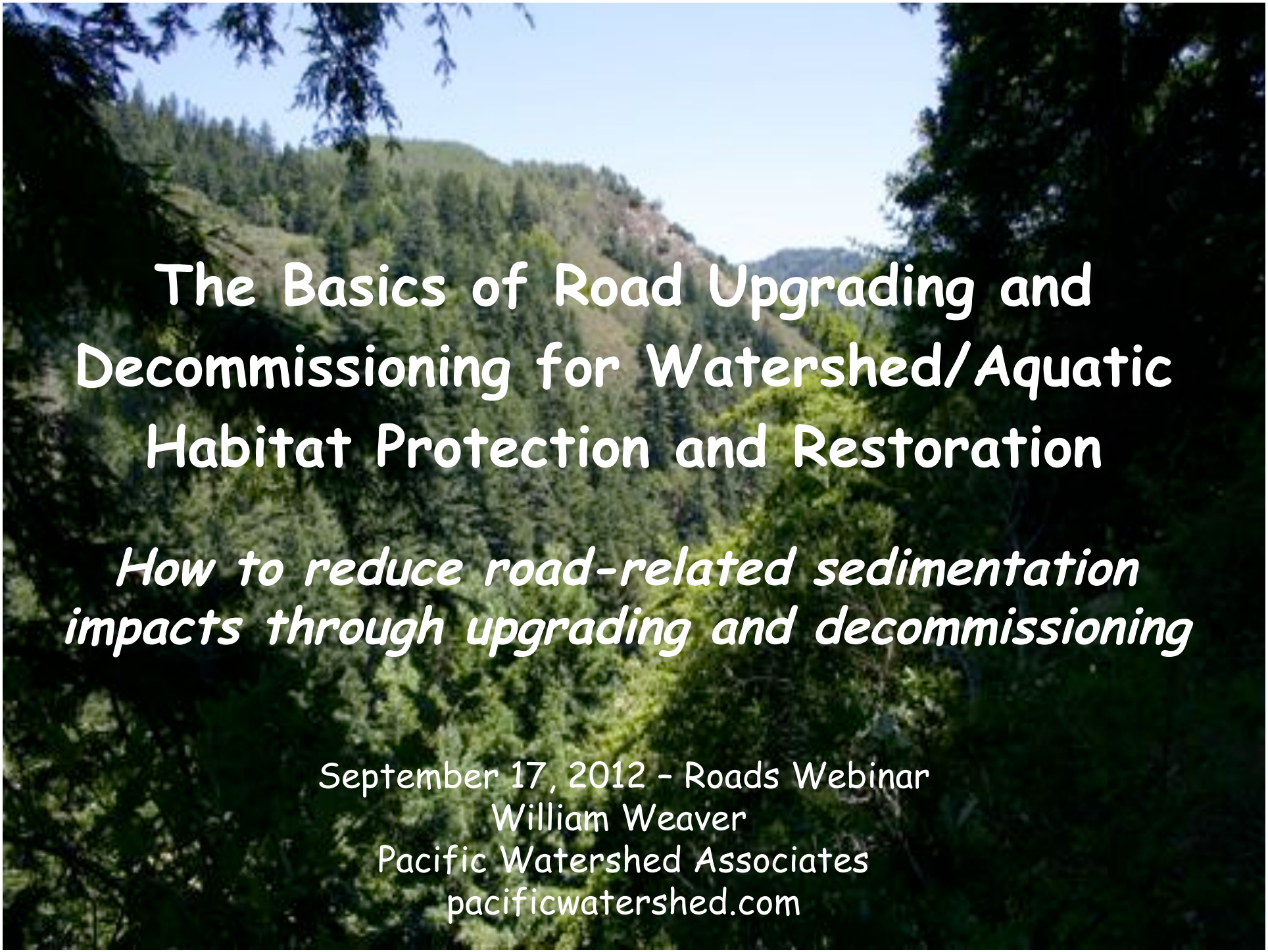

The Basics of Road Upgrading and Decommissioning for Watershed/Aquatic Habitat Protection and Restoration

How to reduce road-related sedimentation impacts through upgrading and decommissioning

September 17, 2012 – Roads Webinar

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Road Upgrading/Decommissioning and Watershed Restoration
(face the facts…)

- Open, maintained roads are common and often generate and deliver large volumes of sediment to streams
- Most roads in most watersheds are not abandoned and will be upgraded and maintained for future management
  - decommissioning is comparatively rare
- Most open, maintained roads were built decades ago to now-outdated standards and have weak points that are susceptible to failure
- Most culverted stream crossings are under-designed, undersized and many have diversion potential
- Most forest roads have high levels of hydrologic connectivity and associated fine sediment delivery
- Old, abandoned legacy roads can be "loaded guns"

Presentation Outline

- **Terminology**
- **Practical objectives** of road upgrading and decommissioning treatments
- The **Seven Step Process** for inventorying and treating road erosion
- Basic **erosion inventory** concepts
  - Conducting a systematic sediment control inventory
- **Prioritizing** roads and sites for treatment
- Basic concepts for **treating** road erosion
  - Deciding what to do: treatment types and treatment mantras
  - Effective road erosion treatments using *upgrading* and *decommissioning*
- **Summary**

Here's why…

Practical objectives for road sediment control treatments

- Reduce failure potential (likelihood)
- Reduce failure magnitude (volume)
- Reduce road-related sediment delivery
- Lower, more predictable aquatic and water quality impacts
- Lower cost of storm damage repair
- Less time "out of service" after storms –fewer washouts and road failures
- Potential increased ability to work and use under "wet" conditions – less turbidity
- Increased ability to manage landscape (forest, ranch, etc)

Here's how…

Seven Step Process of Inventorying and Treating Road Erosion

1) Problem identification – through inventory and assessment
2) Problem quantification – determining future sediment delivery
3) Prescription development – heavy equipment and labor intensive treatments
4) Treatment prioritization
5) Implementation (upgrading & decommissioning)
6) Implementation & effectiveness monitoring
7) Maintenance

Step 1: Identifying the Problems

The Forward-Looking Erosion Inventory

Step 2: Quantifying the Problem

What happens if you do nothing?

Step 3: Prioritize roads and sites for treatment

Getting the most for your money

Location of road-related erosion

- **Stream crossing** erosion (gullying)
- **Road-related landslides** (mass wasting)
- **Road surface runoff and related erosion** (surface erosion and gullying)

- A road location with erosion but no future sediment delivery is not an "erosion site" that needs to be inventoried or treated to protect water quality or fish habitat

Steps 4 & 5: Prescription & Treatment

- Types of road storm proofing
  - Deciding what to do…
- Objectives and standards
- Measures of success
- Common techniques
  - Road upgrading
  - Road decommissioning

What is "Storm Proofing"

Erosion control and erosion prevention work designed to protect a road, including its drainage structures, fills and downslope areas, from serious episodic erosion during large storms and from chronic erosion during intervening periods.

Terminology

Types of road storm proofing

Road Upgrading

Road Decommissioning

Storm Proofing Your Roads

- Types of road storm proofing
- **Objectives and standards**
- Measures of success
- Common techniques
  - Road upgrading
  - Road decommissioning

Technical Standards: Road Upgrading

- Stream crossings
  - Upgraded for 100 year capacity, including organic debris
  - Culvert set on-line and at natural channel grade
  - Plugging potential minimized
  - Diversion potential eliminated
  - Fish passage is accommodated for all life stages
- Road and landing fills
  - Unstable fills that could deliver are excavated/stabilized
  - Spoil is placed where it will not enter a stream
- Road surface drainage
  - Road surfaces and ditches are disconnected from streams
  - Road drainage structures do not drain onto unstable areas

Terminology

Road Decommissioning

Activities that result in the stabilization and restoration of unneeded roads to a more natural state." (USFS)

The physical treatment of a roadbed to restore the integrity of associated hillslopes, channels, and flood plains and their related hydrologic, geomorphic, and ecological processes and properties (Wildlands CPR)

Procedures that permanently close a road in a manner that prevents erosion, maintains hillslope stability, and re-establishes natural drainage patterns (CAL FIRE 2007).

Terminology

Road Decommissioning

-Road decommissioning (permanent)
-Road decommissioning (temporary)
-Road closure
-Road storage
-Road abandonment
-Road obliteration
-Hydrologic obliteration
-Road removal
-Road rehabilitation
-Road reclamation
-Putting the road "to bed"
-Road vacating
-Road deactivation

Technical Standards: Road Decommissioning

- Stream crossing side slopes: Excavated and sloped at 2:1 or to the grade of natural side slopes above and below the crossing
- Stream crossing channel profile: Excavated at natural channel grade through the crossing with no abrupt grade changes at the top or the bottom of the excavation – the standard is to exhume original channel bed
- Stream crossing channel width: Excavated to match or exceed the natural channel width outside of the influence of the crossing; the design standard is the 100-year flow width
- Road approaches and all road reaches: Hydrologically disconnected to minimize direct runoff into the crossing or into nearby streams
- Road related fill slope landslides: Fillslope landslides with potential for sediment delivery are excavated and removed

Storm Proofing Your Roads

- Types of road storm proofing
- Objectives and standards
- **Measures of success**
- Common techniques
  - Road upgrading
  - Road decommissioning

Measures of success

- **Road upgrading – *resiliency & threat reduction***
  - Decreased culvert plugging
  - No unexpected stream diversions
  - Lower frequency of stream crossing washout
  - Lower sediment delivery from crossing failure
  - Lower frequency and delivery from road fill failures
  - Hydrologic connectivity reduced to 10% to 20%, or less
- **Road decommissioning – *eliminate threats***
  - Excavated stream crossings exhibit less than 5%, preferably less than 2%, loss of erodible fill volume
  - Lower frequency & delivery from road fill failures
  - Hydrologic connectivity reduced to less than 5%

Storm Proofing Your Roads

- Types of road storm proofing
- Objectives and standards
- Measures of success
- **Common techniques**
  - **Road upgrading**
  - **Road decommissioning**

Questions?

Road Upgrading Treatments

Road Upgrading

- Goals of road upgrading
- Four treatment mantras
- Stream crossing treatments
  - Types of stream crossing upgrade treatments
  - Culvert accessories
  - Armored fill stream crossings
- Treatment of unstable fillslopes
- Road surface drainage treatments
  - Road shaping
  - Drainage structures

Goals of road upgrading

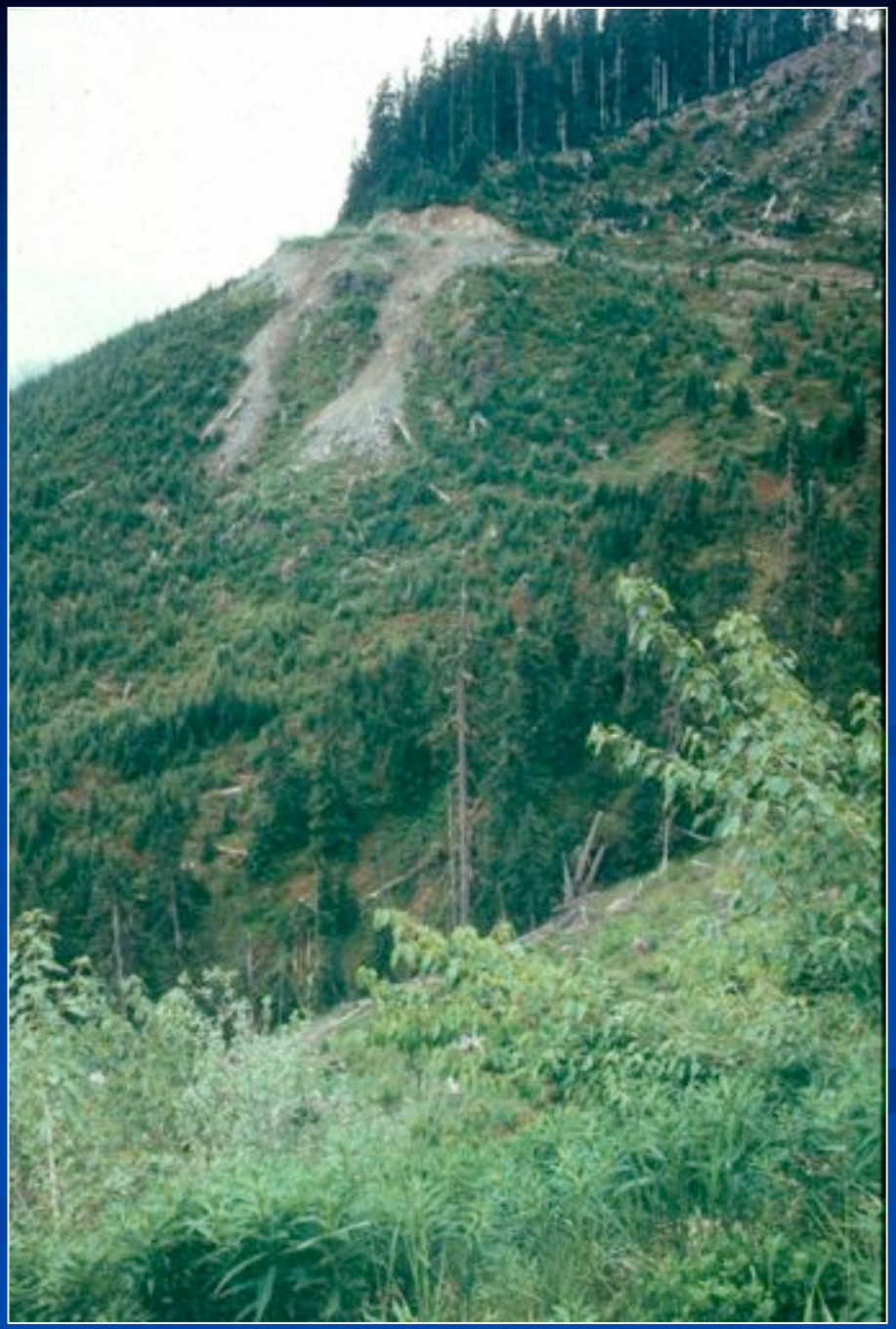
- Minimize the risk of episodic erosion and sediment delivery triggered by large magnitude, infrequent storms
- Strictly minimize fine sediment contributions from roads and ditches to stream channels
- Produce a low maintenance, low cost, low impact road

Four Road Upgrading Treatment Mantras

1) Treat sites of sediment delivery
2) Treat the cause, not the symptom
3) If you don't change anything, it's just going to happen again
4) Prevent erosion before you have to try to control it

Erosion versus sediment delivery:

1) Treat sites of sediment delivery



2) Treat the cause, not the symptom

Gullies from road surface runoff

3) If you don't change anything, it's just going to happen again…

4) Prevent things from happening in the first place!

1) Treating Stream Crossings

A. Treating Stream Crossings

- CAUSE: Stream crossing erosion and sediment delivery is caused by:
  - Culvert overtopping and gullying (washout)
  - Stream diversion (off-site gullying and landsliding)
  - Culvert outlet erosion, downcutting, bank erosion
  - Surface erosion on bare fillslopes

- TREATMENT: Stream crossing erosion is treated by culvert upgrading (upsizing, improved placement, lengthening), eliminating diversion potential, reducing plugging potential, vegetating bare soil areas, and stabilizing and protecting fillslopes.

Stream crossing culvert alignment and orientation

100-yr culvert in anadromous stream (20%+ embedded)

Culvert alignment (vertical and horizontal)

Emergency overflow culverts

Emergency overflow culvert

100-yr CMP with flared inlet & critical dip

Culvert accessories

Critical dips for culverted crossings

(to prevent stream diversions)

Locate critical dips on hingeline to eliminate diversion potential and reduce failure magnitude

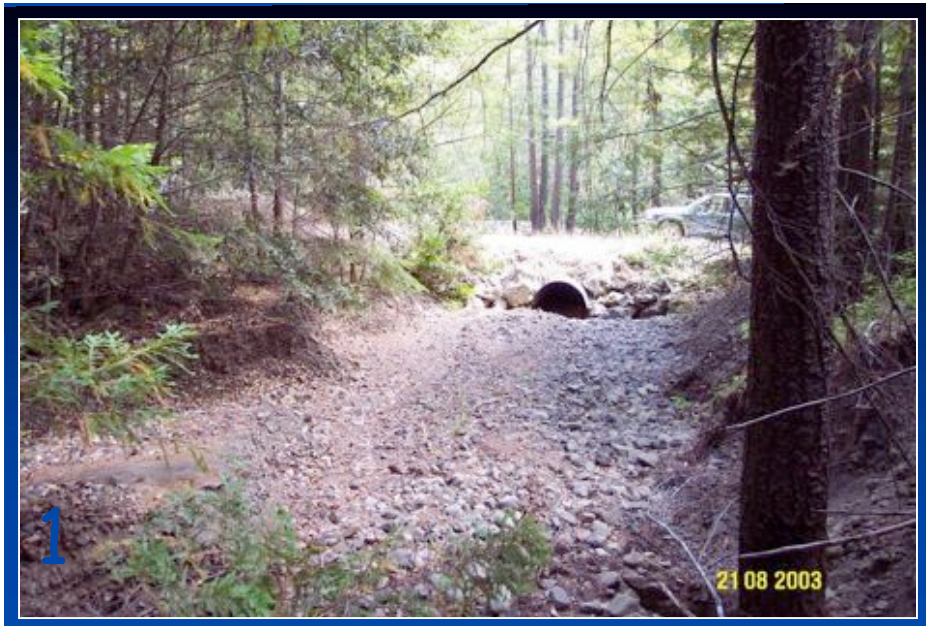
Culvert upgrade: before

Culvert upgrade: 100 yr design

Before

After upgrading (and overtopping)

Conversion of culverts to bridges



Culvert to bridge conversion and culvert upgrades:

Excavating stored sediment

Conversion of culverts to bridges

…to eliminate failure potential

Bridge replacement to current standards

Rolling dip – disconnecting approaches

Road Grade on Bridge Approach

Road erosion treatments - upgrading

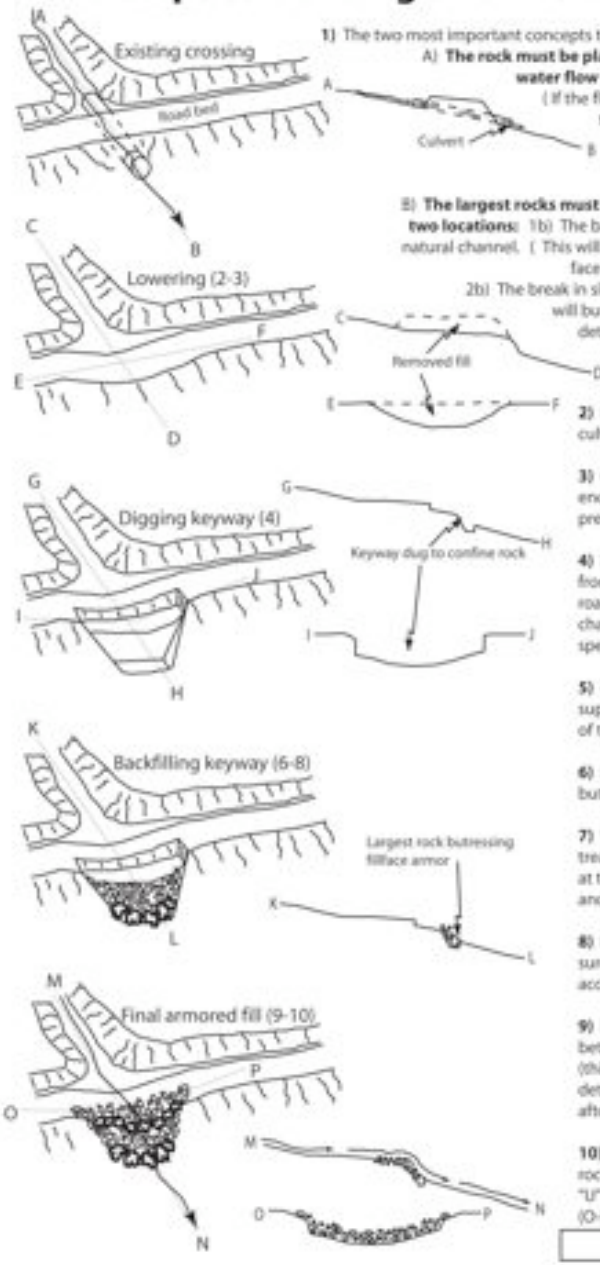
Armored fill crossings: an alternative to culverts

Road erosion treatments - upgrading

Armored fill crossings

10 steps to building an armored fill crossing

10 steps to building an armored fill stream crossing



Building an armored fill

1) The two most important concepts to understand when constructing an armored fill are:

A) **The rock must be placed in a "U" shape across the channel so that the water flow will always stay confined within the armored area.** (If the flow gets around the rock armoring it will quickly gully through the remaining road fill. Proper shaping of the remaining road fill and good armor placement will reduce the likelihood of crossing failure.)

B) **The largest rocks must be used to butresss the rest of the rock armor in two locations:** 1b) The base of the armored fill where the road fill meets the natural channel. (This will buttress the armor placed on the outboard road fill face and reduce the likelihood of it washing downslope.) 2b) The break in slope from the road tread to the outer fill face. (This will buttress the fill placed on the outer road tread and will determine the "base level" of the creek as it crosses the road surface.)

2) Remove any existing drainage facilities including culverts and humboldt logs.

3) Costruct a dip centered at the crossing that is large enough to accomodate the 100 yr. flow event and prevents diversion. (C-D, E-F)

4) Dig a keyway (to place the rock in) that extends from the outer 1/3 of the road tread down the outboard road fill to where the outboard fill meets the natural channel, up to 3' into channel bed depending on site specific specifications. (G-H, I-J)

5) (Optional) Install geofabric within keyway to support rock in wet areas and to prevent winnowing of the crossing at low flows.

6) Put aside the largest rock armoring to create 2 buttresses in the next step. (K-L)

7) Use the largest rock available (as described in the treatment specifications at the site) to create a buttress at the base of the fill. (this should have a "U" shape to it and it will define the outlet of the aromored fill.)

8) Backfill the fillface with remaining rock armor making sure the final armored area has a "U" shape that will accomodate the largest expected flow. (K-L)

9) Install a second buttress at the break in slope between the outboard road and the outboard fill face. (this should define the base level of the stream and determine how deep the stream will backfill after construction.) (M-N)

10) Back fill the rest of the keyway with the unsorted rock armor making sure the final armored area has a "U" shape that will accomodate the largest expected flow (O-P)

Pacific Watershed Associates (2005)

Questions?

2) Treating Unstable Fillslopes

B. Treating Unstable Fillslopes

- CAUSE: Unstable road and landing fillslopes are caused by sidecasting onto steep slopes. Debris flows are caused by filling steep, wet swales during road construction.
- TREATMENT: Only those instabilities or potential instabilities that could deliver sediment to a stream are treated.
- Unstable fillslopes and potential debris flow sites are usually treated by direct excavation of unstable fill material, and redirection of runoff

Excavation of unstable fillslope on upgraded road

Cutbank Debris Slide

3) Treating Road Surface Erosion, Road Drainage and Hydrologic Connectivity

Hydrologic Connectivity

Example Connectivity Results

Road-stream connectivity values reported in the literature

Watershed or Area	Road Length (mi)	Hydrologic Connectivity (%)	Reference
Clearwater basin, Olympic Mountains, Washington	350.0	75	Reid and Dunne, 1984[1]
Blue River, Oregon (Cascades)	38.5	57	Wemple, 1994; Wemple et al., 1996
Deschutes River, Washington	13.7	45 - 57	Bowling et al., 1996; Bowling & Lettenmaier, 2001
Kilchis watershed, Oregon (Coast)	117.0	25 - 39	Mills, 1997
Oregon – All 5 Geo-Regions	285.0	25 - 31	ODF, 1996; ODF, 1998
Bear Creek, North Coastal California	15.9	28 - 35	PWA, 1998
Southwest Washington; Northern Oregon Cascades	453.0	34	Bilby et al., 1989
North Coastal California watersheds	518.0	33 (6-74)	PWA (unpubished)
Central Sierra Nevada, California	12.4	20	Coe & MacDonald, 2001
Total and mean values	1,803	42%	

Sediment Delivery from "Hydrologically Connected" Roads over the next decade (assumes all sites fail and deliver)

Project Area[1]	Watershed	County	Total Miles of Road	Total Sediment Delivery (yds^3)	Total Road Connectivity Delivery (yds^3)	Road Connectivity: % of Total Delivery
Biscuit Fire (OR)	Rogue	Siskiyou	135	389,000	101,000	**26%**
Wilson Creek	Klamath	Del Norte	109	252,000	85,500	**34%**
Reed Mt.	S.F. Eel	Humboldt	30	28,700	17,000	**59%**
Woodman Creek	Middle Eel	Mendocino	25	30,500	17,500	**57%**
Greenfield Ranch	Russian	Mendocino	33	14,300	8,800	**62%**
U.C. Hopland	Russian	Mendocino	36	24,900	16,000	**64%**
Navarro Ranch	Russian	Sonoma	71	80,500	37,000	**46%**
Garrapata Creek	Garrapata	Monterey	21	12,400	5,900	**48%**
Old Coast Road	Little Sur	Monterey	11	27,000	19,900	**70%**
Totals:			**471**	859,300	308,600	**36%**

1) PWA data, various road assessments

Treating Hydrologic Connectivity

- **CAUSE**: Road surface erosion is caused by mechanical abrasion and poor road surface drainage…

- **Sediment delivery** occurs where road surfaces and ditches are "hydrologically-connected" to stream channels

- **TREATMENT**: Hydrologic connectivity is treated by road surface shaping and the installation of road surface and ditch drainage structures to disperse runoff onto hillslopes

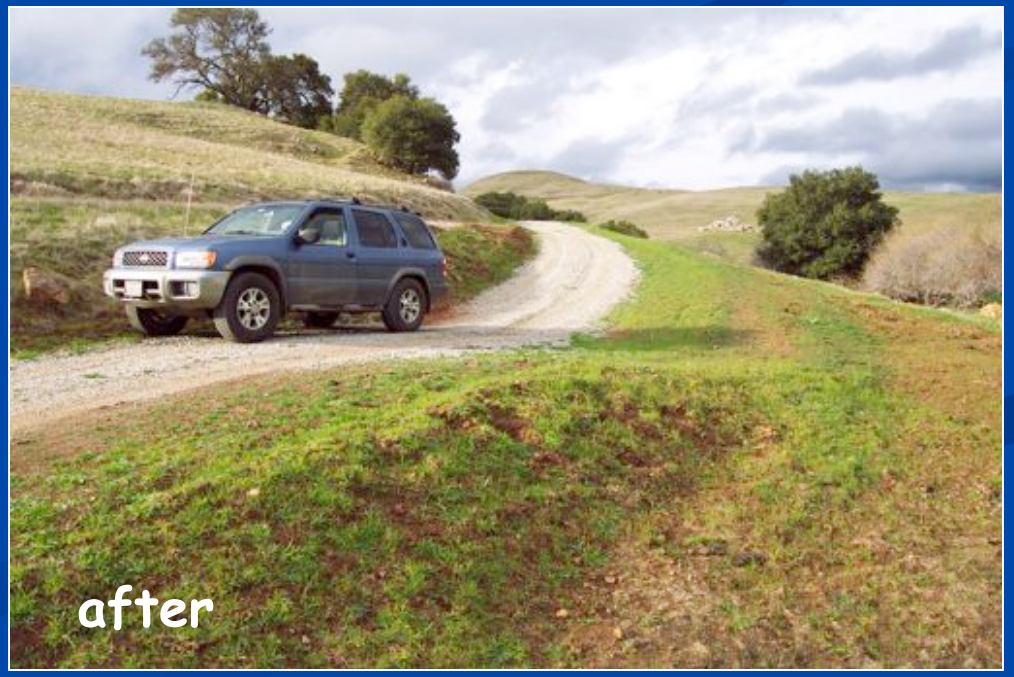
ROAD DRAINAGE TREATMENTS

Road shaping

Road shape conversion

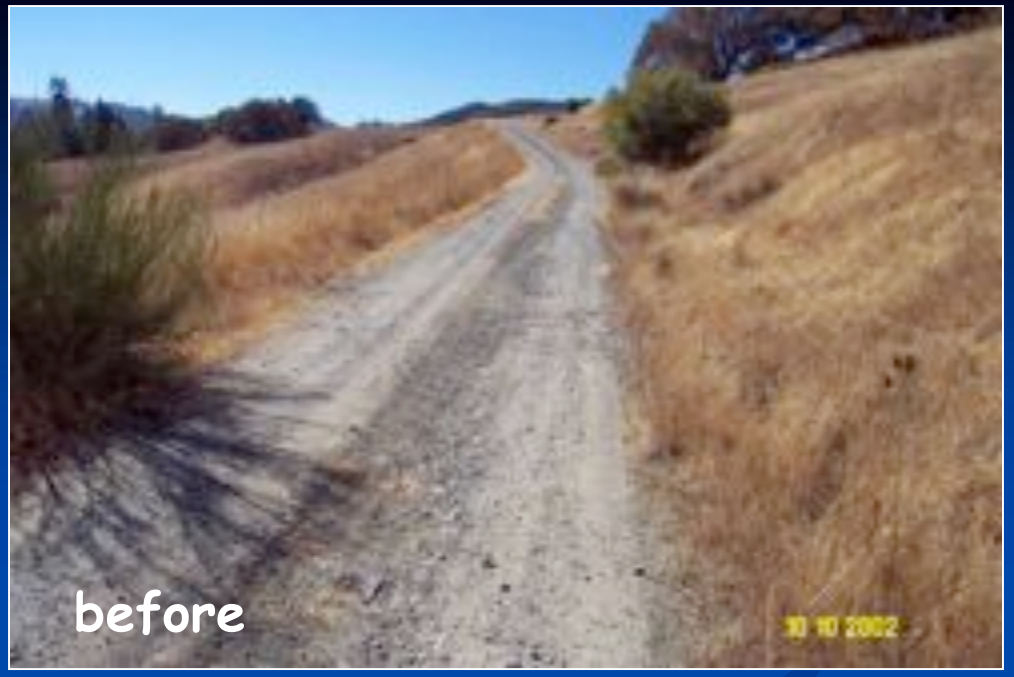
Insloped with ditch, wheel ruts & berm – Gullied with 100% connectivity

Outsloped with rolling dips – No connectivity

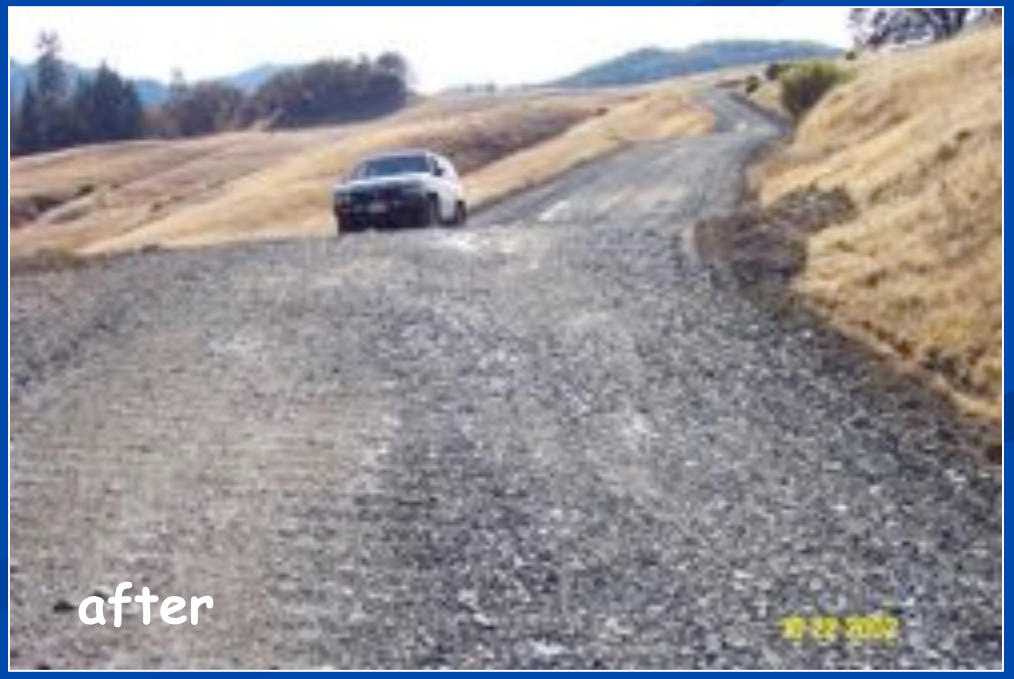


Road shape conversion

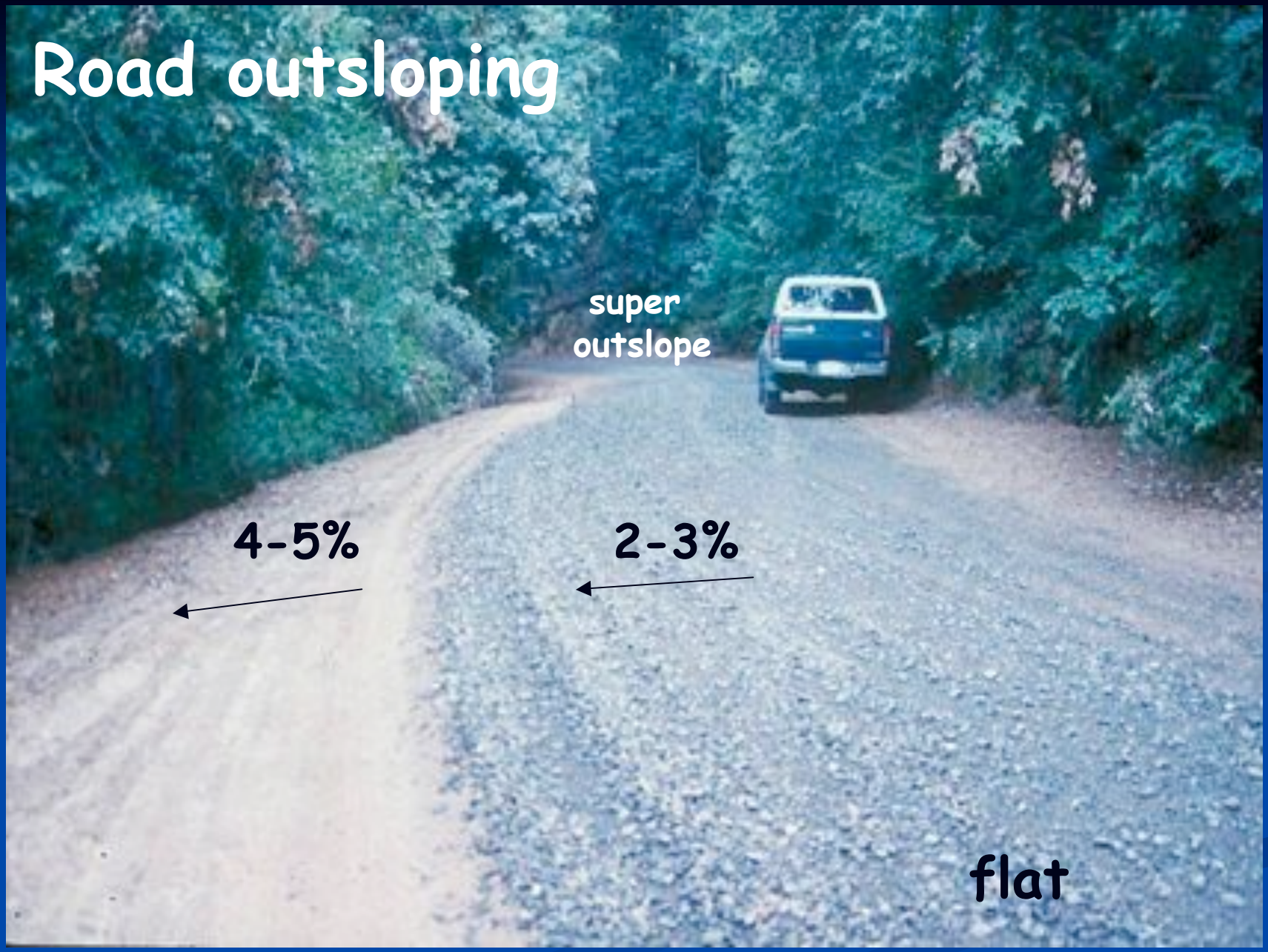
Insloped
with ditch –
100% connectivity



Outsloped with
rolling dips –
No connectivity



Road outsloping



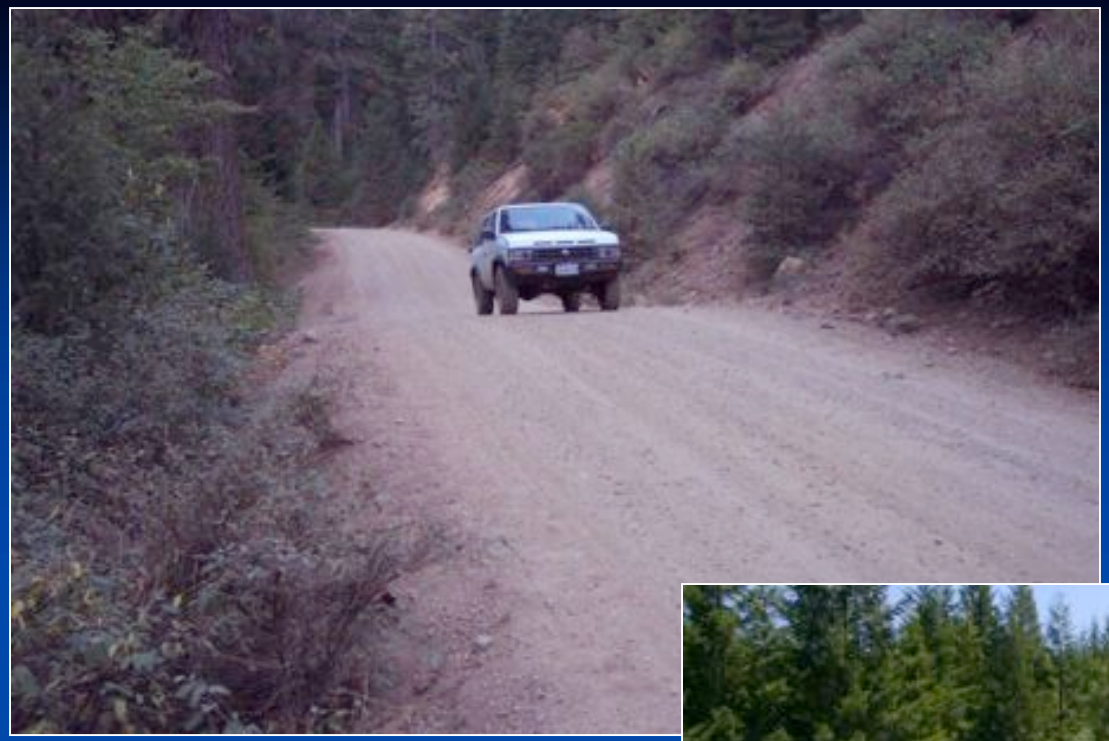
Driveability, Functionality and Safety

ROAD DRAINAGE STRUCTURES

Rolling grade, rolling dips, ditch relief culverts and berm breaks

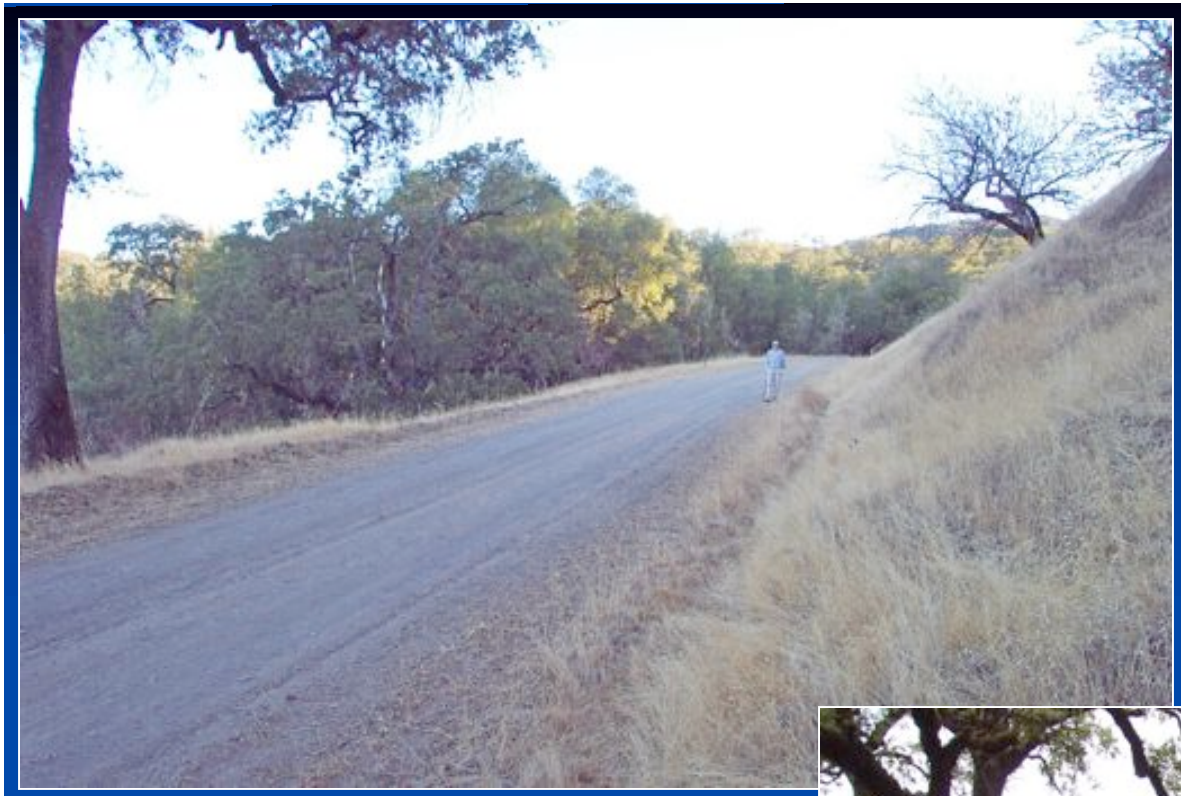
Road with rolling grade

Road erosion treatments - upgrading



Outsloped with rolling dips – ditch eliminated

Road erosion treatments – upgrading



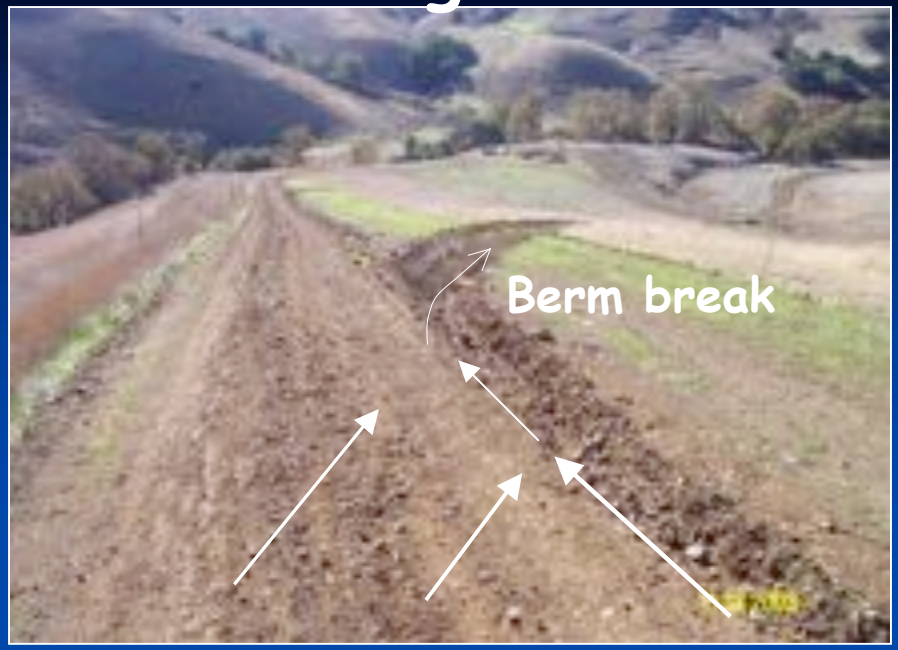
Outsloped with rolling dips – ditch retained

Drainage cut-out drains road rut

Berm breaks on a fall-line road

Road drainage structures

Road erosion treatments - upgrading



Road connectivity comparison following road storm-proofing along 15.2 miles of forest roads.

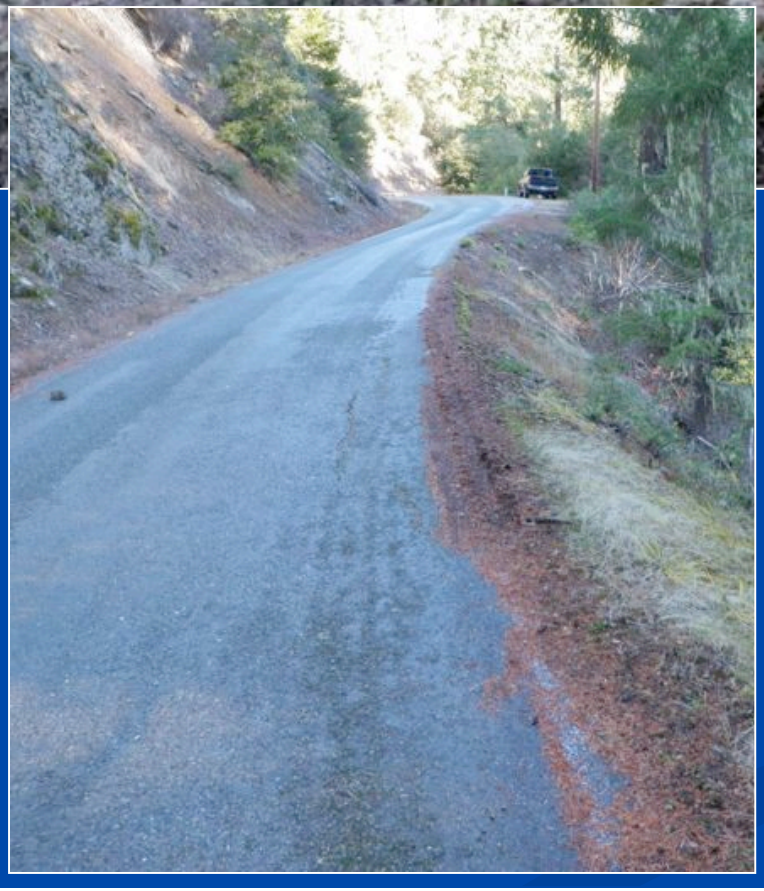
Connectivity site type	1998 Connectivity (pre-treatment) (ft)	Connected road/ditch length of forest roads (ft)		Average connected length as of 2005
		2004	2005	
Stream crossing approach	23,930	14,100	3,630	84 ft
Ditch relief culvert	27,000	9,450	1,600 [1]	178 ft
Gully/rolling dips	3,860	5,325	800 [1]	200 ft
Other	6,350	825	0	0 ft
Total (15.2 mi):	**61,140'**	**29,700'**	**6,030'**	108 ft
Connectivity	**76.2%**	**37.0%**	**7.5%**	--

[1] Eliminating these connected sources would reduce overall connectivity to **4.5%**

Variants & Obstacles in Upgrade Treatments

- Paved roads
- County Roads (paved/unpaved public roads)
- Main Line USFS roads (paved and unpaved)
- Roads in the snow zone
- Steep roads (>~12%)
- Road use types and levels (speed and clearance restrictions (e.g., lowboys, FedEx and BMWs); commercial roads vrs subdivision roads)
- Stream crossings in debris flow channels

Obstacles and variants to typical upgrading treatments



Obstacles and variants to typical upgrading treatments

Treatments in the snow zone

Insloping

Outsloping

Road erosion treatments - upgrading

Trenchless pipe ramming under high traffic public roads

SUMMARY
Measures of Success for Road Upgrading Treatments

- **Road upgrading**
  - Decreased culvert plugging
  - No unexpected stream diversions
  - Lower frequency of stream crossing washout
  - Reduced sediment delivery from crossing failures
  - Lower frequency and delivery from road fill failures
  - Hydrologic connectivity reduced to 10% to 15%, or less!

Questions?

Road Decommissioning

Common Techniques: Road Decommissioning

- Ripping or decompaction
- Cross-road drain construction or outsloping
- Excavation of unstable fillslopes
- Stream crossing removal
- Endhauling and spoil disposal

Road Decommissioning Heavy Equipment

Ripping and decompaction

Decommissioned Road

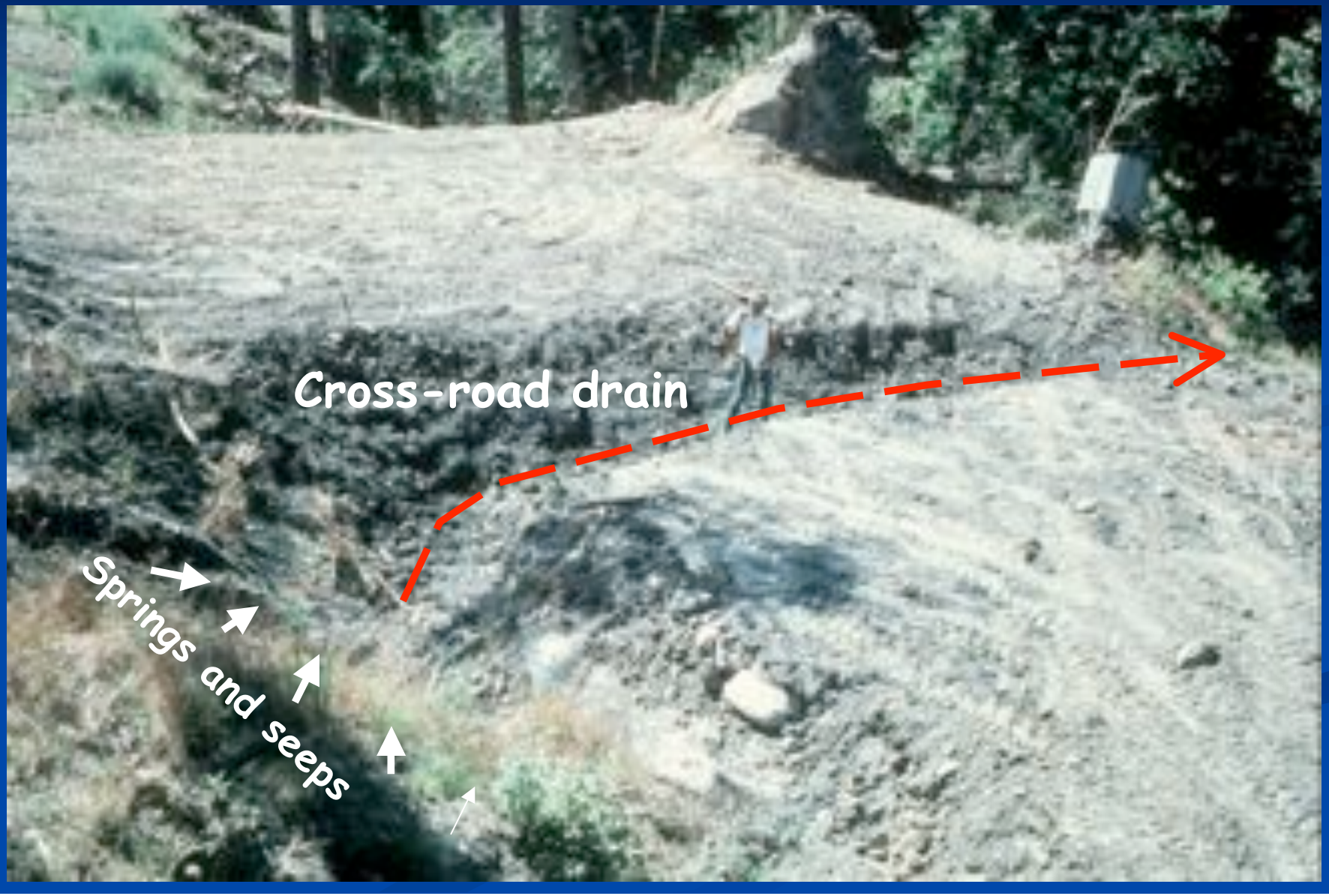
Decompaction or Road Ripping:

- ✓Increases infiltration
- ✓Reduces runoff
- ✓Promotes vegetation

Road Decommissioning

Road Decommissioning

Cross Road Drains



Decommissioned forest road

Road ripped and cross-road drained

(straw mulch was added to improve microclimate & promote revegetation)

In-place Outsloping

Road erosion treatments – decommissioning

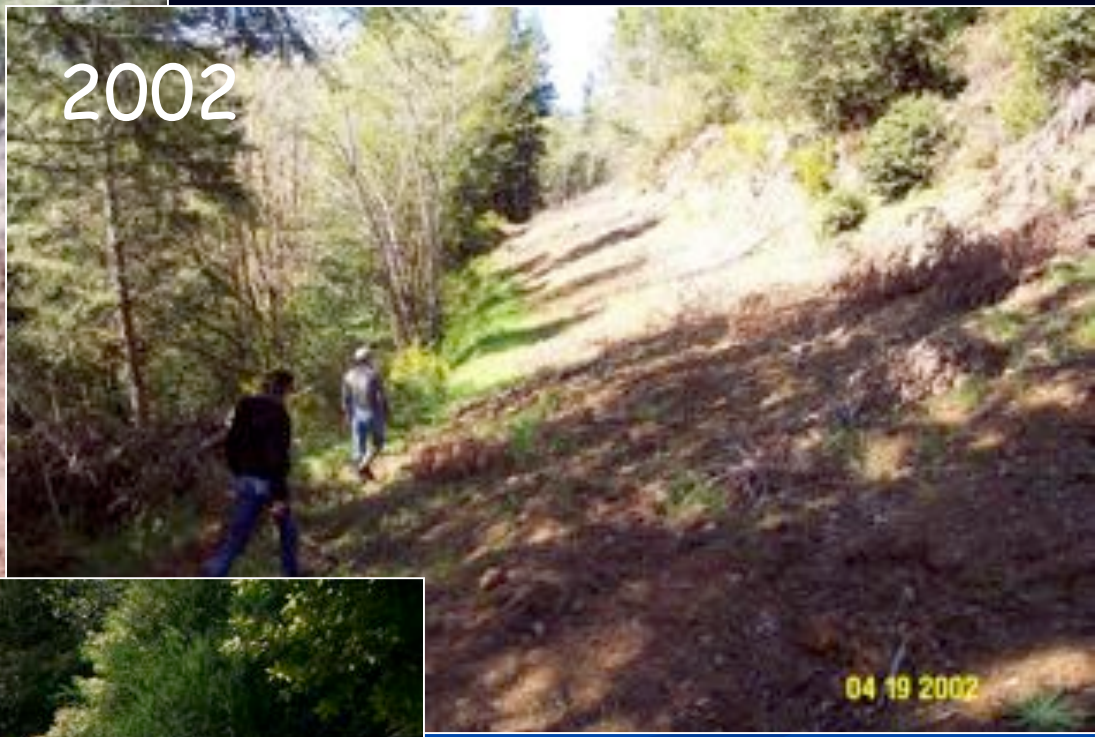
In-Place Outsloping
Local spoil disposal

In-place outsloping

(local spoil disposal)

Export Outsloping

(spoil endhauled)



Import outsloping

(spoil hauled to site and used to outslope stable road)

Trail outsloping (road-to-trail conversion)

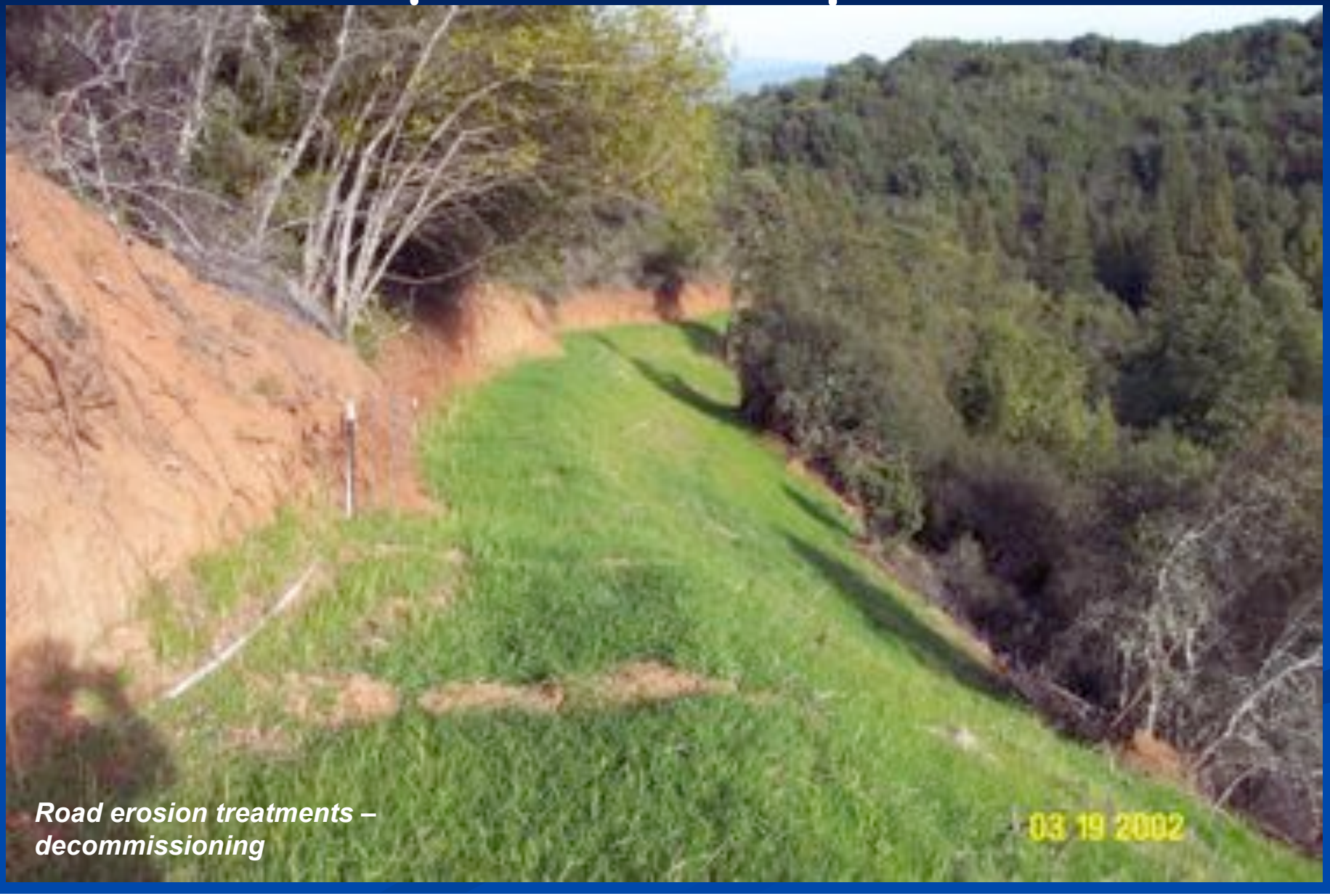
Road erosion treatments – decommissioning

Trail outsloping (road to trail conversion)

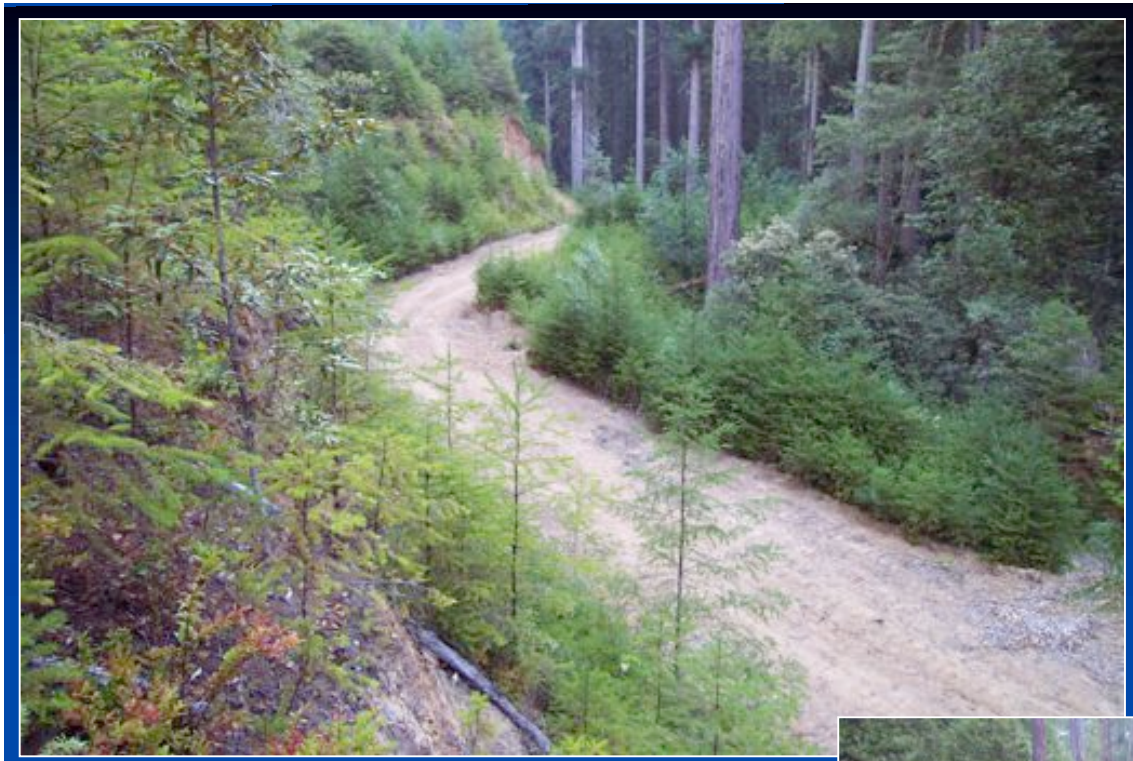
Road erosion treatments – decommissioning

Trail outsloping (road to trail conversion)

Trail outsloping (road-to-trail conversion) with quad fire escape route



Road erosion treatments – decommissioning



Road Obliteration
(total recontouring)

Stream Crossing Decommissioning
(small = <250 yd^3)

Stream Crossing Decommissioning (medium=250-500 yd^3)

Before

After

Decommissioned stream crossing
(large = >500 yd^3)

Road erosion treatments – decommissioning

Decommissioned stream crossing

(very large = >2000 yd^3)

Road erosion treatments – decommissioning

Decommissioned stream crossing (large)

Road erosion treatments – decommissioning

Decommissioned stream crossing (large)

Road erosion treatments – decommissioning

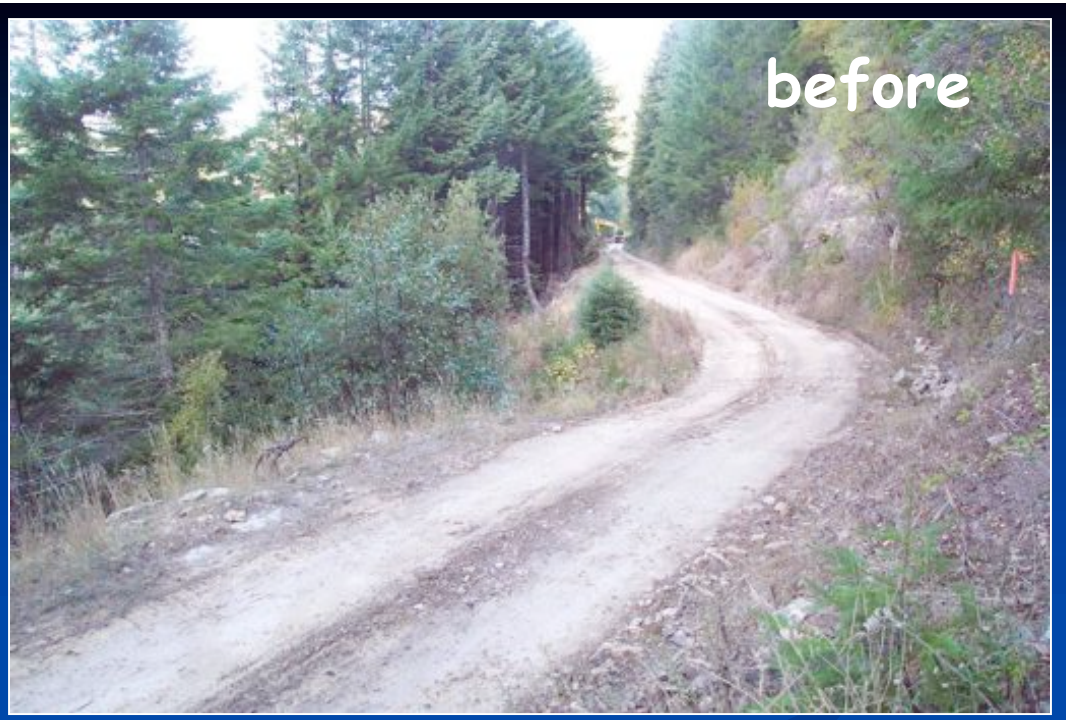
Decommissioned stream crossing (large)

Road erosion treatments – decommissioning

Decommissioned Class I stream crossing (fish passage)

Road erosion treatments – decommissioning

Unstable road and landing fillslope excavation



Measures of success for Road Decommissioning Treatments

- **Road decommissioning**
  - Stream crossing decommissioning prevents at least 95% of predicted erosion and sediment delivery.
  - Decommissioning results in a lower frequency & delivery from road fill failures
  - Hydrologic connectivity is reduced to less than 5%

Typical errors in road decommissioning

Potential Problems: Bank Erosion and Channel Downcutting

Insufficient channel width

Incomplete excavation

Problems: Side Slope Failures

Spoil disposal on sideslopes of decommissioned stream crossing

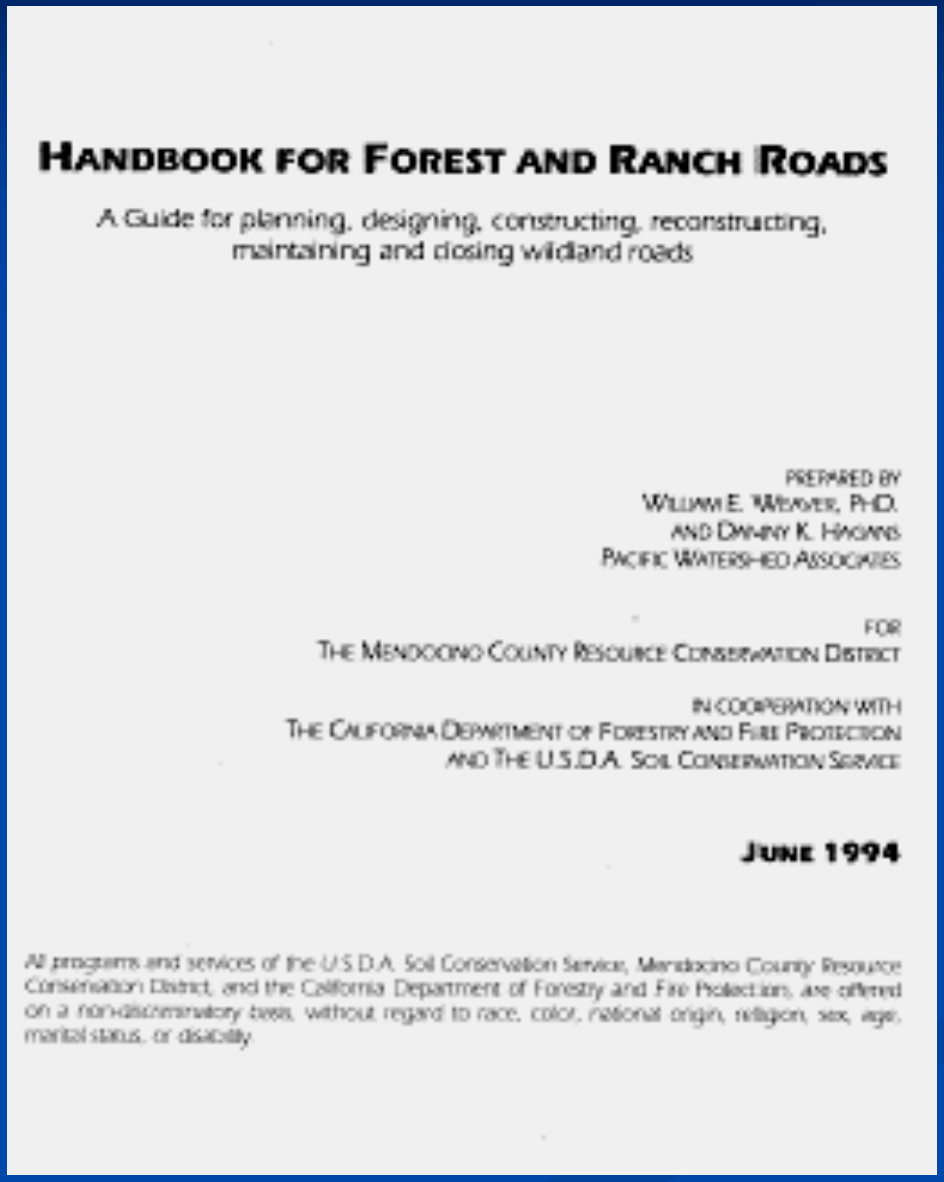
Summary

1) Determine what road(s) need to be inventoried
2) Use a standardized data form that is accepted by regulatory agencies (e.g., http://www.dfg.ca.gov/fish/Resources/HabitatManual.asp)
3) Employ systematic, repeatable, quantitative data collection and measurement techniques in the inventory
4) Only inventory sites of sediment delivery
5) Have an experienced, qualified person check your conclusions and proposed prescriptions (QA/QC)

Summary (continued)

6) Prioritize the roads/sites that are recommended for treatment, according to your project requirements (H, M, L)
7) Prescribe and use the most cost-effective treatments
8) Prevent problems before they develop (erosion prevention)
9) Only treat sites of sediment delivery
10) Treat the cause of the problem, not the symptom.
11) Monitor, observe and maintain the project for best performance

Useful References



HANDBOOK FOR FOREST AND RANCH ROADS

A Guide for planning, designing, constructing, reconstructing, maintaining and closing wildland roads

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FOR
THE MENDOCINO COUNTY RESOURCE CONSERVATION DISTRICT

IN COOPERATION WITH
THE CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION
AND THE U.S.D.A. SOIL CONSERVATION SERVICE

JUNE 1994

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The Road-Ripper's Guide to Wildland Road Removal
By Scott Bagley

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Wildlands Center for Preventing Roads (Wildlands CPR) is a national clearinghouse and network working to protect and restore wildland ecosystems by preventing and removing roads and limiting motorized recreation.

Wildlands CPR uses a visionary strategy that integrates conservation biology, activism and law to:

- **Act as a national clearinghouse**, providing activists with the tools and strategies needed to prevent or close environmentally damaging roads and motorized recreation in wildland ecosystems.
- **Train activists** to prevent, close and remove wildland roads using sound biological and legal information.
- **Inform the public** about the environmental damage caused by roads and motorized recreation and how to change public land management decisions.

Wildlands Center for Preventing Roads
P.O. Box 7516
Missoula, MT 59807
406/543-9551
WildlandsCPR@WildlandsCPR.org
http://www.wildlandscpr.org/

Useful References *(cont)*

The goals of this video and the companion Forest and Ranch Roads Handbook are to assist landowners in:

- Making roads safer and more reliable in all kinds of weather
- Maintaining downstream water quality by avoiding excessive erosion caused by the road
- Reducing road maintenance costs
- Avoiding litigation as a result of excessive erosion such as violations of the Clean Water Act, or property damage to downhill or downstream neighbors
- Low impact and low cost roads in the future

Copies of this video and the Forest and Ranch Roads Handbook are available from

MENDOCINO COUNTY RESOURCE CONSERVATION DISTRICT

405 S. Orchard Avenue
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(707) 468-9223
www.mrcd.co.nacdnet.org

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Forest and Ranch Roads

A guide to improving, repairing and restoring roads for water quality, fish and humans.

High Low Media Video Productions

Pacific Watershed Associates

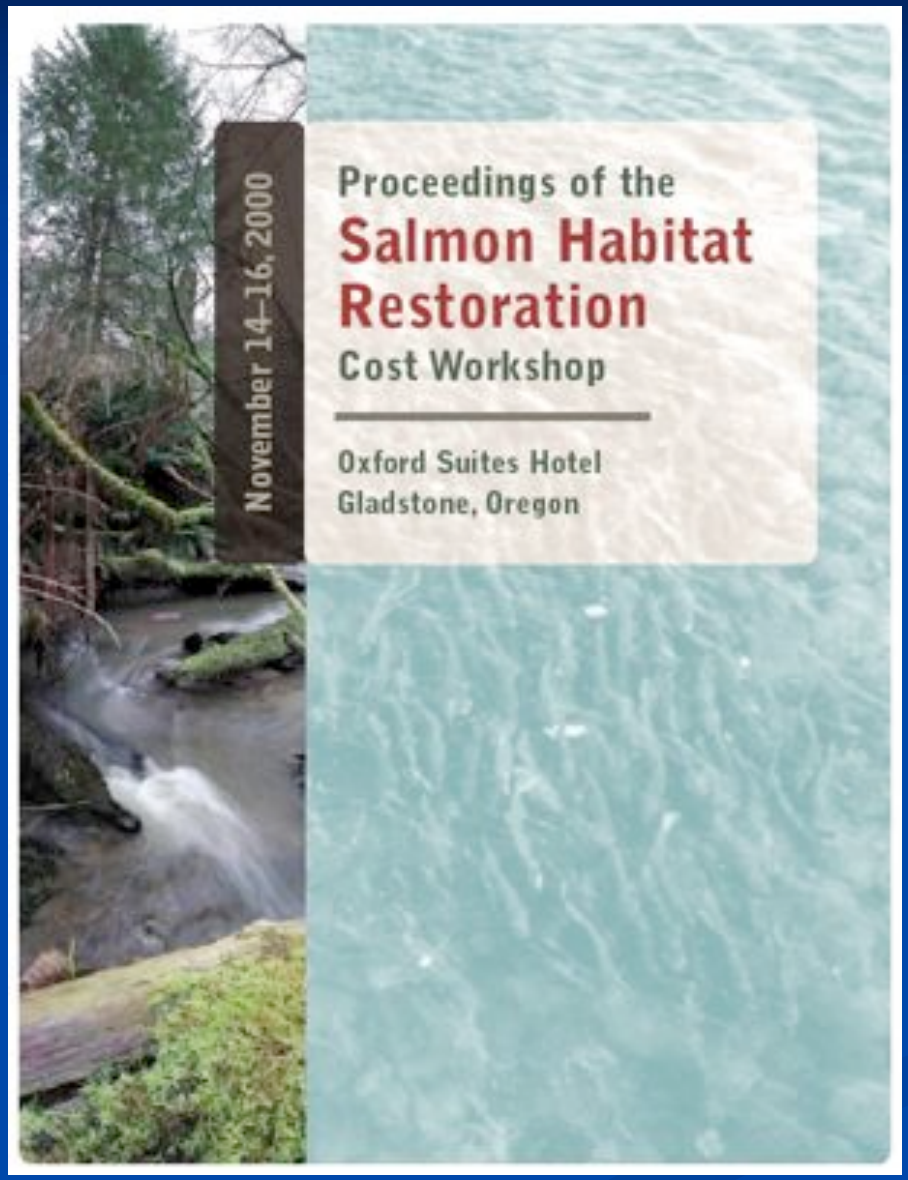
Ridge to River

58 Minutes

Forest and Ranch Roads

A guide to improving, repairing and restoring roads for water quality, fish and humans.

Useful References *(cont)*



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graphic design: Jeff Bright, www.jeffbrightdesign.com

spawning coho salmon photos: Thomas Dunklin, www.thomasbdunklin.com

Useful References *(cont)*

State of California
The Resources Agency
Department of Forestry & Fire Protection

Designing Watercourse Crossings for Passage of 100-year Flood Flows, Wood, and Sediment

California Forestry
Report No. 1

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February 2004

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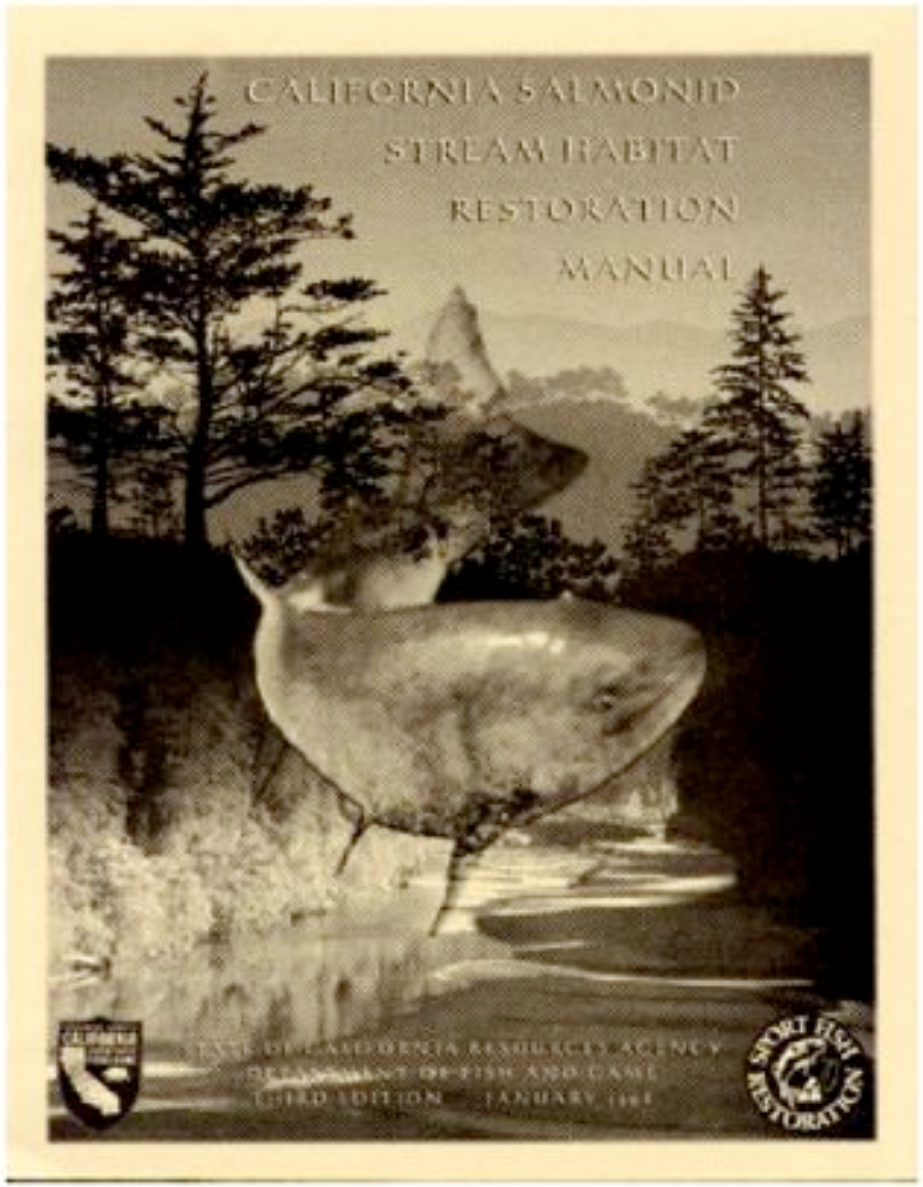

PART X

UPSLOPE EROSION INVENTORY
AND SEDIMENT CONTROL GUIDANCE

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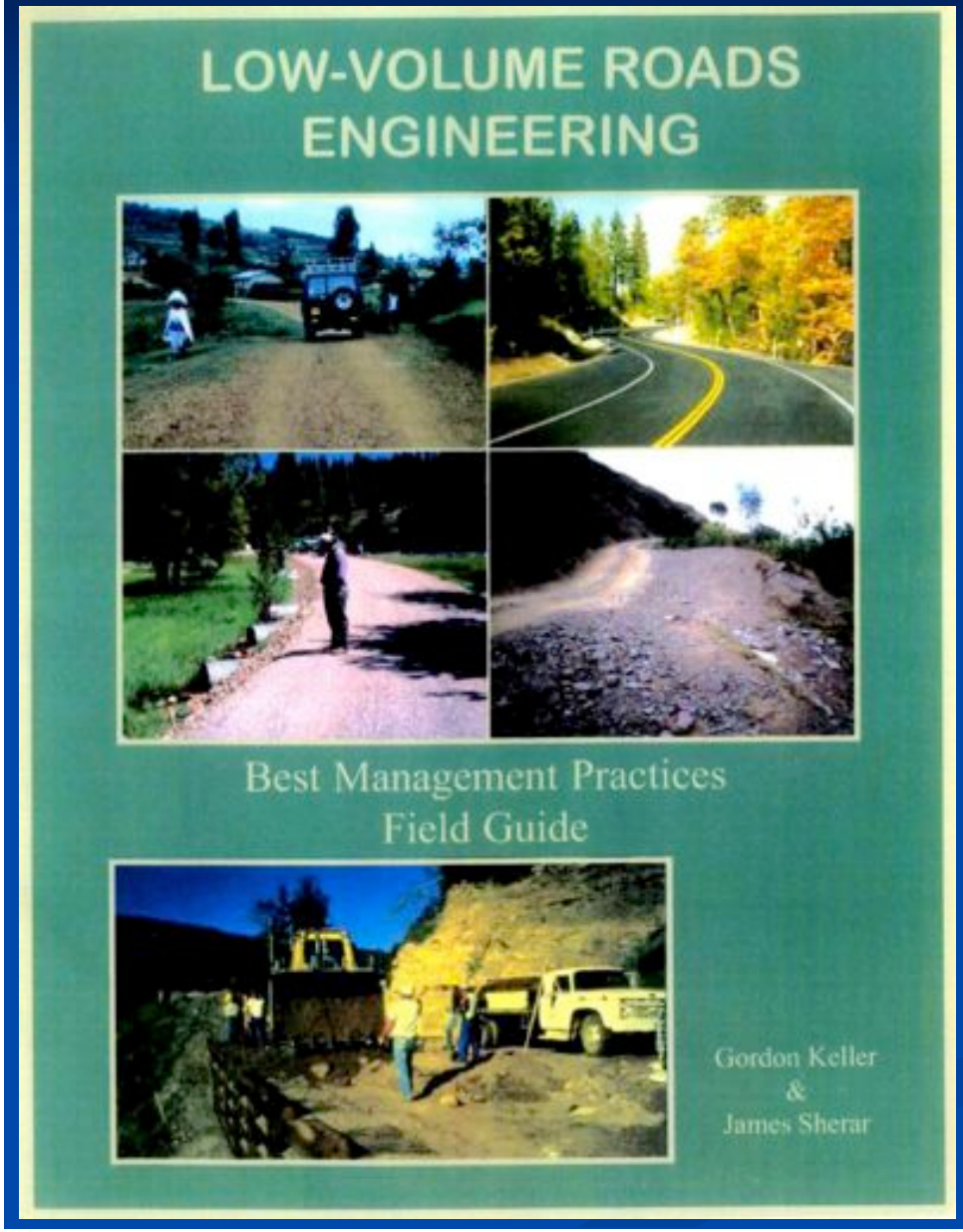

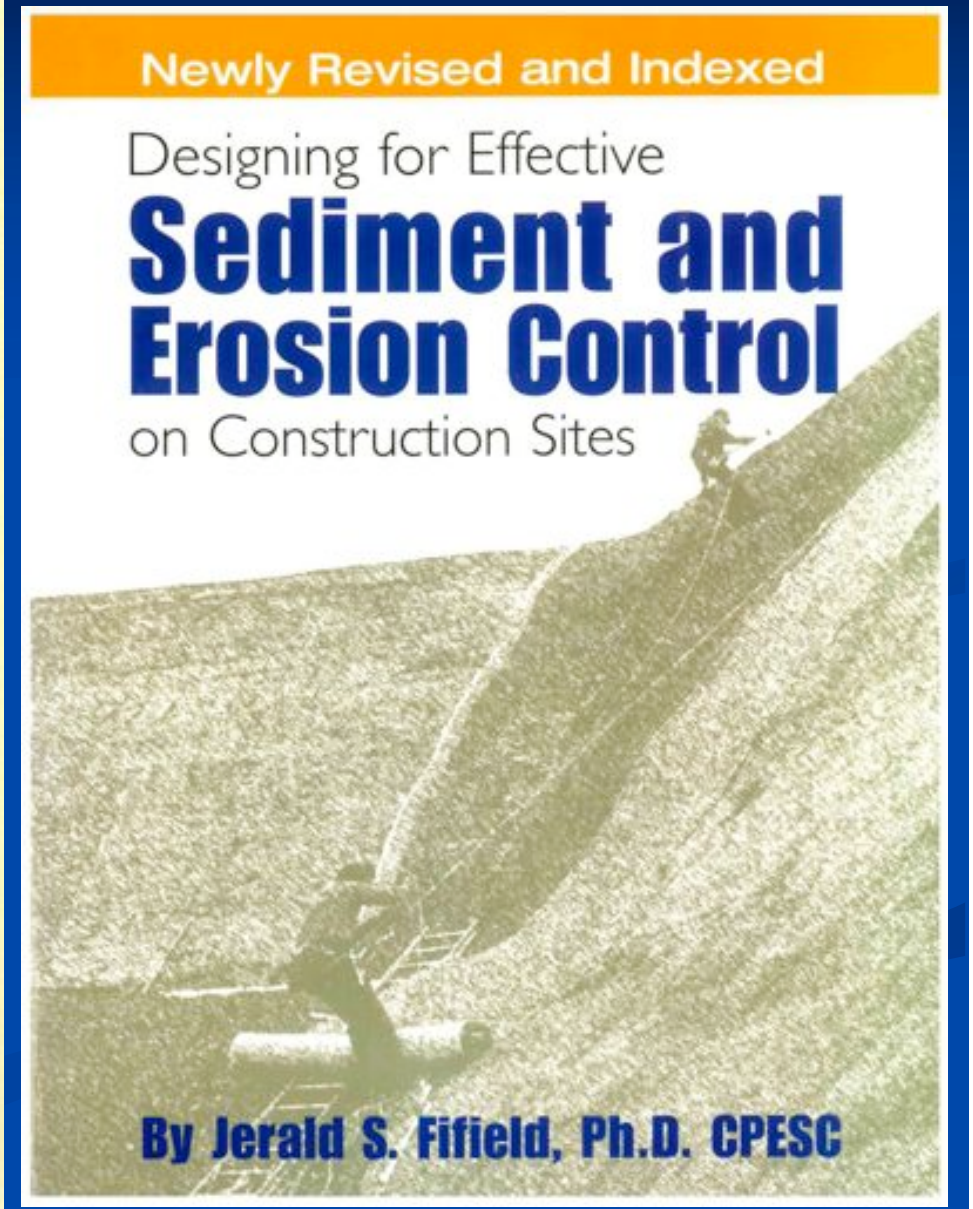

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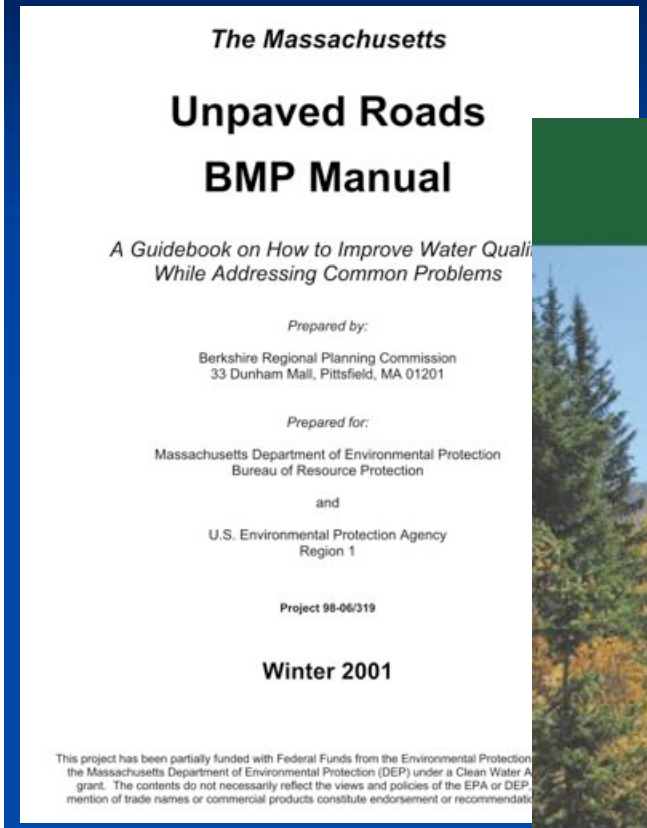

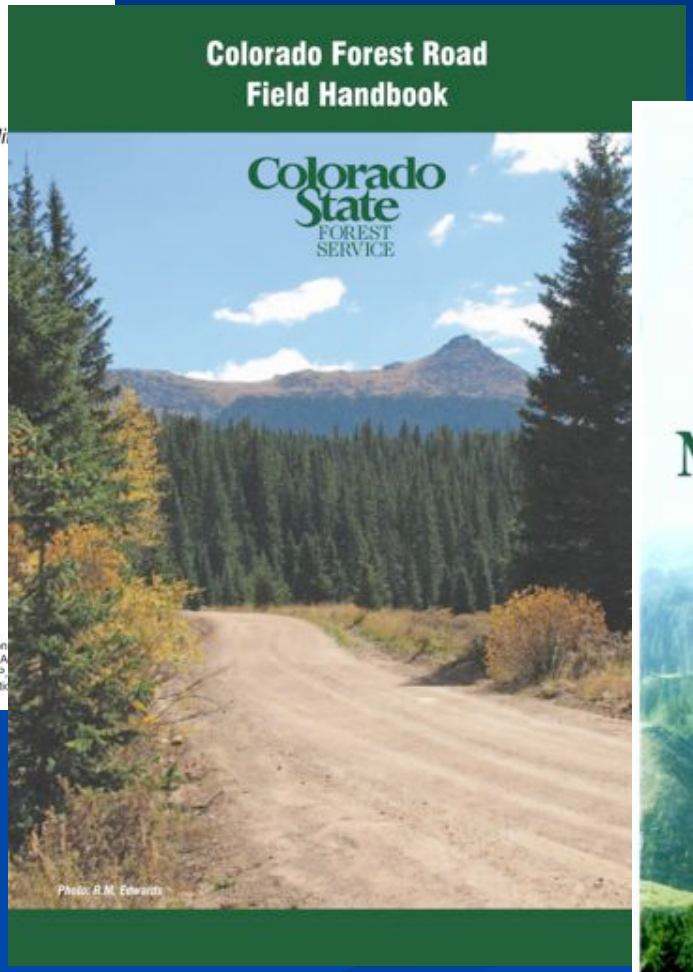

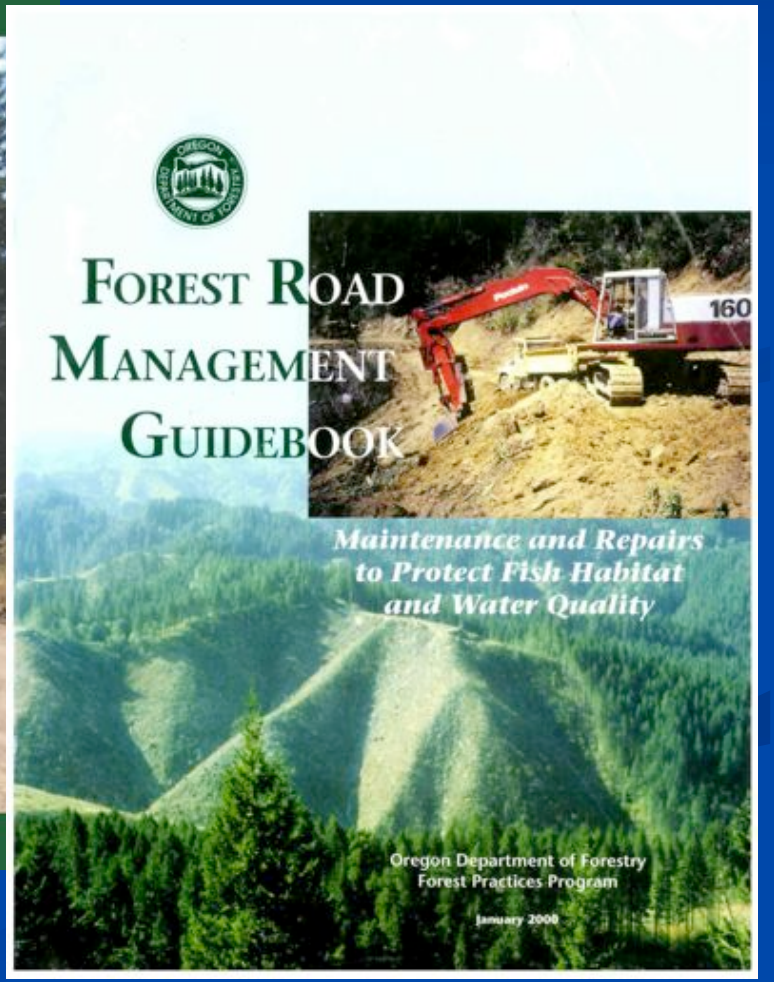

www.pacificwatershed.com

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