Salmon Restoration Federation 2016 Erosion and Sediment Control Workshop

Thomas H. Leroy
Pacific Watershed Associates

Thanks, CDFW

Part I

Basics of roads and road system design

Assessing environmental impacts from accelerated erosion and sediment delivery

Evaluating sediment sources for their potential to deliver sediment to streams

Identifying sediment sources and quantifying erosion volumes

Prioritizing road related erosional features for implementation

Part II

Creating erosion control and prevention plans

Top priority upgrading/decommissioning priorities for environmental protection

Choosing the most appropriate treatment options for your road

Performance standards and BMP designs for road upgrading and decommissioning

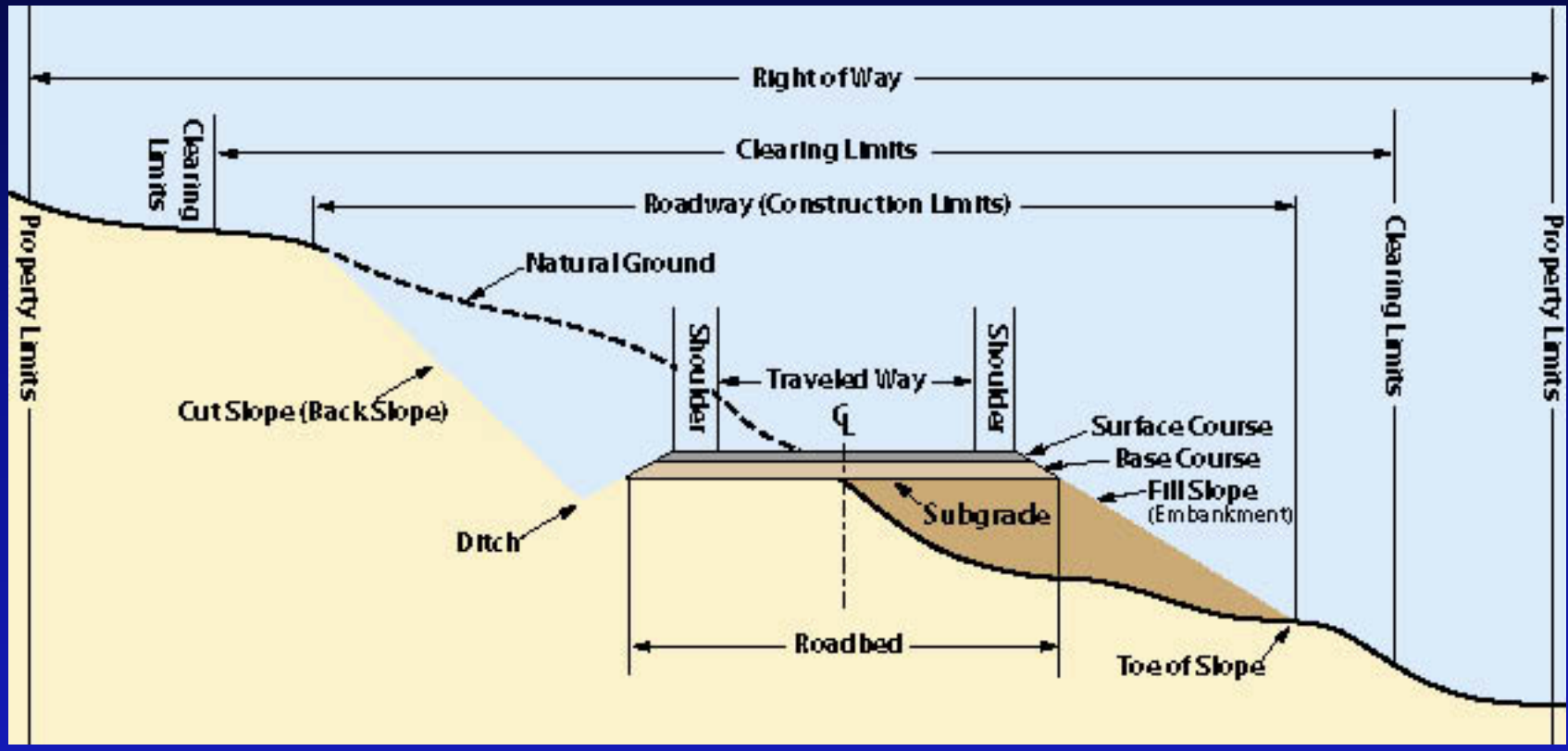
Environmental permitting application process and requirements

Perhaps ambitious…….

Part 1

-Basics of roads and road system design
-Assessing environmental impacts from accelerated erosion and sediment delivery
-Evaluating sediment sources for their potential to deliver sediment to streams
-Identifying sediment sources and quantifying erosion volumes
-Prioritizing road related erosional features for implementation

Elements of a road



Road Systems

Current and Legacy Impacts of Land Management in Northern California

Impacts to the Eel River Watershed Past and Present

Upslope logging, and rural development


1:20,000
22-65
N 6 -FF-20

Environmental impacts from poor road construction and maintenance

Some sources and environmental impacts from road systems

- Sediment Delivery to streams
- Disruption of hillside hydrology and alteration of a streams hydrograph
- Fish barriers
- Road encroachment and riparian disturbance
- Road related landslides

Fine sediment discharge

Disruptions to hillside hydrology

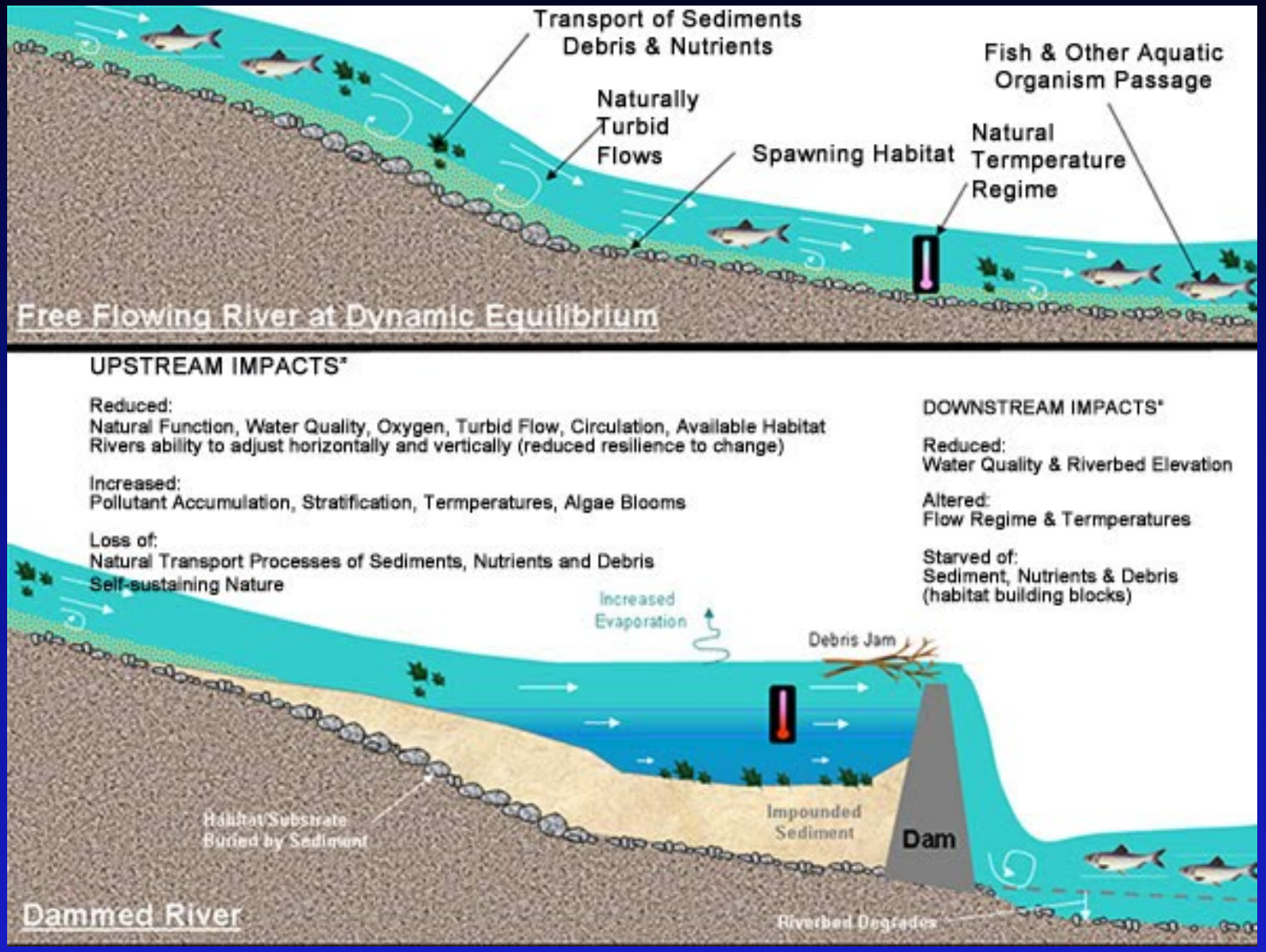
most people don't understand the linkage between roads and water resource availability

Culvert Fish Barrier

Bridge Fish Barrier

Velocity Fish Barrier

Impacts of Dam and Fish Barriers

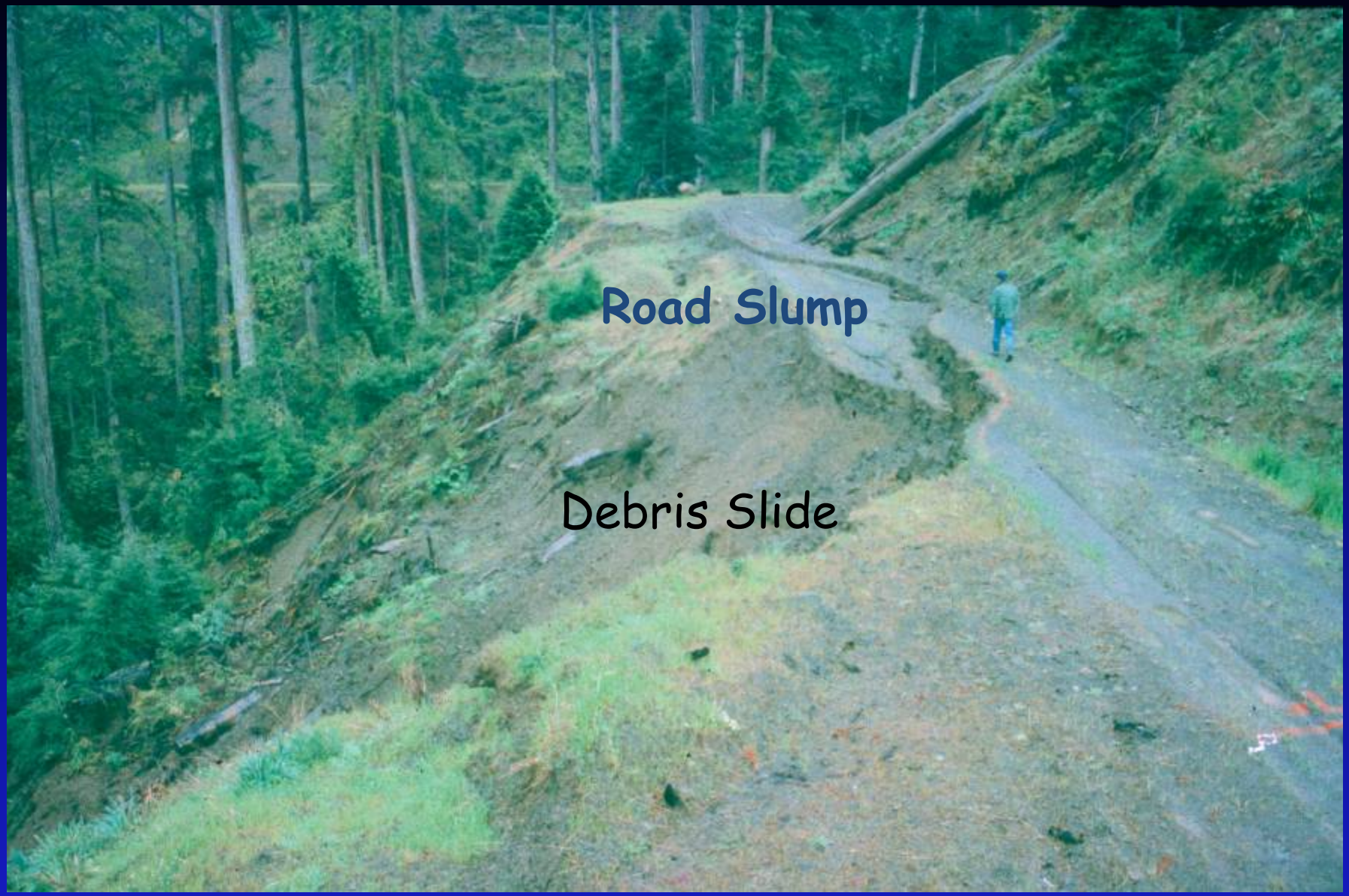


Road Encroachment on streams and riparian disturbance

Landslides

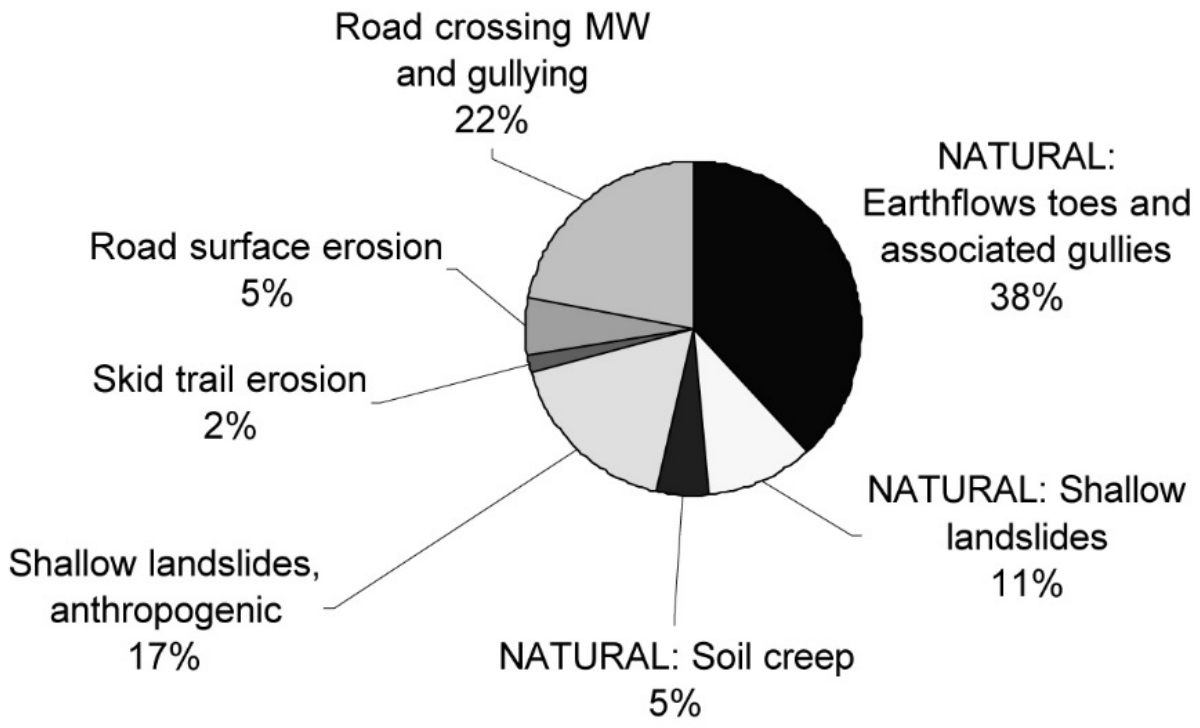
Cutbank Debris Slide

Fillslope Debris Slide at Stream Crossing


Road Slump
Debris Slide

Lets revisit the basinwide sediment sources

Basinwide South Fork Eel Sediment Sources



Sediment Production

versus

Sediment Delivery

Non-delivering fillslope landslides

Types of Erosion

- Surface Erosion
- Gully Erosion
- Channel Erosion
- Mass Wasting (landslides)

Soil Pedestals

Rills

Gully Erosion

Landslides

Washed-out stream crossing

Cutbank surface erosion

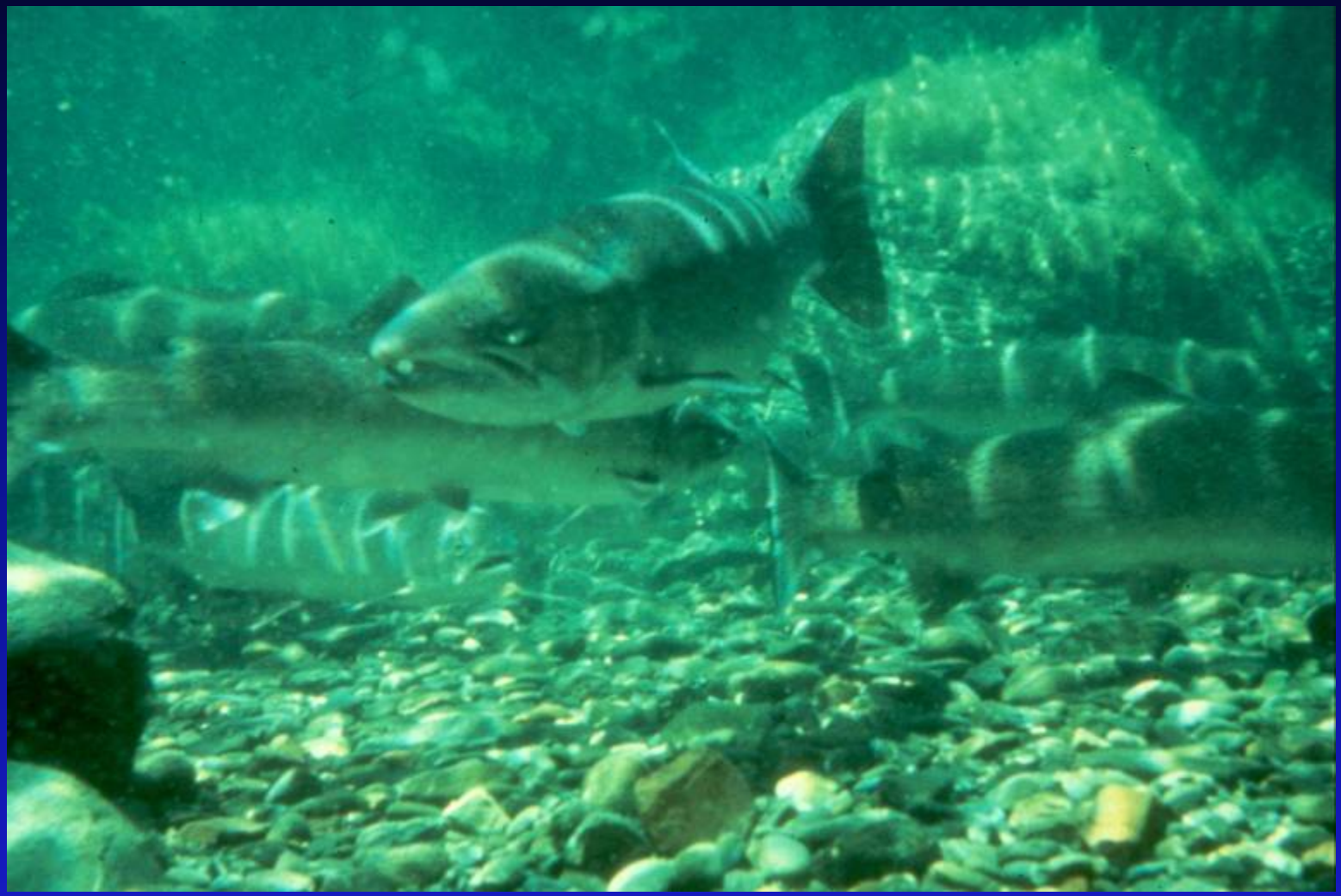
Hydrologic Connectivity

Fine sediment discharge

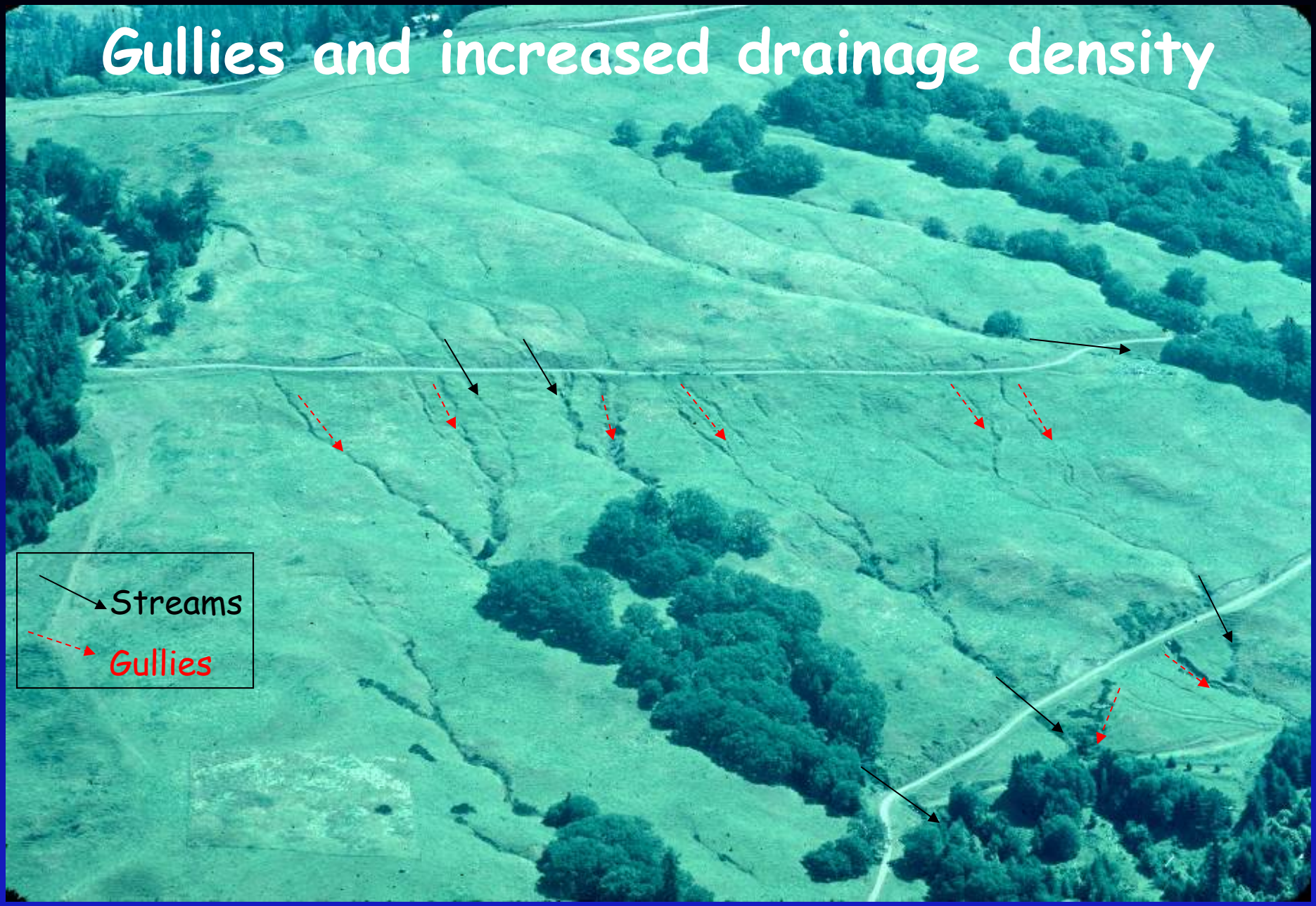
Environmental Problems Caused by Roads and Road Management Activities

Roads are "unique"……

Clean water, Clean gravel



Gullies and increased drainage density



Stream Crossing Erosion:
Gullying and Fillslope Landslides

Roads where streams should be: Road Surface and Stream Bank Erosion

Roads and Erosion

- Types of erosion
- Erosion problems caused by roads

Road surface erosion

Road-related landslides

Stream crossing erosion

Road Surface, Cutbank and Ditch Erosion

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

Pot holes – poor road drainage

Road Surface Erosion

Road Berms: Outsloped Road

Sediment from seasonal road

Road Surface Erosion

Road Surface Erosion

Road Surface: Mechanical Abrasion

Road Surface Rilling

Road Surface Gullying

Road Surface Gullying

Road surfaces and eroding cutbanks feed active ditches…

Cutbank Erosion

Ditch Sediment Transport

Ditch Erosion

Ditch Relief Culvert: Gullying

Ditch Relief Culvert: Gullying

Ditch Relief Culvert:
Gullying and Connectivity

Mature, Hydrologically Connected Gully

Ditch Relief Culvert Connectivity

Dispersing Road Runoff: Berms

Road Berms: Crowned Road

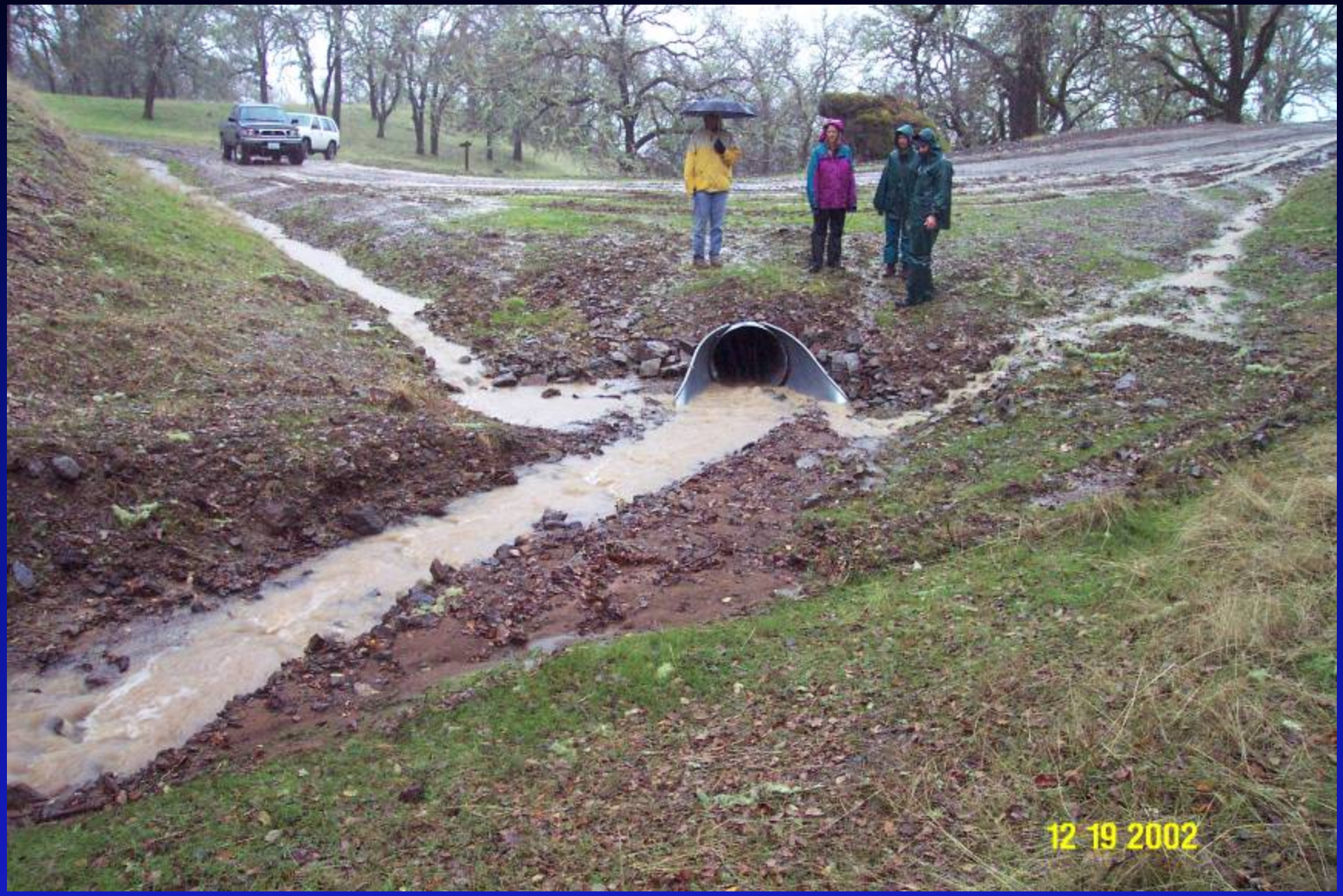
Road Berms: Insloped Road

Road Berms: Outsloped Road

Breached Berm and Gully

Road Surface Erosion and Sedimentation

Hydrologic Connectivity



Hydrologic Connectivity of Roadside Ditches

Connectivity of Roads and Ditches

Sedimentation from Ditch

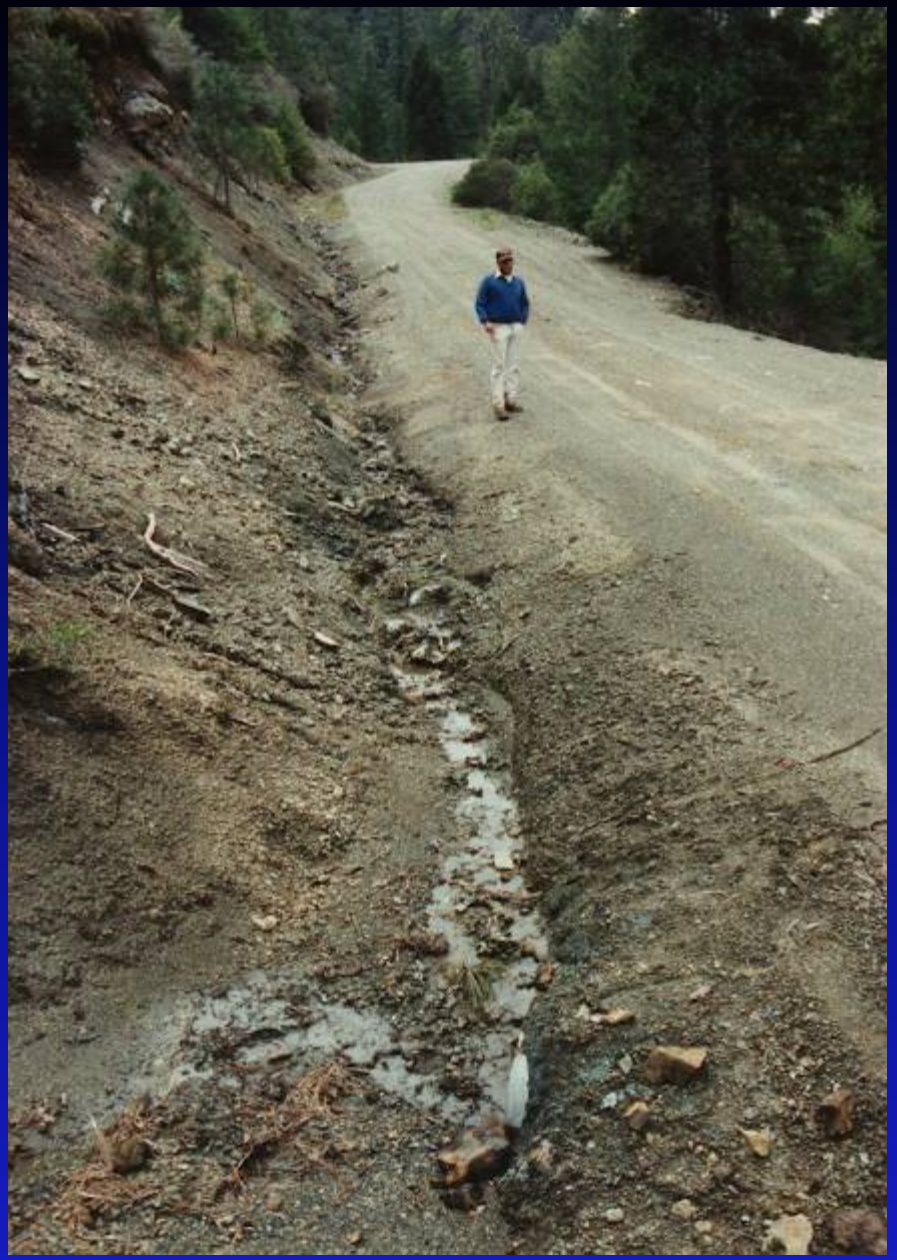
Connectivity from upslope ditch relief culvert

Traffic, fine sediment, and connectivity

Quiet, but common, connectivity

Mature, Hydrologically Connected Gully

Classical Road Drainage Engineering: Connected Road, Cutbank and Ditch



Treated Road - Clean Connectivity

Roads and Erosion

- Types of erosion
- Erosion problems caused by roads
  - Road surface erosion
  - **Road-related landslides**
  - Stream crossing erosion

Road-Related Landslides:

Cutbank Landslides
and
Fillslope Landslides

Cutbank Slump

Cutbank Debris Slide

Delivering cutbank landslide

Cutbank Slides Generate Spoil

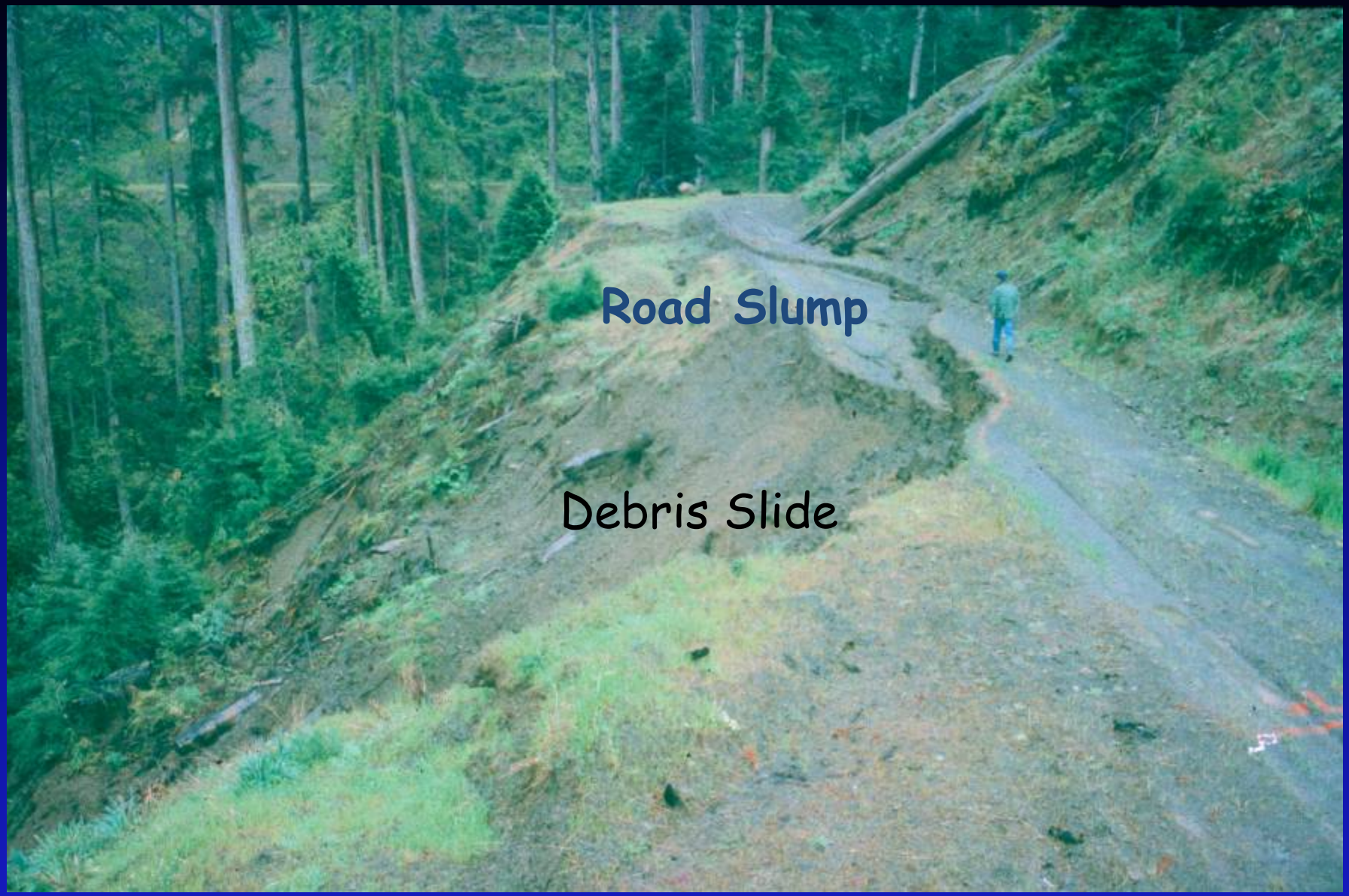
Soil Disposal Practices

Spoil Management Practices and Water Quality

Fillslope Debris Slide at Stream Crossing

Fillslope Debris Slide at Stream Crossing

Fillslope Slump

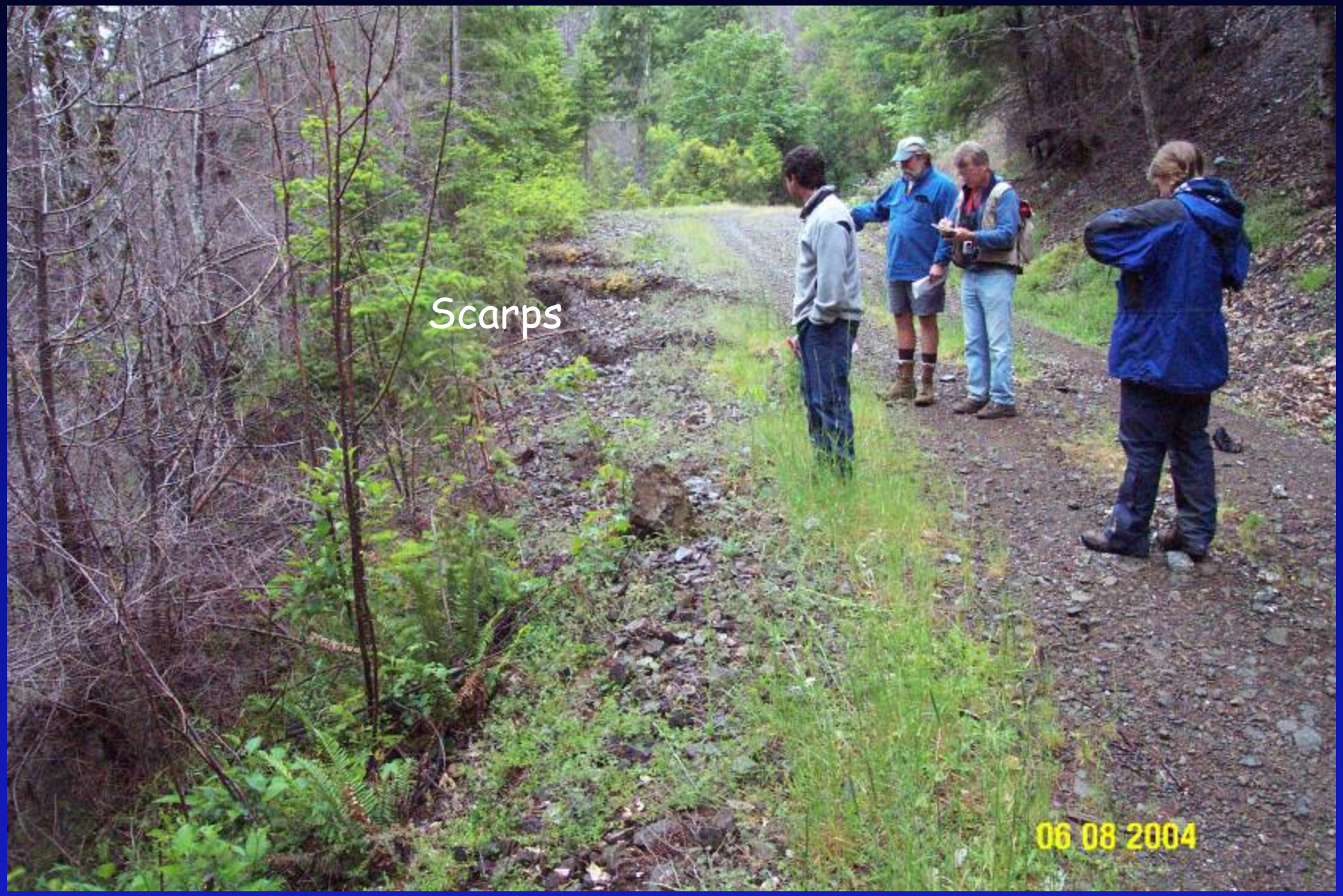

Road Slump
Debris Slide

Potential Fillslope Failure

Potential Fillslope Failure

Potential Fillslope Failure

Potential Fillslope Failure



Potential Fillslope Failure

Deep Seated Landslide

Deep Seated Landslide

Roads and Erosion

- Types of erosion
- Erosion problems caused by roads
  - Road surface erosion
  - Road-related landslides
  - **Stream crossing erosion**

Stream Crossing Erosion:

Washouts (Gully) and Stream Diversions

Culverted Stream Crossings

Unculverted Stream Crossings

Unculverted Stream Crossings

Hardened Ford

Undercut Hardened Ford

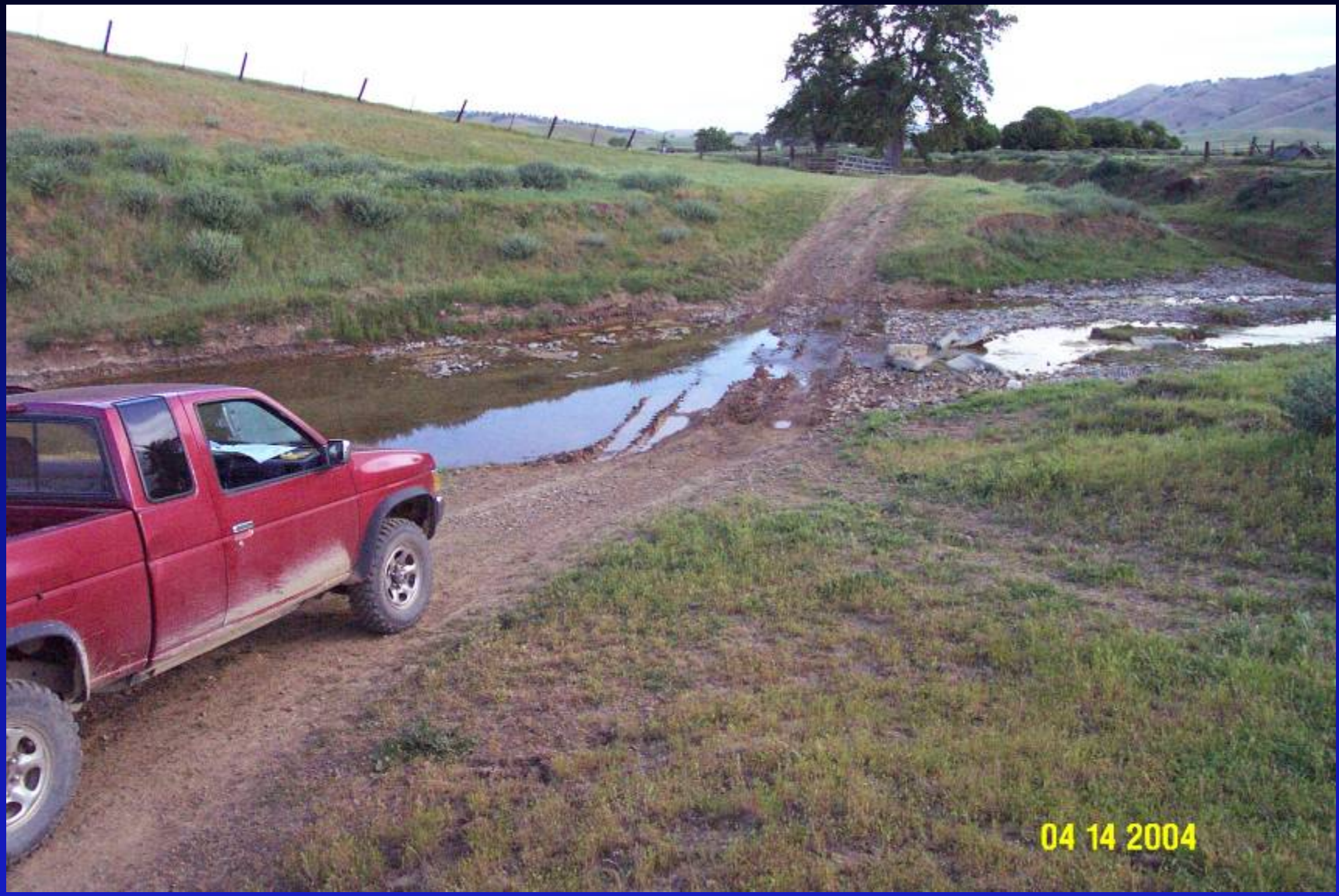
"Repaired" Hardened Ford

Armored Fill

"Unofficial" Armored Fill

Ford

Ford with soft bottom



Ford with soft bottom

Ford with soft bottom

Ford with connected approaches

Plate Arch (Bottomless-Culvert)

Plate Arch (Poor Orientation)

Bridge

Bridge (insufficient capacity)

Collapsing Log Stringer Bridge

Reduced channel width

Undercut armor

Fine sediment from approaches

Culverted Stream Crossing

Shallow, Short Culvert

Short Culvert

Short Culvert

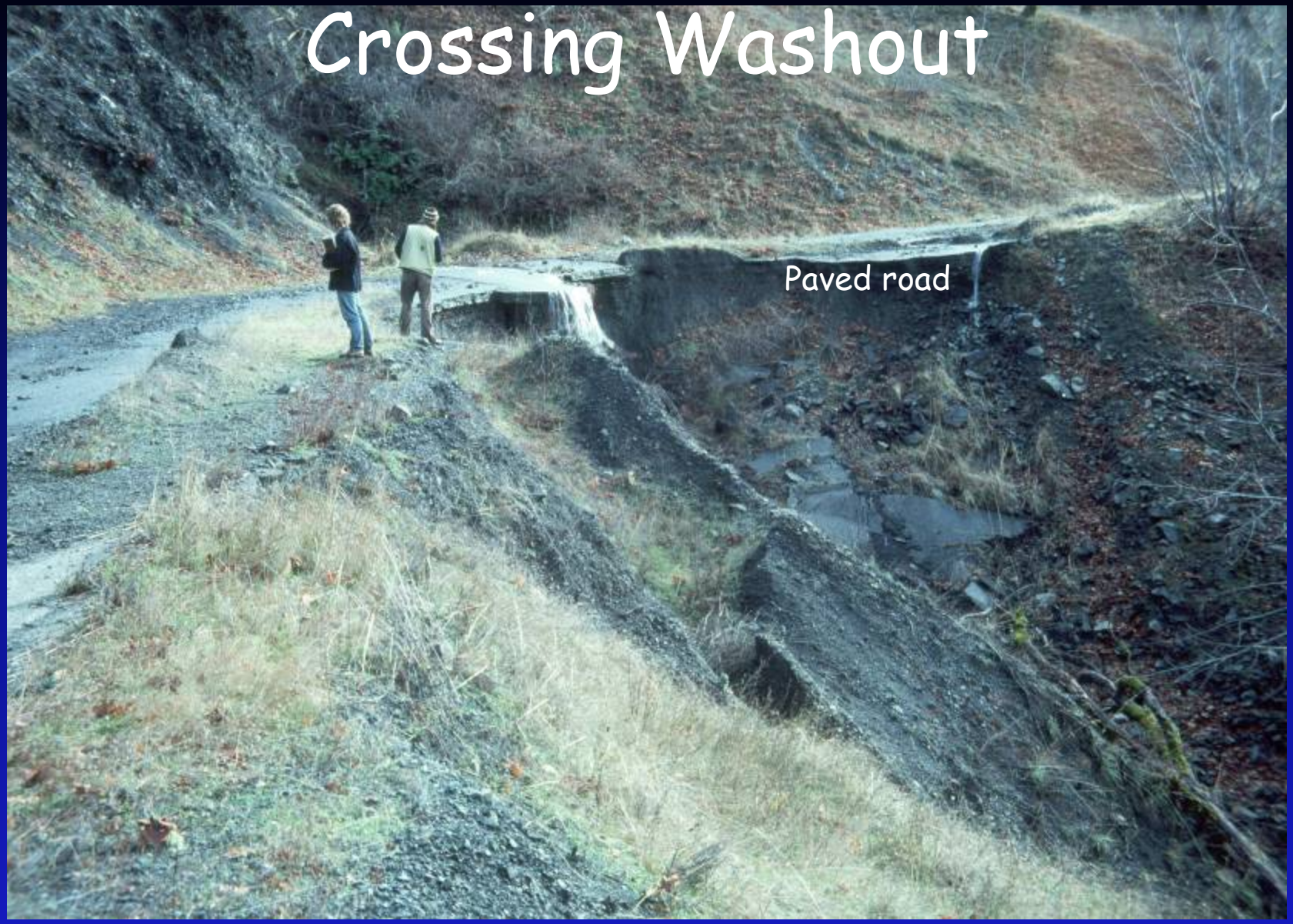
Culvert too short…


Plugged Culvert
and Pond

Plugged Culvert – Crossing erosion

Washed Out Stream Crossing

Crossing Washout



Undersized Culvert(s)

Undersized Culvert

Culvert Plugging

Culvert Plugging

Culvert Plugging

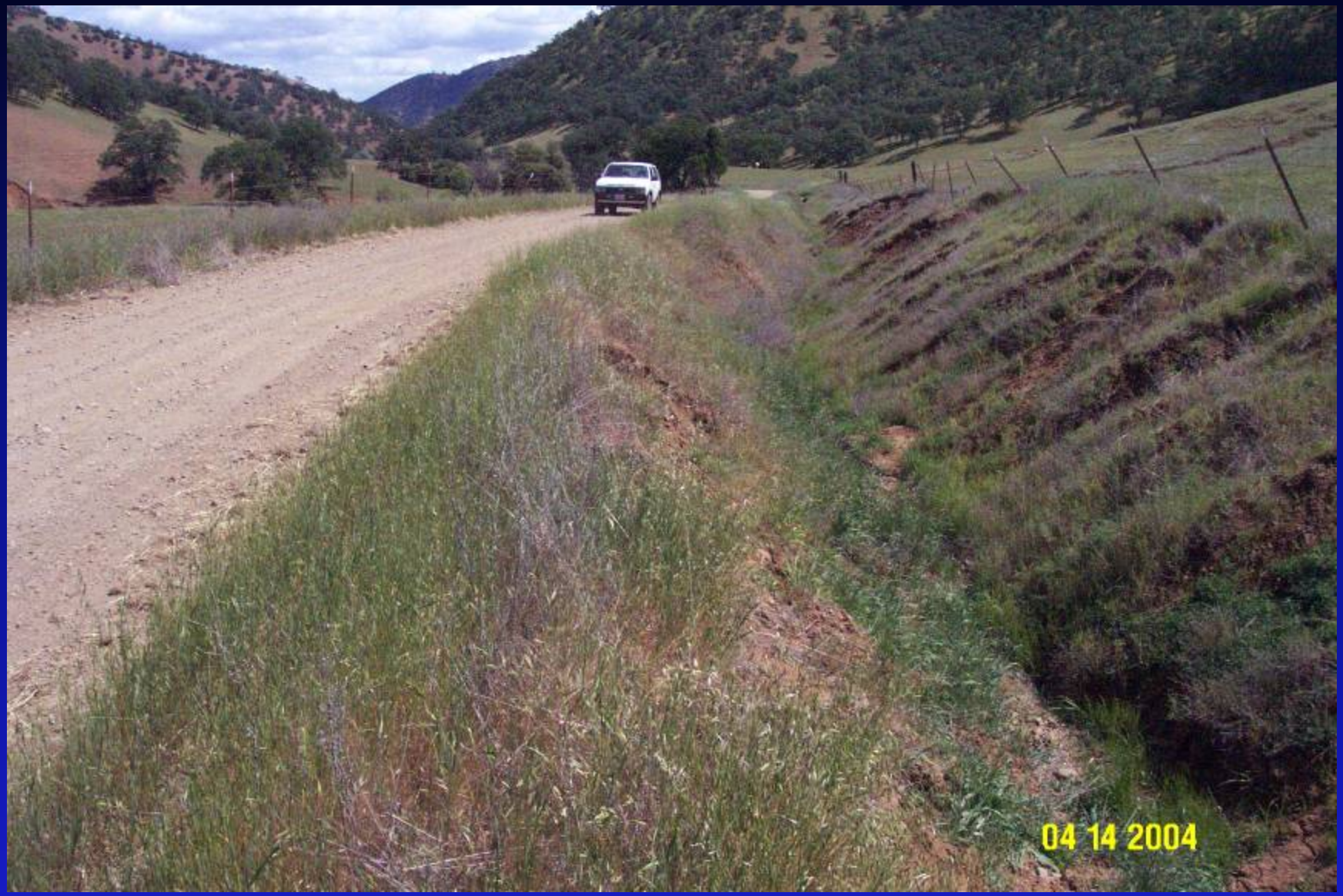
Culvert Plugging

Plugged Culvert and Stream Diversion

Stream Diversion

Stream Diversion Gully

Stream Diversion Gully



Stream Diversion Gully

Stream Diversion Gully

Other Culvert Problems:

…too flimsy
…too old
…too shallow
…too short
…too small…

Separated Culvert, Collapsing Fill

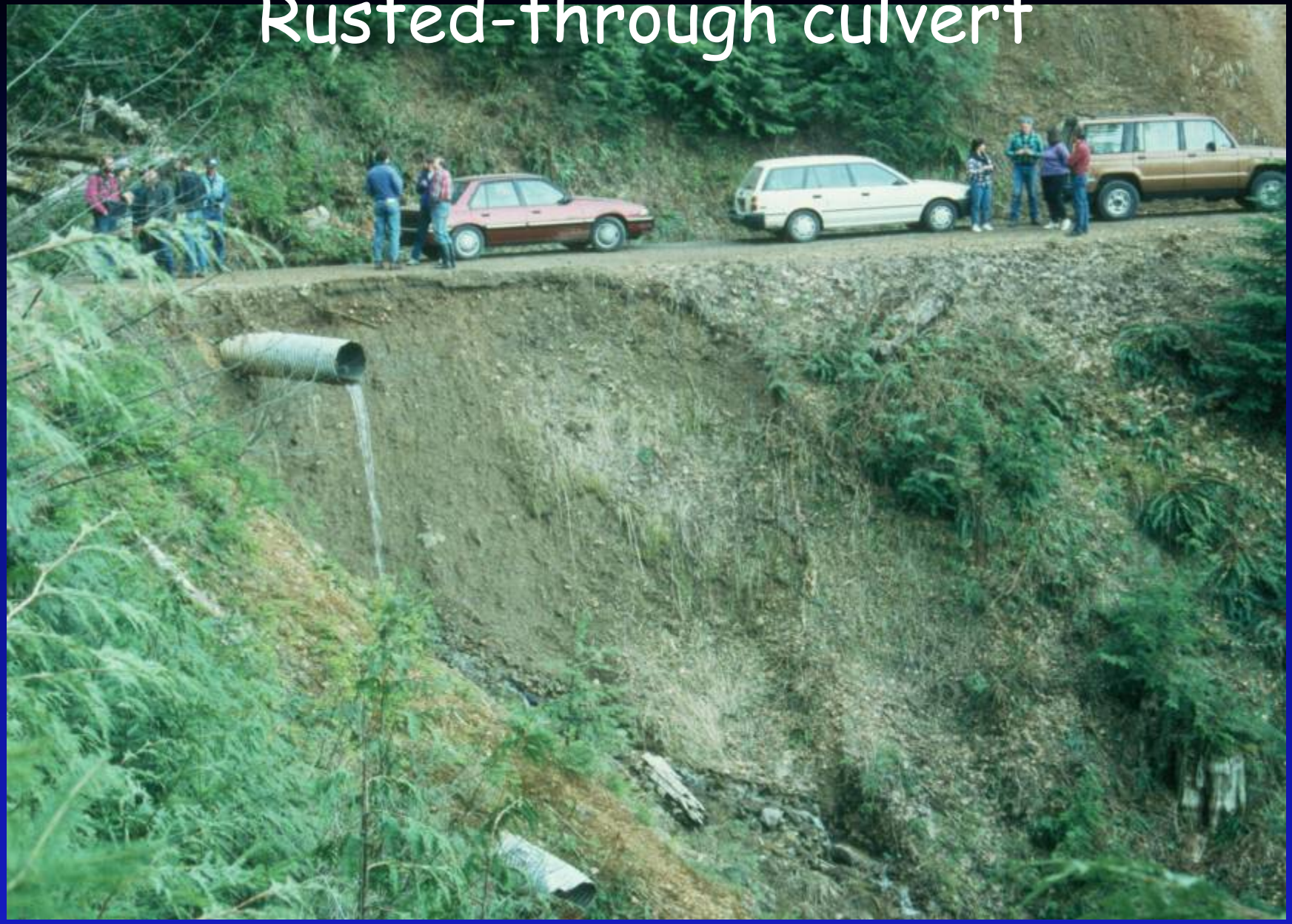
Separated Culvert, Collapsing Fill

Humboldt Crossing, Collapsing Fill

Rusted-through culvert

Rusted-through culvert

Rusted-through culvert



Culvert is prone to plugging

Undersized Culvert

Culvert is undersized or plugs

Undersized Culvert and Spoil Disposal

Undersized Culverts

Summary of common road related erosion and sediment delivery problems

Poor choice of road alignment or location

Hydrologic connectivity from:
- Upland road surfaces
- Stream crossing approaches
- Bare areas related to the road
- Hillside gully erosion

Poor stream crossing construction
- Inadequate bridge installation
- Culvert undersized
- Culvert not aligned with channel
- Culvert not a channel grade
- Stream diversion potential
- Culvert high plugging potential

Road related landslides

Prioritizing road related features for implementation

Considerations:

- Problem types: Fish barrier, stream crossing performance, potential sediment delivery, landslides, chronic erosion
- Likelihood of sediment delivery
- Future volume of sediment delivery
- Biologic importance of receiving waterbody

Part II

Creating erosion control and prevention plans

Top priority upgrading/decommissioning priorities for environmental protection

Choosing the most appropriate treatment options for your road

Performance standards and BMP designs for road upgrading and decommissioning

Environmental permitting application process and requirements

Creating an erosion control and prevention plan for roads and road systems

1) Compile available data for the area of interest
   - Digital terrain models
   - Spatial and temporal distribution of biologic resources
   - Ownership boundaries
   - Historic air photo imagery
   - GIS layers (roads, timber harvests, ect.)

2) Use the available data and landowner input to create a base map with:
   - Road construction history
   - Past land use/disturbed areas
   - Observable historic and current landslides
   - Desired future conditions of roads (upgrade/decommission)
   - Design vehicle information for the roads subject to inventory

Creating an erosion control and prevention plan for roads and road systems

3) Create a project dataform that is specifically designed to capture data on road related sediment delivery sites including:
- Physical characteristics (past/future sediment delivery volumes)
- Location
- Erosion potential
- Treatment priority
- Proposed treatment measures

4) Conduct a systematic inventory of the roads, starting at the highest portions of the watershed within which the project is being done

5) Enter the data from the inventory into a database

6) For stream crossing sites
- Calculate required culvert sizes
- Estimate road fill volumes from geometric measurements in the field
- Estimate equipment time to upgrade/decommission the crossing

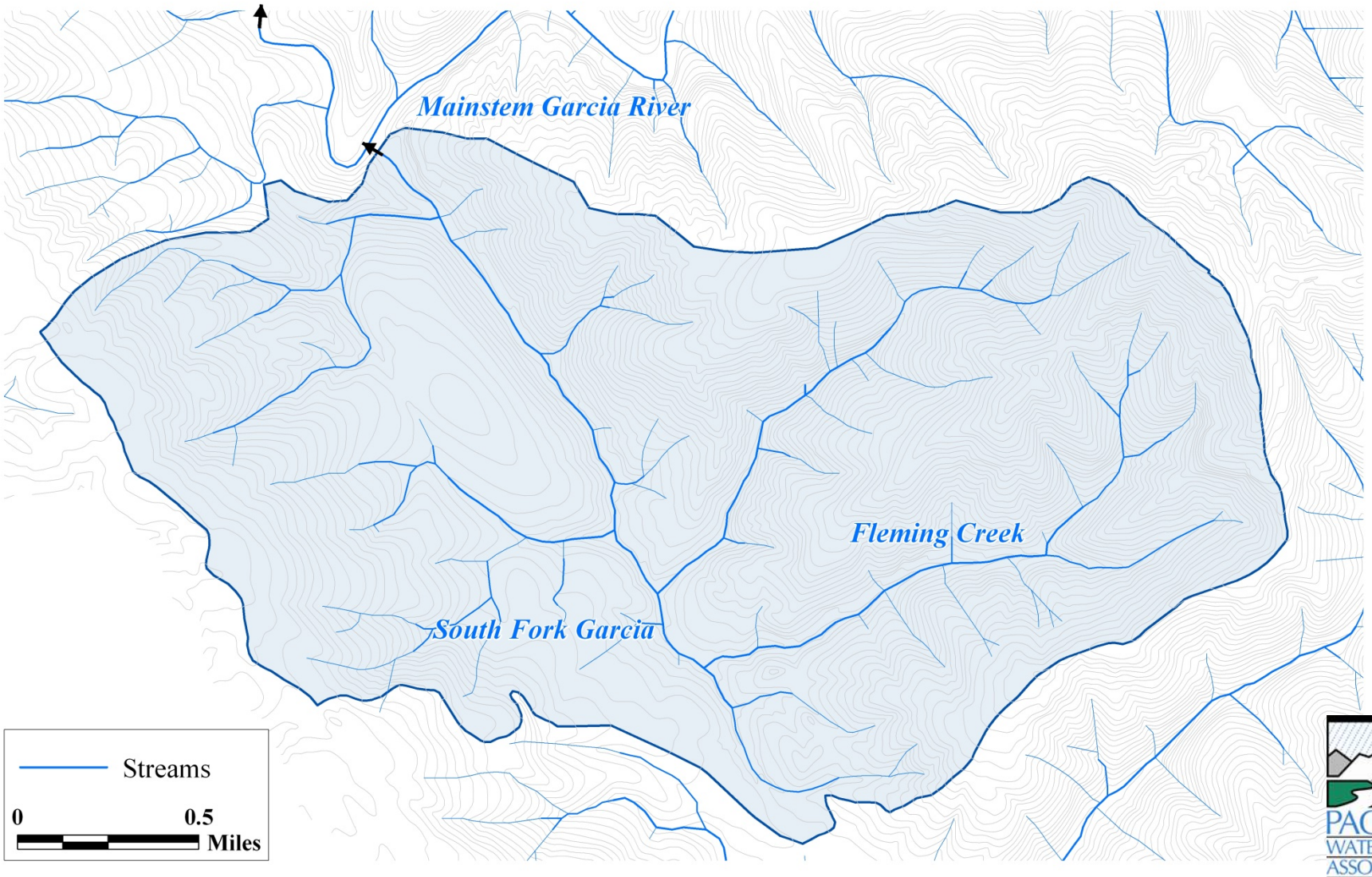
Creating an erosion control and prevention plan for roads and road systems

7) Add stream crossing data to the database and create a series of tables used to summarize the findings and projected costs of project implementation

8) Compile all data into a GIS database and create maps of the project area

1998 South Fork Garcia River sediment source assessment

4.3 square mile watershed

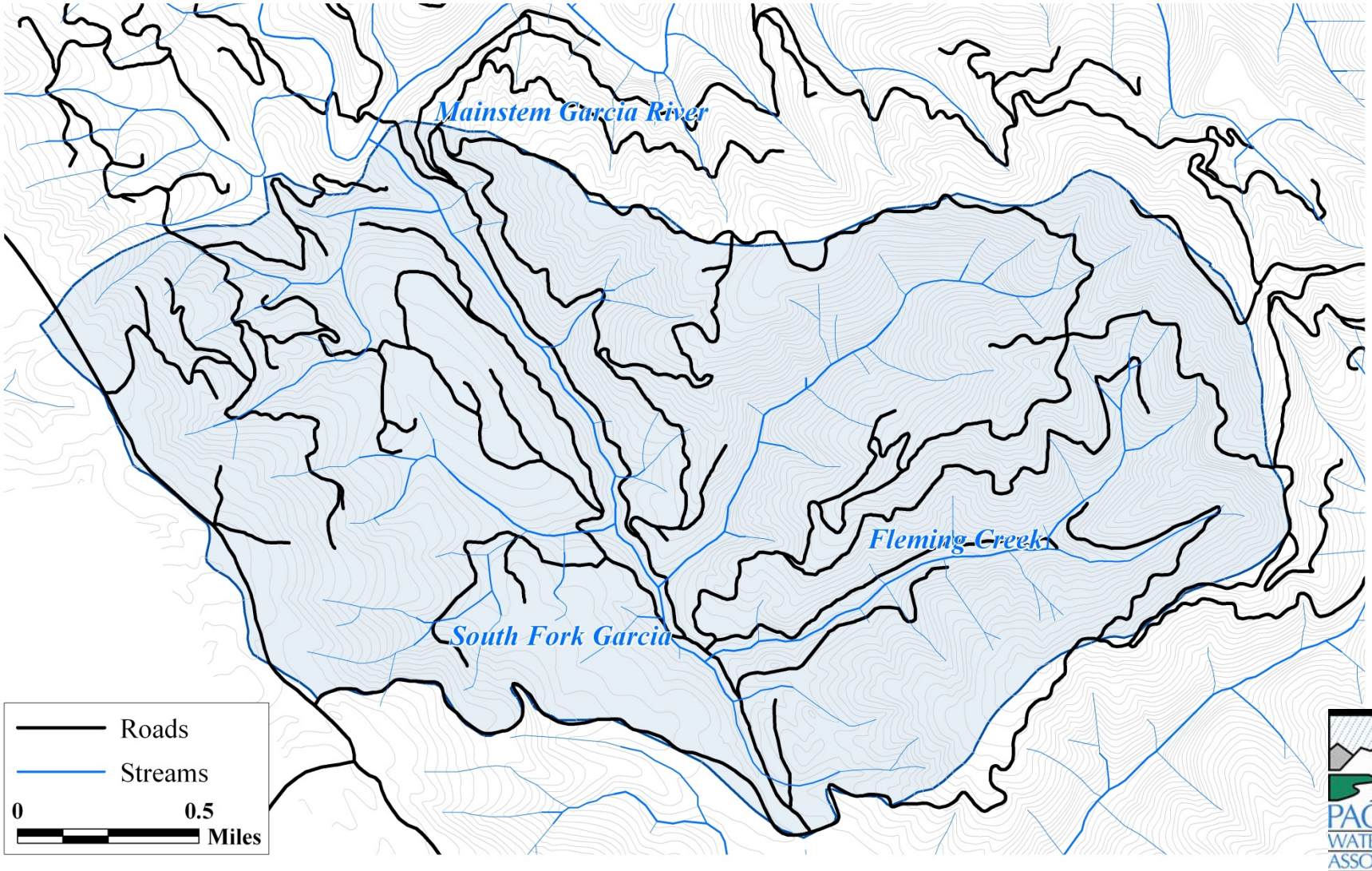


PACIFIC WATERSHED ASSOCIATES

Road construction history results

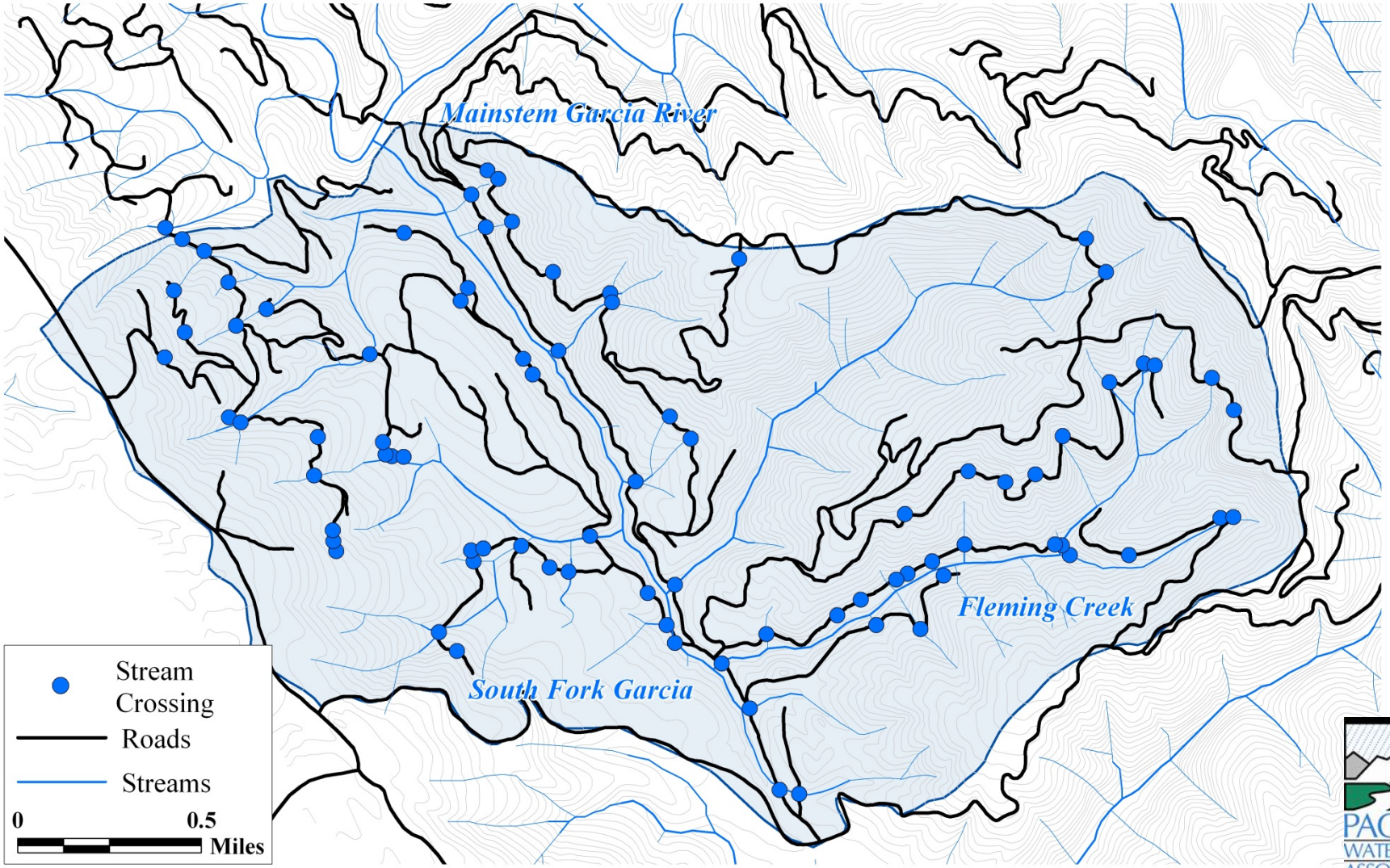
30.6 miles of road

7.1 miles of road/square mile



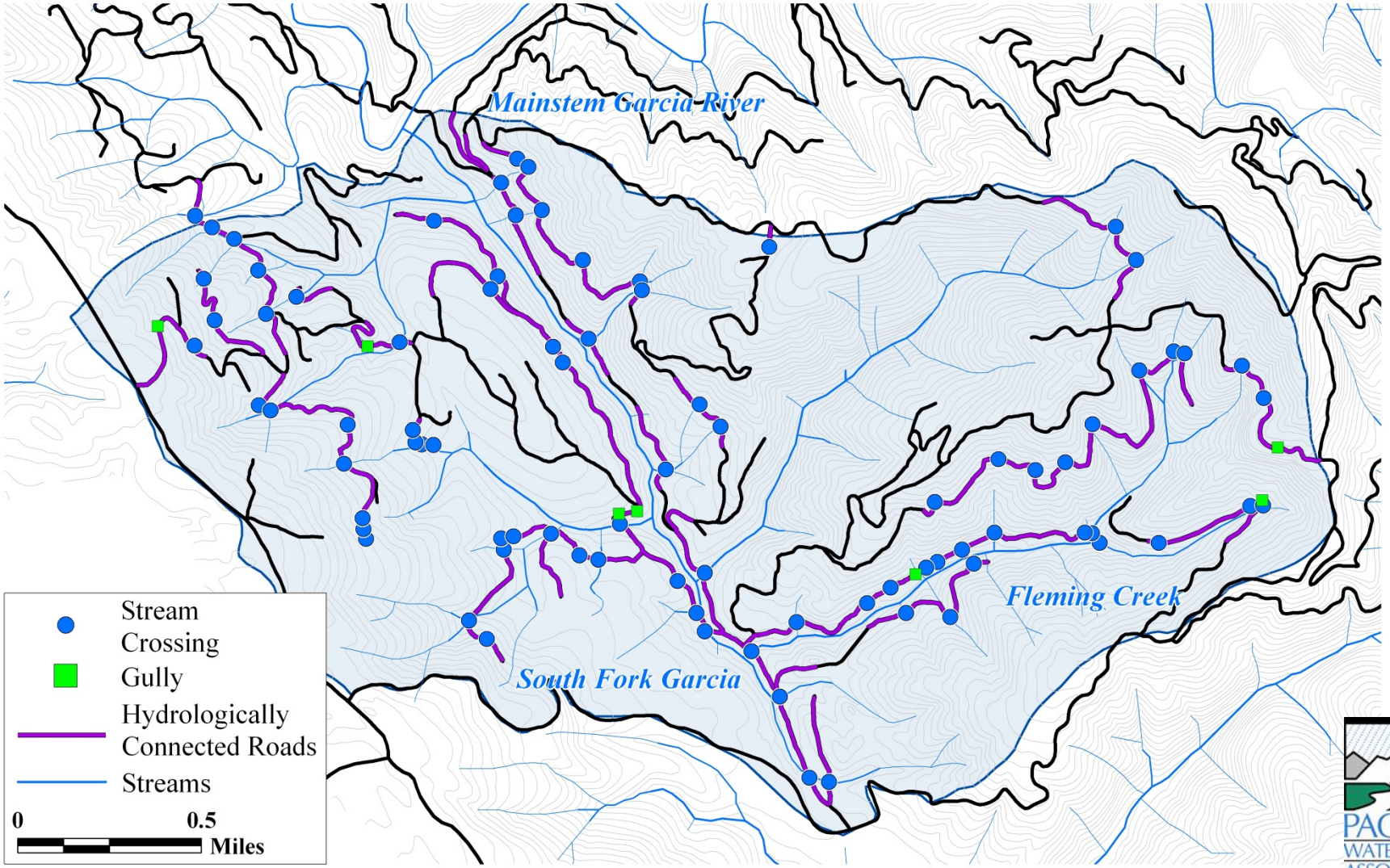
Sediment assessment results

84 stream crossings



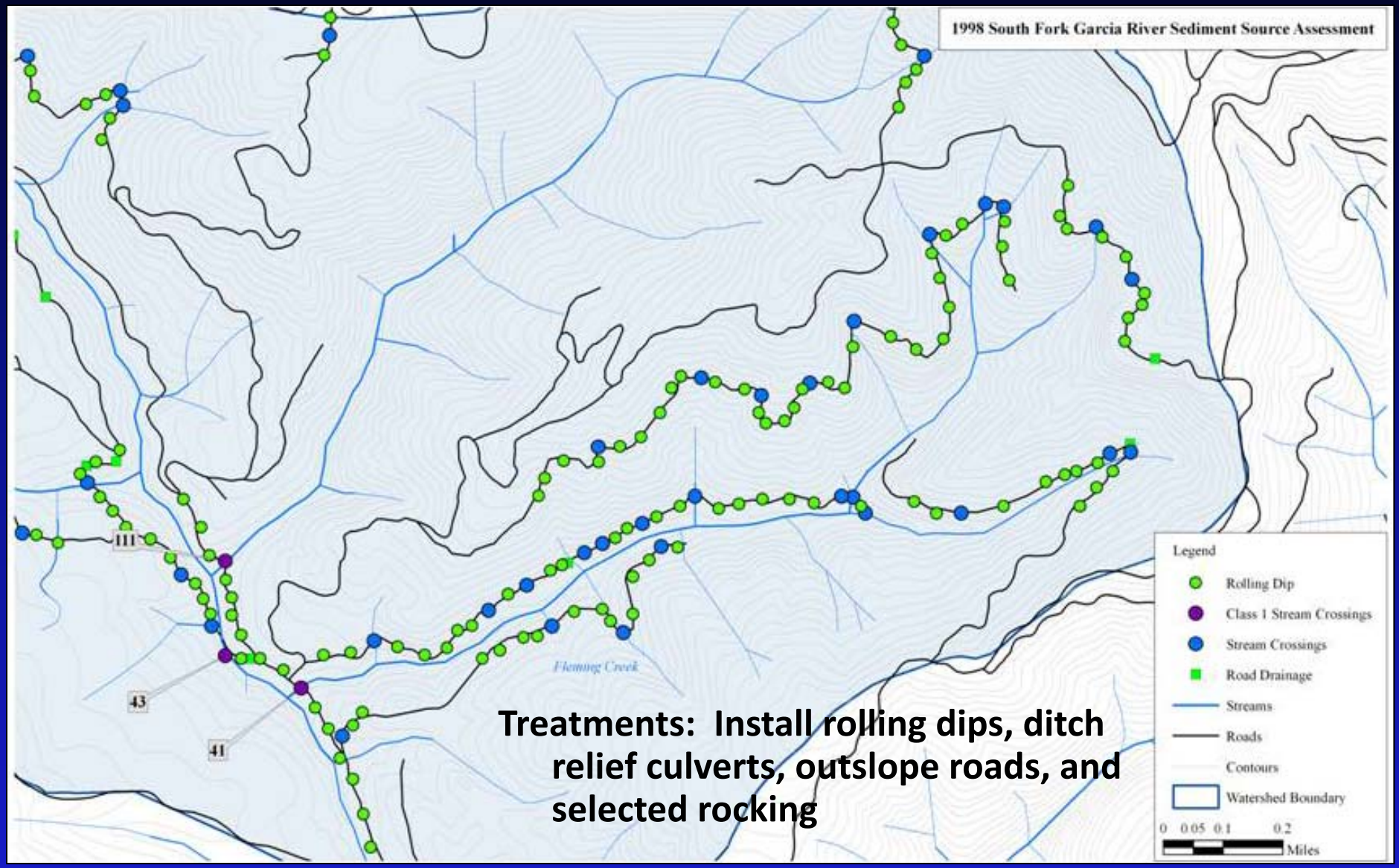
Assessment results (cont)

14.3 miles of hydrologically connected road surfaces and ditches



Treat 12.9 miles of hydrologically connected roads:

Total *"Streamlined"* and "Complete" sediment control cost $80,000



Treatments: Install rolling dips, ditch relief culverts, outslope roads, and selected rocking

Choosing the most appropriate treatment options for your sediment delivery site or road system (There's more than one way to skin a cat)

Choosing the most appropriate treatment options for your sediment delivery site or road system

Each sediment delivery point on a road requires a unique treatment based on the site conditions and the landowners requirements

For each proposed treatment option you may consider:
Potential benefits
Potential limitations
Likelihood of success (effectiveness)
Relative costs
Impacts to current and future road use
Required future maintenance

Control and prevention of surface erosion

- Minimize bare soil
- Cover bare soil – mulch or revegetate
- Disperse runoff from bare soil areas
- Direct concentrated runoff to vegetation
- Break up bare soil areas into smaller areas
- Disconnect and disperse flow paths (e.g., road surfaces) and ditches
- Feasible Target: ≤10-20% of road network; less on upper hillslopes; abandoned rds ≤ 5%

Recommendations to reduce or eliminate roads as a source of fine sediment:

- Construct outsloped road shapes with no berms, and periodic rolling dips, disconnecting crossing approaches,
- Utilize inboard ditches only where springs are present along the cutbank, or to collect runoff from upslope,
- Disconnect ditches using frequent ditch drains,
- Minimize ditch grading; revegetate connected ditches
- Avoid through-cut roads & roads down the axis of swales,
- Do not pipe riparian road runoff directly to streams; use perforated flex pipe on contour to disperse flow,
- Culvert spacing should result in no hillslope gullies,
- Dewater connected gullies, even if they are stable, and
- Construct properly designed and sized sediment basins.

Don't forget….treat the cause and not the symptom of your problem

keep in mind……every complex problem has a simple solution that doesn't work……..

Gullies from road surface runoff

Another gully…

Treating the cause by dispersing road runoff

ROAD DRAINAGE TREATMENTS

Road shaping

Road shape conversion

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

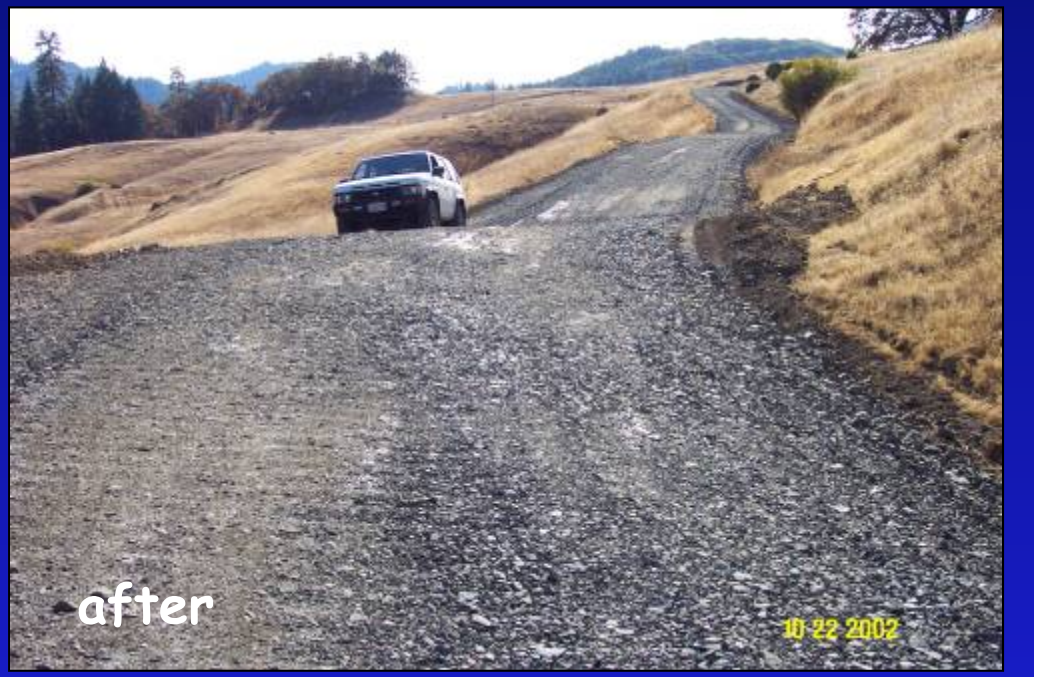
Outsloped with rolling dips – No connectivity

Seasonal use roads with outsloped shapes and rolling dips (no berm or inboard ditch)

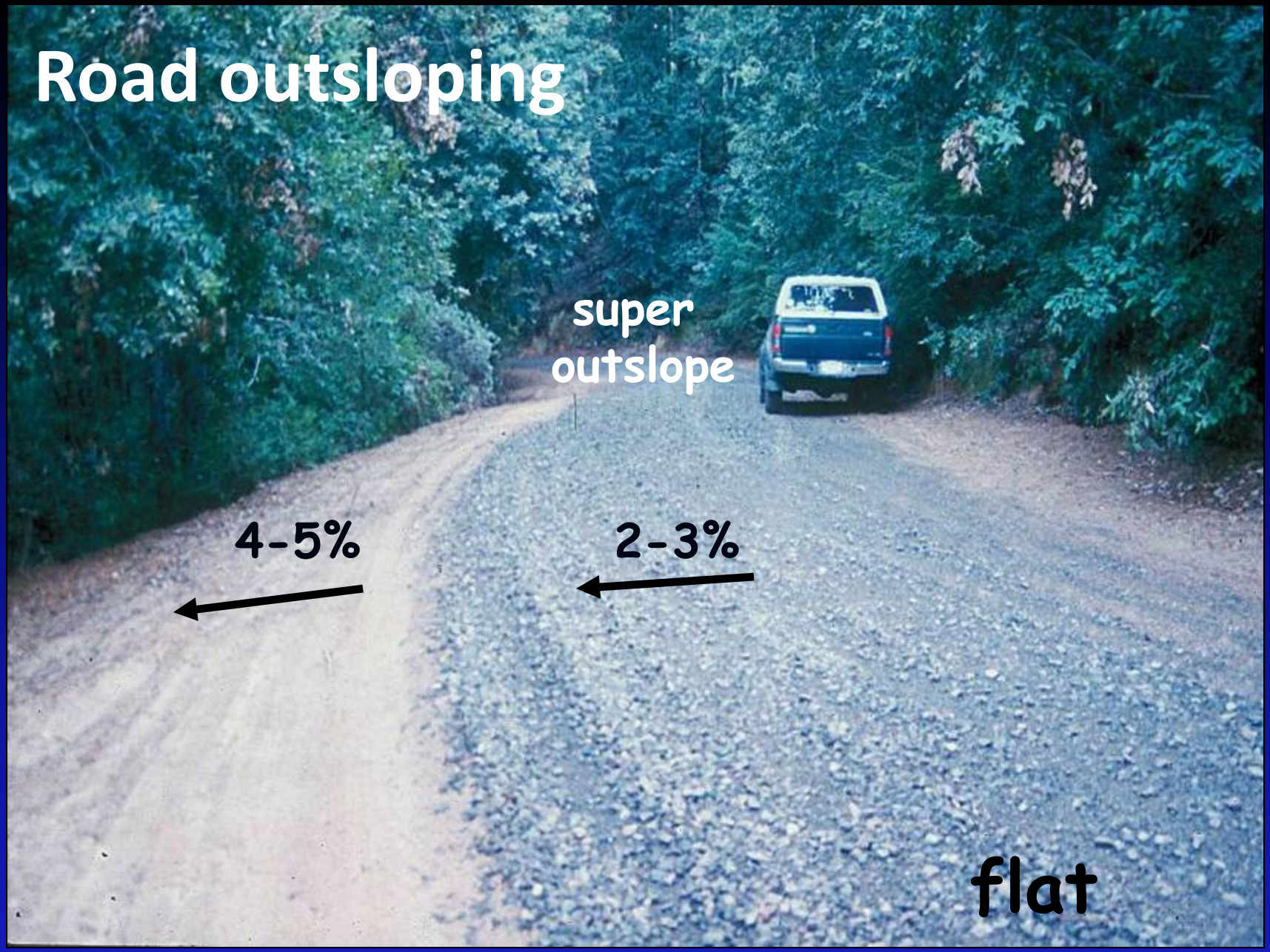
Road shape conversion

Insloped with ditch – 100% connectivity

Outsloped with rolling dips – No connectivity



Road outsloping



Driveability, Functionality and Safety

Treated Road - Clean Connectivity

ROAD DRAINAGE STRUCTURES

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

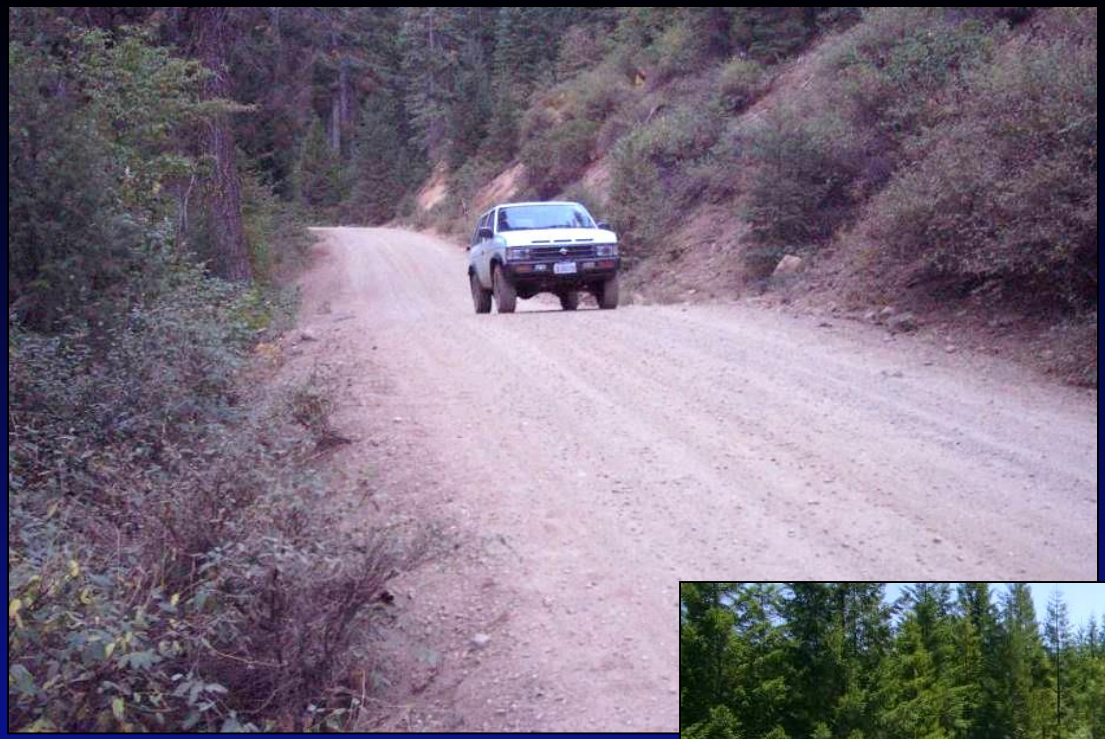
Road with rolling grade

Outsloped roads with Rolling dips

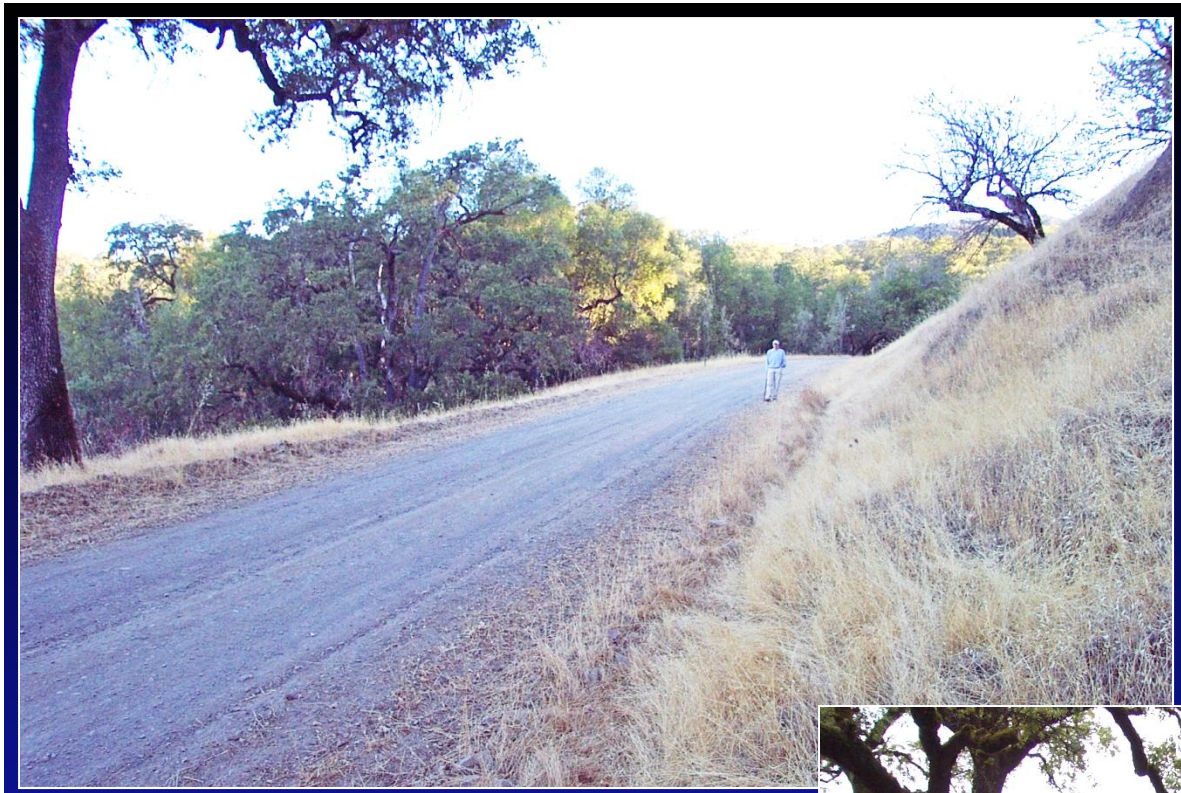
Rural subdivision

Logging haul road

Road erosion treatments - upgrading



Outsloped with rolling dips – ditch eliminated



Insloped road with ditch – hydrologically connected

Outsloped road with rolling dips – ditch retained

Lead-out ditch or cut drains road rut

Berm breaks on a fall-line road

DRC – no gully

DRC installation

Full-round downspout

Energy dissipation

Road drainage structures

STREAM CROSSING TREATMENT TYPES

Culvert alignment

Culvert alignment (what's missing?)

Culvert alignment

Culvert extension and fillslope grade

Fillslope <2:1 …No outlet armor needed

Fillslope 1½:1 …Fillslope armored (pit-run)

…Three years later

Armoring inside…

…and outside fillslopes

Standards: 2:1 no rock required;
1½:1 - 50% up fill face;
> 1½:1 - 100% up fill face

Over-rocked fillslope

Armoring bridge abutments

Embedded culvert for fish passage (minimum 20%)

Culvert upgrade: before

Culvert upgrade: after

Culvert upgrade: before

Culvert upgrade: after

Upgraded stream crossing

Before

Gone fishing…for sediment

After

Before

During

After

After 1st winter

Shallow culvert with downspout

Downspout

Energy dissipation

Fill compaction

Bermed fillslope

Emergency overflow culvert

Emergency overflow culvert

Before

After

Emergency overflow culvert

Emergency overflow culvert

Plate arch (bottomless arch)

Ford

Hardened ford


01 05 2002


09 20 2002

Before

After

Before

After

After 1 winter

Bridge approach connectivity

Slotted road drain

Rolling dip

Road Dip on Bridge Approach

Measures of success

- Road decommissioning
  - 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%
- Road upgrading
  - 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