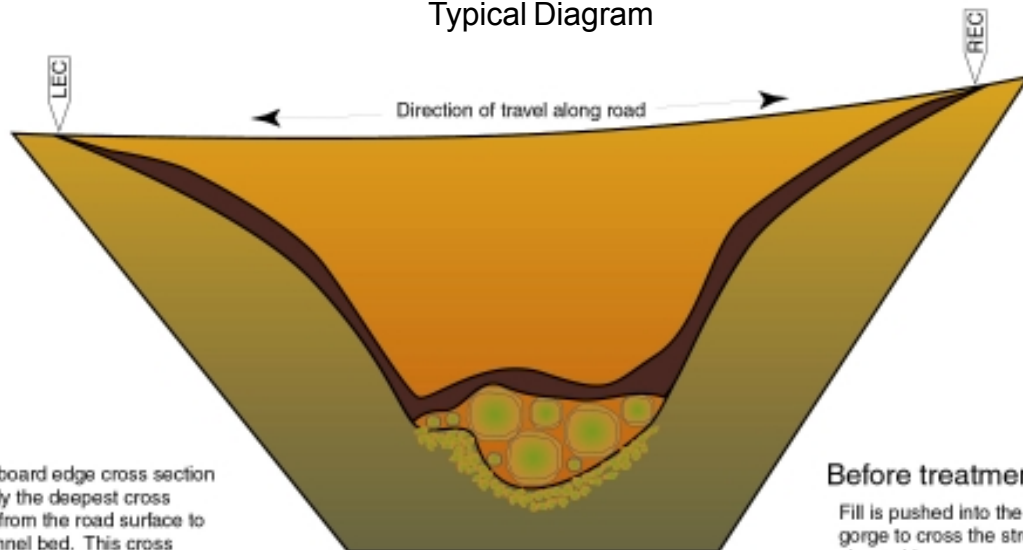
LEGEND

- Bedrock
- Excavated Fill
- BOT - Bottom of cut
- LES - Lower end stake
- TOP - Top of cut
- UES - Upper end stake
- XS# - Cross section

Humboldt Stream Crossing Excavation

Cross Section Cutaway

Typical Diagram



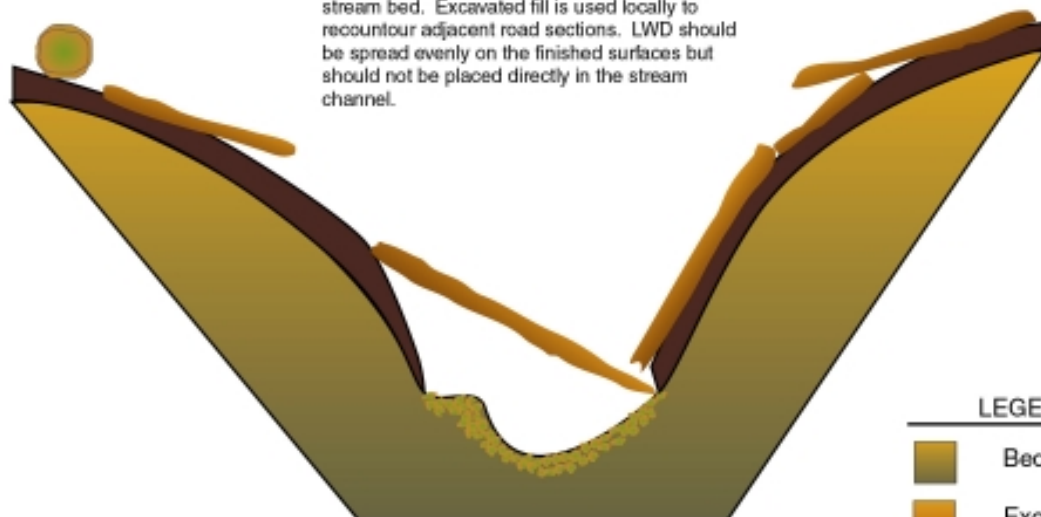
The outboard edge cross section is usually the deepest cross section from the road surface to the channel bed. This cross section would be representative of an outboard edge cross section. This view is looking downstream.

Before treatment

Fill is pushed into the channel and inner gorge to cross the stream channel. A channel is present upstream and downstream of the crossing. Logs and/or culverts are common in these crossings to convey flow under the road. Diversions at these crossings are a serious erosion threat.

After treatment

The fill and culverts are excavated from the channel to re-expose the channel armor along the stream. Soil is not redistributed along the stream bed. Excavated fill is used locally to recontour adjacent road sections. LWD should be spread evenly on the finished surfaces but should not be placed directly in the stream channel.



LEGEND

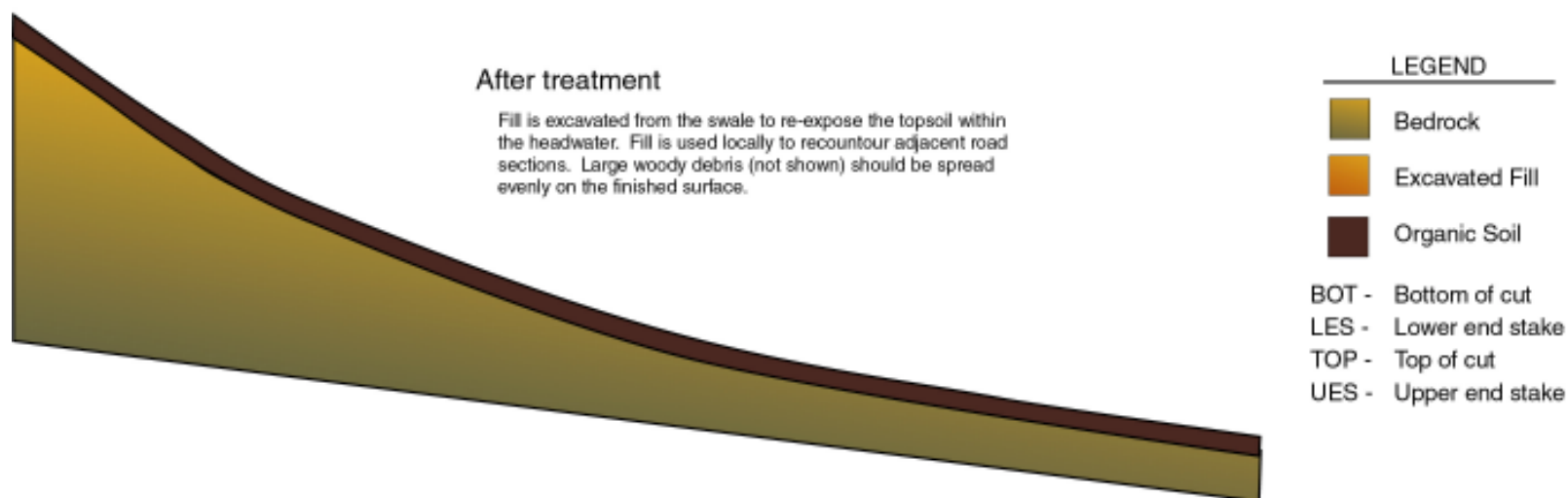
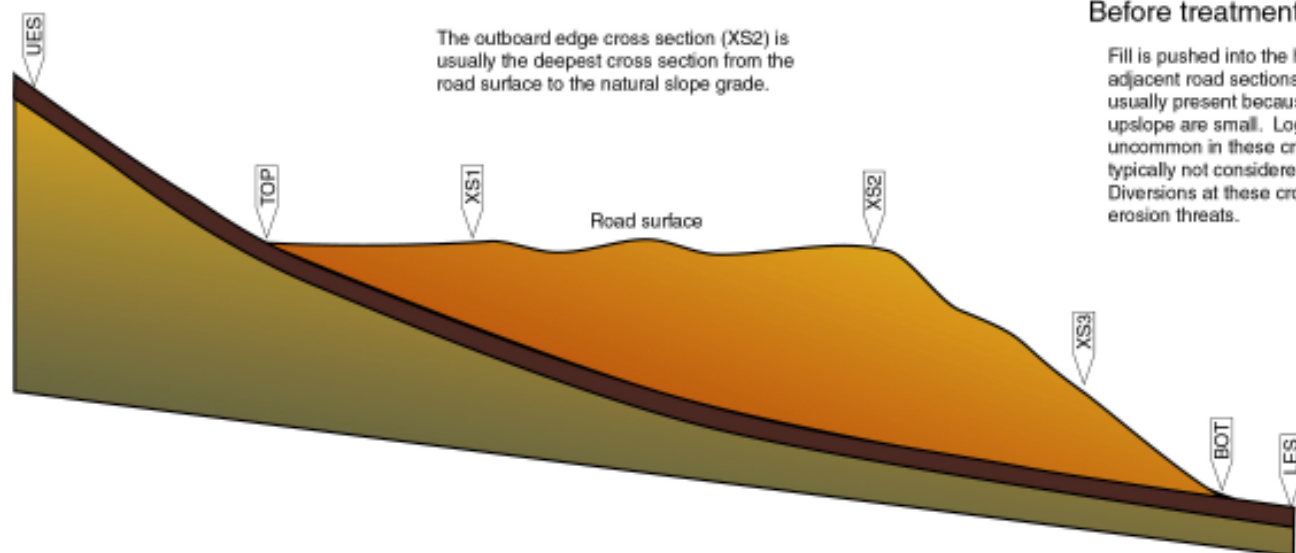
- Bedrock
- Excavated Fill
- Organic soil

LEC - Left edge cut
REC - Right edge cut

Headwater Swale Export Recontour

Cross Section Cutaway

Typical Diagram



APPENDIX B

GLOSSARY

aggrade - the filling of a stream channel with sediment. This usually happens when the supply of sediment is greater than the stream is transporting. Compare to “degrade” and “graded stream.”

alignment - the area affected by a road or trail including the fill slopes, road bench, and cut bank. Also a linear representation of features on a map such as a stream channel.

curvilinear - a curving line. Refers to a meandering trail that curves around boulders and trees following contours across the land at a flat or oblique angle.



A curvilinear trail meanders around trees and boulders and follows contours of the land through swales and around ridges.

cutbench - the portion of a roadway that has been cut into bedrock or native soil. Compare with embankment.

decommissioning - the treatment of a road to eliminate diversion potential during periods of nonuse. A road is typically decommissioned when the road will not be used for a period of time but may be used some time in the future. Decommissioning includes the removal of stream crossing fill and partially recontouring or outsloping road segments between crossings.

degrade - refers to the erosion of a stream channel. This usually happens when the supply of sediment is less than the amount the stream is transporting. Compare to “aggrade” and “graded stream.” Also refers to poor water quality or a disturbed watershed function.

ditch memory - subsurface water flow along a former drainage ditch after road removal is completed. This often occurs when ditches have not been ripped. Also see memory.

duff - partially decayed organic material composed of needles, leaves, and twigs on the forest floor.



A blown-out culvert is a typical problem with road stream crossings where sediment, woody material, or very large flows have overwhelmed the capacity of the pipe.

embankment - fill excavated from the cutbench and used to construct the outboard road bench. This is often referred to as the fill slope or outboard fill material.

erosion control - activities that prevent soil from being detached and moved down slope including, but not limited to, road removal, revegetation, mulching with brush, out sloping, and compaction of unstable fill.

fall line - an imaginary line on a sloped surface that follows the steepest angle. You can think of the fall-line as the line that would be made by a ball rolling down the slope.



Bike tracks in a recently recontoured meadow concentrate flow and cause rill and gully formation.

geomorphology - the study of the earth's surface and the processes that shape it. Geomorphology is closely related to geology.

geomorphologist - a person who studies geomorphology.

grade - the natural, proposed, or planned ground surface. Usually grade is set to match the surrounding topography.

graded stream - a stream that, over a long period of time can move as much sediment as is supplied to it. Compare to "aggrade" and "degrade."

gradient - the measurement of the angle along the length

fill - material used to construct roads and related structures. Fill can include soil, rock, and large organic debris.

full recontouring - the treatment of a road that completely eliminates (obliterates) the road from the landscape. Full recontouring is accomplished by recovering all available fill and burying the cutbank until the surrounding terrain is fully matched. This type of treatment is also referred to as road removal or road obliteration. See obliteration.



A deep gully is hidden by the young forest overstory. Many chronic erosion problems are hidden by vegetation.

of a road or a stream. This term is often confused with grade (see grade).

gully - a steeply sided channel caused by concentrated surface runoff erosion. Gullies can usually be identified by their location away from natural stream valleys.

Humboldt crossing - a stream crossing constructed with logs set parallel to the stream channel and covered with fill.



A road removal project with thick brush mulch under construction.



A dozer and excavator remove fill from a dry stream crossing.

hydrology - the science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rock, and in the atmosphere. This term is often confused with hydrogeology, which is the science of groundwater.

inboard - refers to the upslope side of a road, trail or other feature.

inboard ditch - a drainage ditch cut along the inboard side of the roadbed to intercept drainage from the slope above or small streams. Inboard ditches usually direct their water through a culvert that crosses under the road.

large woody debris (LWD) - also known as large organic debris (LOD), refers to logs and stumps found in stream channels, road fills, etc., having a diameter greater than 12 inches and a length greater than 6 feet.

legacy road - a road originally constructed for another purpose that remains in use. Many of today's park roads were originally constructed as logging roads but now serve as backcountry access roads.

mass wasting - a general term that includes many types of massive earth movements. These include rock slides, debris slides, debris flows, and earthflows, etc.

meander - a series of gentle curves in a stream, road, or trail.

memory - a subsurface zone where water will preferentially flow due the presence of a gully or inboard ditch buried in recontoured fill. Also see ditch memory.

obliteration - to completely remove the



Excavator operator removes an outside berm while dozer shapes the final surface in the background.

road feature from the landscape. This is accomplished by full recontouring. See full recontouring.

outboard - refers to the downslope side of a road, trail or other feature.

operator - the person operating heavy equipment or other machines.

outsloping - the treatment of a road to eliminate diversion potential along the roadbed during road reengineering. Outsloping includes excavation of some of the road fill along the outboard edge of the road and placing it against the cutbank to eliminate the inboard ditch and provide drainage toward the outside of the road. Outsloped roads are commonly graded and covered with compacted road base to harden the surface.

partial recontouring - similar to outsloping, this term is reserved for roads that are to be removed or decommissioned. The partial recontour often has a steeper cross slope on the former roadbed to ensure proper drainage. Partially recontoured roads are not matched at the top of the cutbank like fully recontoured roads.

permeability - a measure of the rate at which water can pass through soil.

ripping - decompaction of the soil by means of rippers mounted on the rear of a dozer.

roadbed - the surface of the road where driving takes place. The roadbed extends from the inboard ditch or cutbank to the outboard slope break or berm.

roadway - the corridor including the cutbank, the inboard ditch, the roadbed, and the embankment.

runoff - rainwater flowing on the surface of the ground. Runoff can be generated by rain falling on saturated ground or from heavy rain that cannot soak in fast enough.

sediment - Silt, sand, clay, and gravel that is moved by water and deposited at some location.

sediment control - activities that filter dirt out of water, including silt fence and sediment retention basins.

slope angle - the angle of the hill slope measured in percent along the fall line.

soil - clay, silt, sand, compost, air, water, and weathered rock mixed in various proportions. Soil consists of horizons or layers that display different amounts of weathering and fertility.

stream crossing - a constructed road section across a natural stream. There are many types of crossings such as bridges, culverts, Humboldt (see definition), and fill crossings.

topography - the natural shape of the land's surface.

topsoil - the uppermost layer of decayed organic matter, seeds, soil, and microorganisms.



After recovering culverts from the excavation the excavator bucket is used to crush them. Crushed culverts can be hauled off or buried in the fill. If you bury them in the fill be sure to crush them completely and avoid stringing them along the inboard ditch. This could form a conduit for subsurface flow. Instead, spread them out and seal the individual pieces in well compacted fill.

APPENDIX C

LITERATURE AND OTHER RESOURCES

ADDITIONAL LITERATURE

California Department of Fish and Game. **California Salmonid Stream Habitat Restoration Manual**. CDFG Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814 or call (916) 654-5997.

California State Parks, 2000, **Trails Handbook**, North Coast Redwoods District, P.O. Box 2006, Eureka, CA 95502-2006 or call (707) 445-6547.

Moll, Jeffry. 1996. **A Guide for Road Closure and Obliteration in the Forest Service**, San Dimas Technology and Development Center. For copies write USDA Forest Service, Technology & Development Center, 444 East Bonita Ave., San Dimas, CA 91773 or call (909) 599-1267.

RCAA, Natural Resources Services Division, 1997, **Stream Care Guide**. Funded by California State Coastal Conservancy and Patagonia. Copies available from Redwood Community Action Agency, 904 G Street, Eureka, CA 95501 or call (707) 269-2059.

Spreiter, Terry. 1992. **Redwood National Park Watershed Restoration Manual**, National Park Service. For copies write to RNP, P.O. Box 7, Orick, CA 95555. Call (707) 464-6101.

United States Department of Agriculture, Forest Service, 1997, **The Water/Road Interaction Technology Series**, San Dimas Technology and Development Center, San Dimas, California.

Weaver, William, and Danny Hagans. 1994. **Handbook for Forest and Ranch Roads. A guide for planning, designing, constructing, reconstructing, maintaining, and closing wildland roads**. The Mendocino Resource Conservation District. Copies available from MCRCD, 405 Orchard Ave., Ukiah, CA 95482.

INTERNET RESOURCES

For general information on State Parks or to obtain this document in PDF format, see <http://www.parks.ca.gov>.

For an annotated bibliography from the The Water/Road Interaction Technology Series, see <http://fswb.sdttdc.wo.fs.fed.us/programs/eng/w-r/w-r.html>.

For information on the erosion and sediment control industry, see <http://www.erosioncontrol.net>.