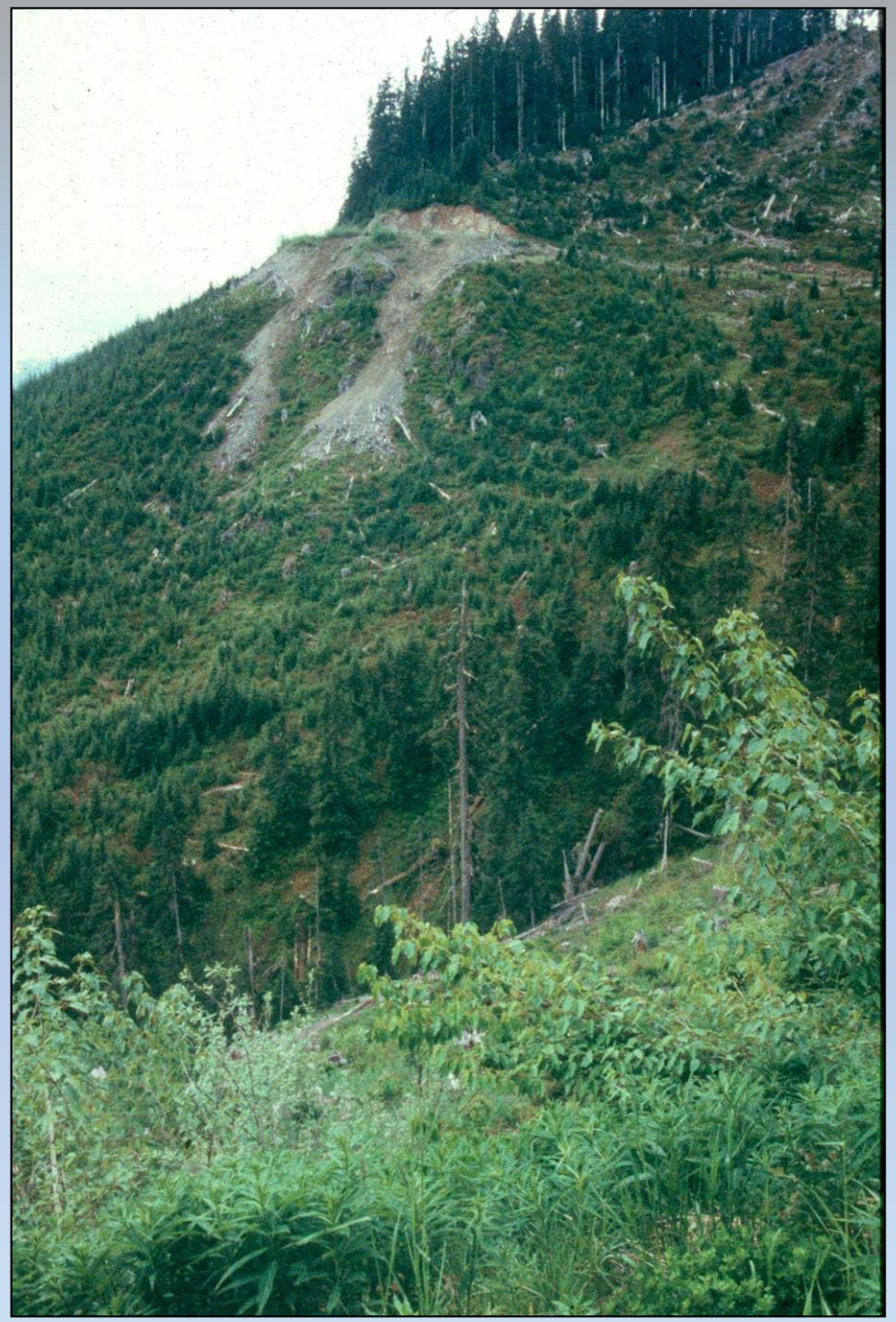
# Road Surface Upgrading Treatments

# Five Road Upgrading Treatment Mantras

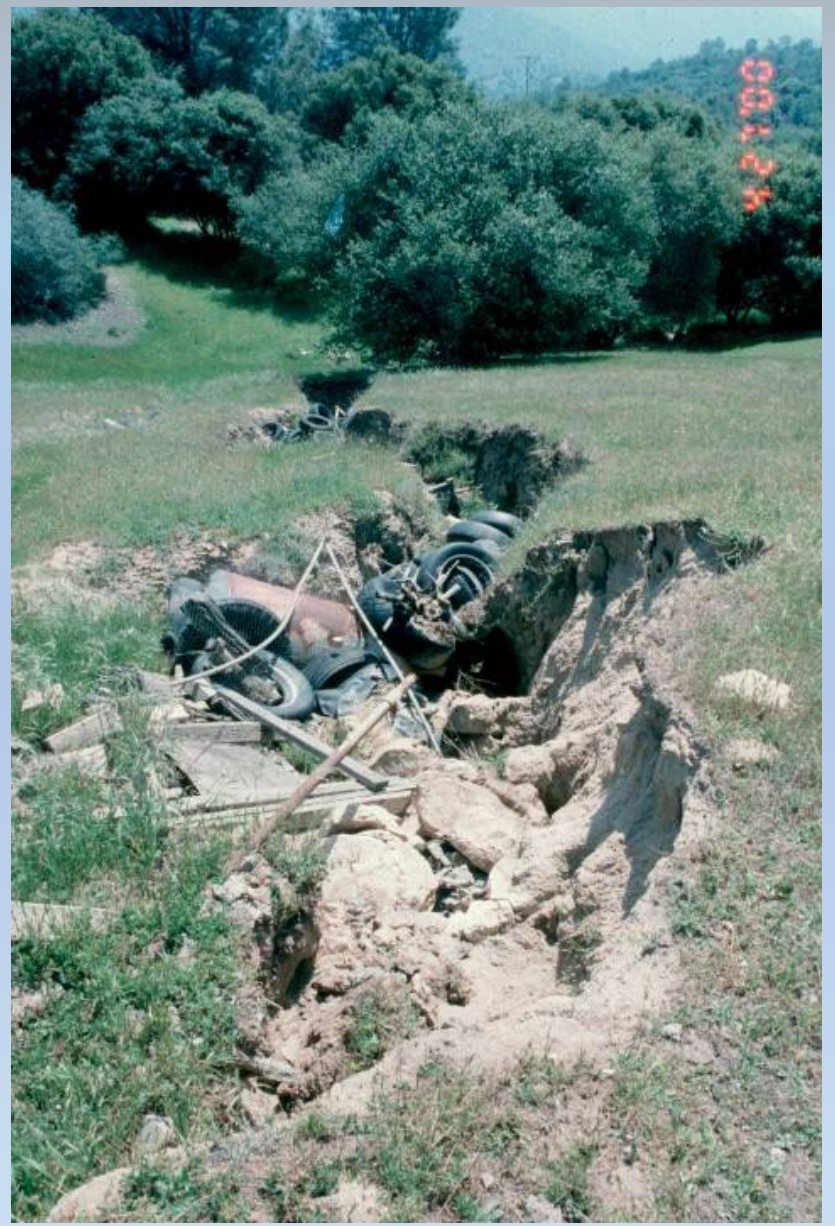
1) Treat sites of sediment delivery
2) Treat the cause of a problem, not the symptom
3) If you don't change anything, it's just going to happen again
4) Prevent erosion before you have to try to control it
5) Get a little bit of water off the road in a lot of places
6) Every complex problem has a simple solution that doesn't work

# Erosion versus sediment delivery:

1) Treat sites of sediment delivery



# 2) Treat the cause of a problem, not the symptom



DRC gully

Treating the symptom is rarely as effective as treating the cause of a problem

# Treating the symptom

DRC gully…a symptom

Symptomatic gully…

…Symptomatic treatment

# Treat the cause and not the symptom of a problem

remember……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

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

# 4) Prevent things from happening in the first place!

# Specific Treatment Strategies for Road Surface Maintenance and Related Sediment Delivery Sources

There's a time and place for just about everything, but there some bad ideas out there also……

# Questions you should be asking yourself as you evaluate your road upgrade and maintenance plans

(1) Have you identified all of the locations where the road surface is hydrologically connected to the stream system?
(2) Are the initial treatment prescriptions based on site specific conditions and are they appropriate to minimize, to the extent possible, hydrologic connectivity and sediment delivery? Think performance based not prescriptive based
(3) In locations where hydrologic connectivity is unavoidable (such as the final approach to a stream crossing), have you prescribed road surfacing material (such as road rock) to minimize sediment production from the road surface?
(4) Have you developed a science based, property wide, prioritized action plan to address hydrologic connectivity between the road and the stream network?
(5) Do you have a thorough monitoring and adaptive management plan and is it being implemented?
(6) Does your road management plan include designating which roads are seasonal and which are for year round use?

# What is wrong with this conversation?

Tom—"What condition would you consider your ranch road system to be in"?

Landowner—"Our roads are in great condition, we grade them every year"……

# What is wrong with this conversation?
# Discussion

The issue here is that the landowner is focusing on drivability and not environmental protection or long-term maintenance costs……They view a good road as one that does not inhibit their intended use for it, without regard to the cost of regrading every year……This is not uncommon and can be addressed with a little education….

Typically if a landowner says something like this to me I say…. "if your road systems were in great condition you wouldn't need to grade them every year"

The reality is, an environmentally protective road is also usually a low maintenance road…

# The perpetual grading cycle
# And how to change your current bad habits

**The steps in the perpetual grading cycle**

1) A road alignment is established
2) The road is graded for smooth driving with little regard to establishing road drainage
3) Water intercepted by the road causes rilling and pot holes
4) The road is graded for smooth driving with little regard to establishing road drainage and becomes thru-cut or exhibits an outside berm.
5) Proceed to step 3

So….. one can see from this that there is a looping cycle between step 3 and 5, this is undesirable from a road maintenance perspective….In fact, the more times the loop between 3 and 5 occurs, the more difficult and expensive it will become to fix your road system.

This leads to one of the key PWA mantras of road maintenance……

**If you don't change something, its just going to happen again!**

**Or as someone put it…..” The definition of insanity is doing the same thing over and over and expecting different results”**

# An example of the results of the perpetual grading cycle

Note how there is no way for the water to get off the road driving surface
This will cause rilling and gullying on the road surface, necessitating more grading

# Jahnsian Steps to Geologic Safety
# *Remember…keep it scientific*

- Modified for road-related erosion processes

1. **Recognition** of local erosional features
2. **Characterization** of the erosional features
3. **Analysis** of the existing conditions and proposed treatment
4. **Mitigation** of the identified issue

# Analysis of connectivity and sediment delivery from the road system

- Ideally, the characteristics of each road surface discharge point is entered into a database and integrated into a GIS format for quantitative and spatial analysis

- This will allow the landowner to:

(1) Spatially visualize the condition their road system is in
(2) Identify specific problematic spots or road reaches on their property
(3) Estimate upgrade costs and logistics requirements
(4) Develop a prioritized treatment schedule
(5) Identify areas of increased monitoring and adaptive management requirements

# Mitigation objectives road drainage effectiveness

A road drainage system must satisfy two main criteria if it is to be effective throughout its design life:

1) It must allow for a minimum of disturbance of the natural drainage pattern.
2) It must drain surface and subsurface water away from the roadway and dissipate it in a way that prevents excessive collection of water in unstable areas and subsequent downstream erosion.

# Mitigation tools for hydrologically connected road surfaces

What tools and techniques are available and pertinent for the site specific discharge point?

- *Road shaping* (can significantly reduce contributing road surface area and effectively disperse road runoff)
- *Adding or improving road drainage infrastructure* (encourages water dispersion and infiltration)
- *Road and or ditch surfacing* (reduces erosion potential of the road surface)
- *Sediment control* (captures and retains in-transport sediment)
- *Road Realignment* (moves road to preferable location)

# Mitigation strategies for hydrologically connected road surfaces

- Effective and environmentally friendly road drainage treatments should be designed to allow road runoff to disperse and infiltrate on the native hillside

- Road drainage improvements that collect and concentrate runoff are inherently more likely to result in erosion and hydrologic connectivity between the road and stream network. They are also more costly to maintain and are more likely to irritate landowners who you have easements through

# Mitigation strategies for treating connectivity

1) Install a "disconnecting" drainage facility or structure "close" to the watercourse crossing;
2) Increase the frequency of ditch relief culverts for connected roads with inside ditches;
3) Eliminate existing ditch relief culverts with connected gullies
4) Convert crowned or insloped roads with inside ditches, to outsloped roads with rolling dips;
5) Remove or breach outside berms on crowned or outsloped roads if they result in connectivity;
6) Avoid discharging concentrated runoff onto unstable areas.

# It is important to develop a road surface upgrade plan that is consistent with local environmental conditions, expected use levels, and other constraints. "Safety-Performance-Protection"

- Keep in mind that there are a lot of tools and techniques available to landowners, the ones they employ should be the ones that perform best given the characteristics of each road segment and discharge point while considering other constraints

*As an example*: the gold standard geometry and drainage for many roads may be outsloping with frequent rolling dips but this may not be practical for roads in the snow zone (safety) or for steeper road grades where the design vehicle may be a lowbed truck (access)

*Similarly*, outsloping may be a great choice for the geometry of a road system, but it still may not be a good idea on a turn where momentum may carry a vehicle off of the road

## Have a "high quality" monitoring and adaptive management plan for road surface maintenance…..and implement it

- Its important to implement a road surface upgrade plan that is based on scientific analysis and Best Management Practices but it is just as important to develop a monitoring and adaptive management plan that identifies and treats weak spots in your original plan…..
- So in other words, much of the time, large road upgrade plans are not "one and done" but rather they require monitoring and touch up after going through their first winter.
- One challenge is when the maintenance crews work is driven by specific task orders that don't allow for site specific professional judgement to be employed when prudent. This can lead to overlooking easy treatments that can have profoundly beneficial impacts to the roads drainage performance. As an example, perhaps the work order is for grading vegetation off the road surface…. but if the maintenance crew determines a few non-functioning rolling dips could be "tuned up" to improve the road drainage, its logistically smart to do it while the equipment is on site rather than wait until the lack of good drainage becomes an access issue.

Road drainage performance is more important than meeting prescriptive recommendations

# Treating Hydrologic Connectivity

Hydrologic connectivity is treated by road surface shaping and the installation of road surface and ditch drainage structures

# Treatments for connected roads and ditches…

- Connected stream crossing approaches (road shape, berms, relief culverts, rolling dips, and road surfacing)
- Ditch drainage structures (ditch relief culverts, rolling dips, sediment basins)
- Road shaping (insloped, crowned, outsloped)
- Road surface drainage structures (road dips, rolling dips, waterbars and rubber waterbars, open top box culverts, berms, critical dips)
- Leadout ditches (for switchbacks, crowned roads, through cuts, fall line roads)
- Berm removal and berm breaks
- Abandonment treatments (ripping, cross road drains, outsloping, crossing excavation, fillslope excavation)

# "Hydrologic invisibility"

The goal is to have the road only minimally affect the water's "natural, pre-road" flow path on the hillslope…..

Water encounters the road via:

- Rainfall and surface flow from the roadbed and cutbank
- Shallow subsurface flow from the cutbanks
- Streamflow at stream crossings

# ROAD DRAINAGE TREATMENTS

## Road shaping

Outsloping and conforming
to the topography


Free draining, outsloped roads

Before

After

Before

During

Before

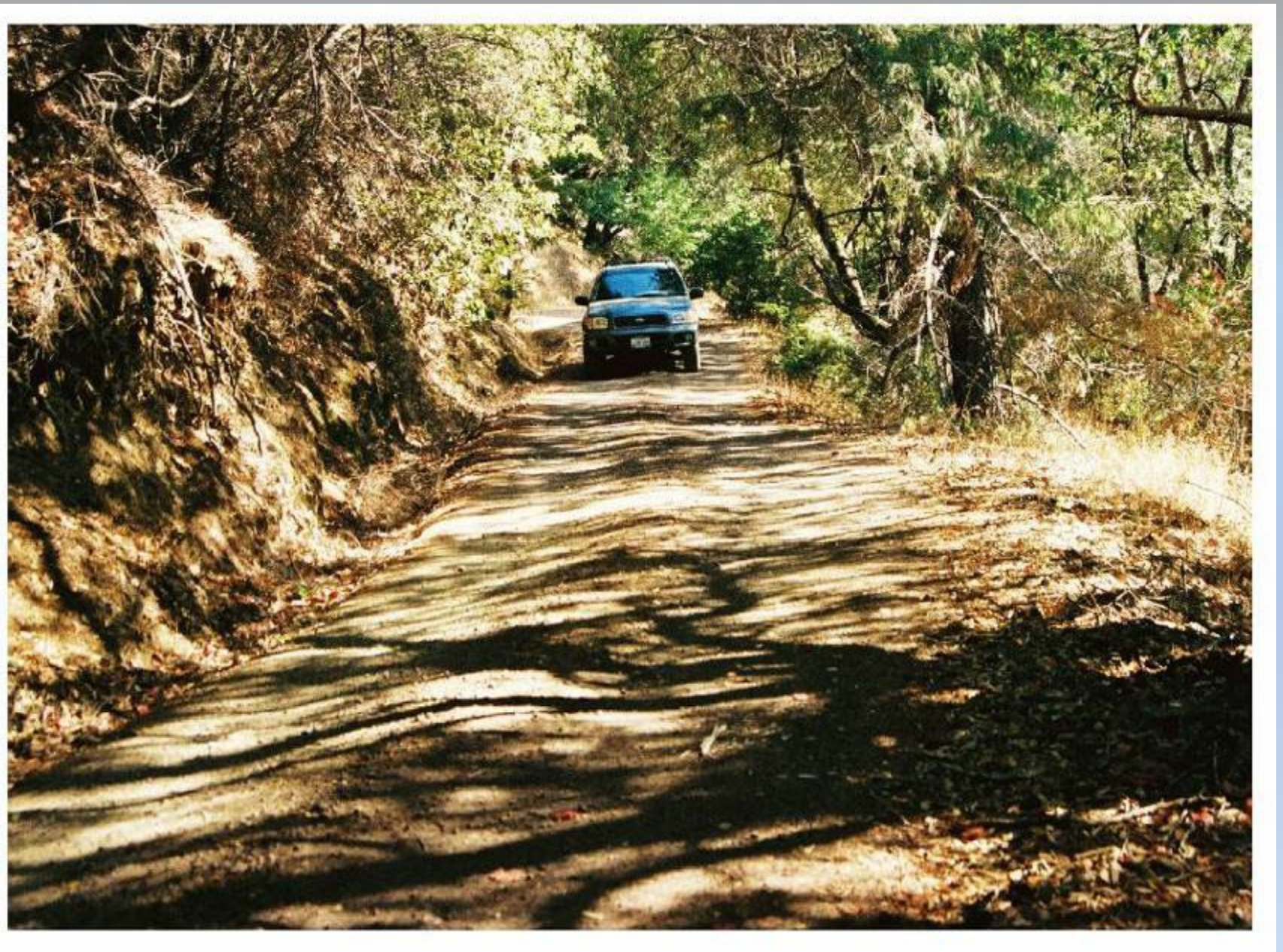
After


Before


After


Before


After



Before

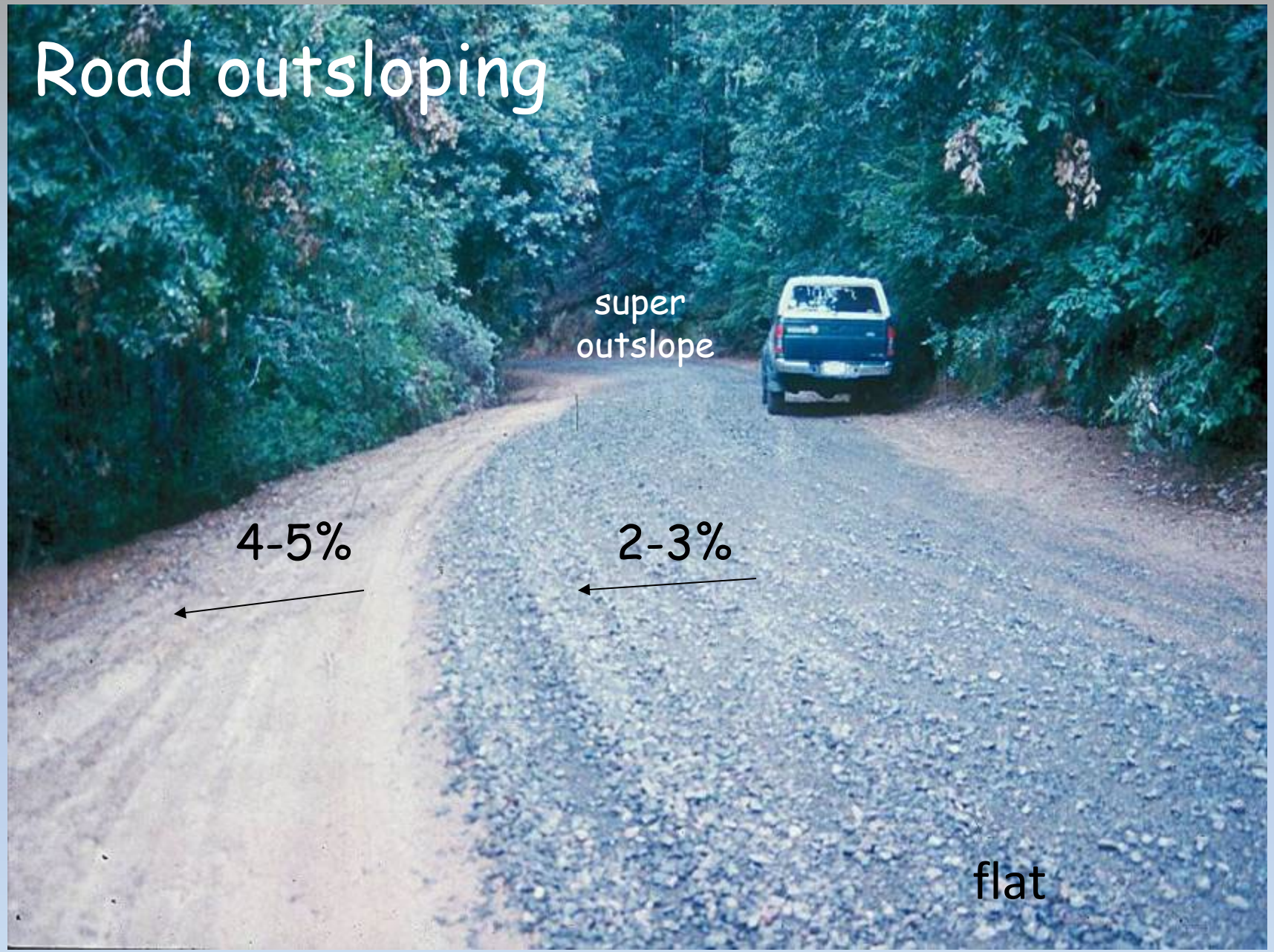

After

Before


After

Outsloped with ditch

# Road outsloping




Driveability, Functionality and Safety


# Turnout outsloping

Woven geotextile (road fabric) used to increase road strength and improve subsurface drainage

Tensar geogrid used to increase road strength and improve subsurface drainage


DRC – no gully


DRC installation


Full-round downspout


# Energy dissipation


Perforated DRC flex pipe spreaders

DRC drop inlet

Draining through-cuts


# Berm breaks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# Drainage cut-out drains road rut


# Berm breaks


Silt fence ditch filter


Sediment storage on vegetated flat


Sediment basin under construction


Sediment basin

Roadside sediment retention basin

Sediment basin at end of through-cut

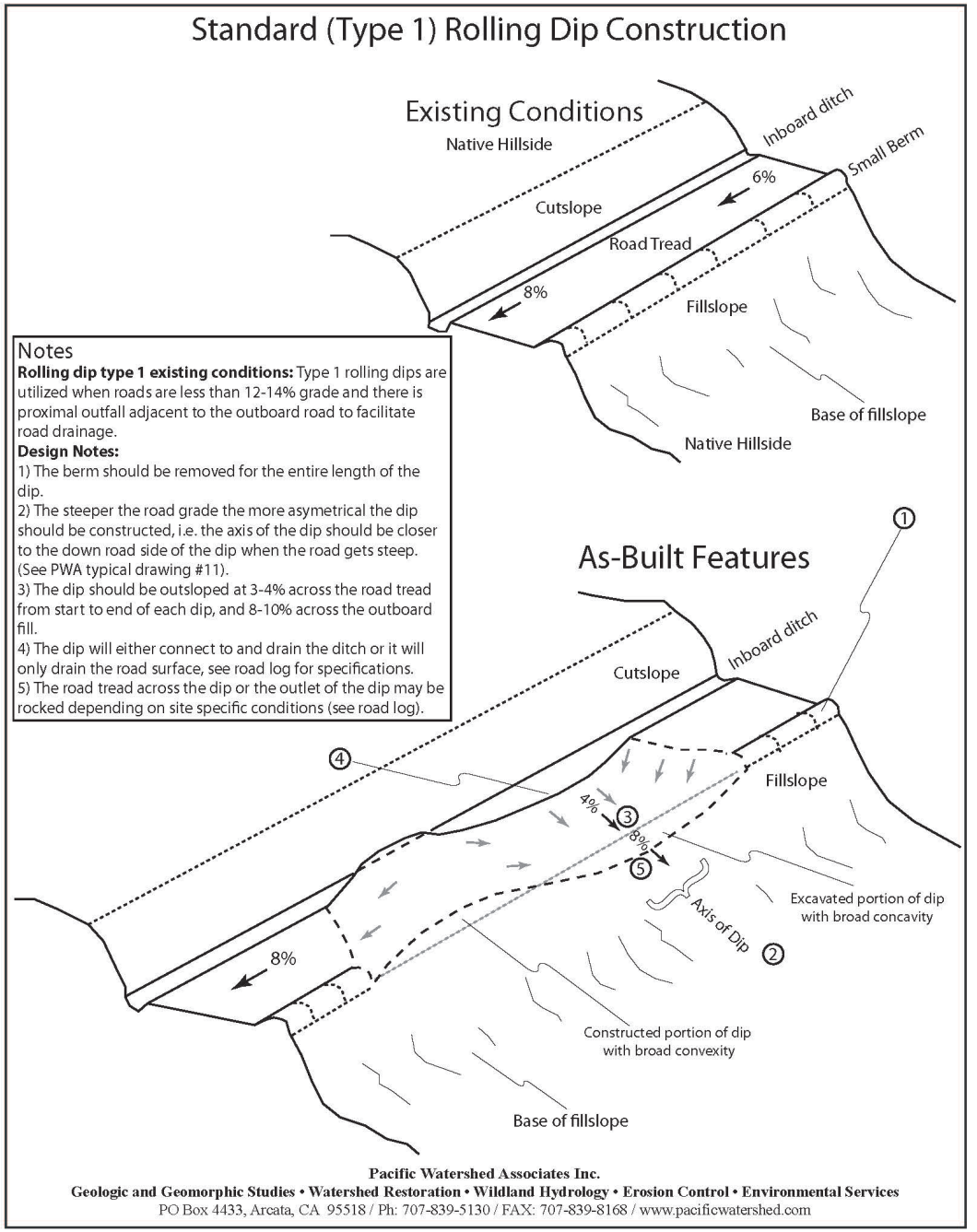
Sediment basin drainage outlet

# Different types of rolling dips

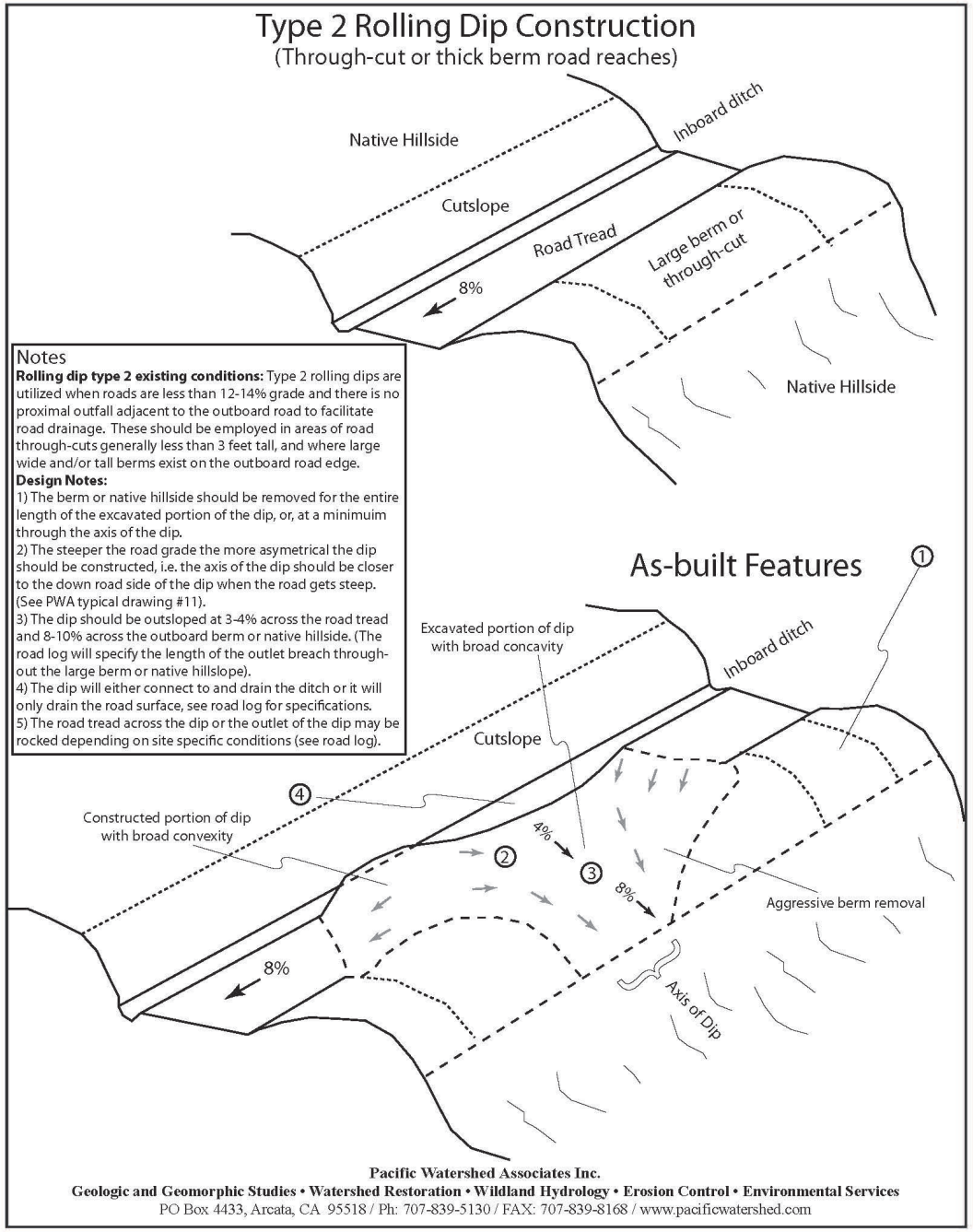
PWA has developed typical drawings for three different rolling dip types, the different dip types are meant to be employed as necessary based on the existing road and hillside geometry.

Type 1- employed in areas with low to moderate road grades and small outboard berms
Type 2- employed in areas where the road is through-cut or exhibits thick berms on the outboard road
Type 3- employed where the road grades are relatively steep and developing reverse grade on the dip would inhibit vehicle traffic

# Rolling dip-Type 1

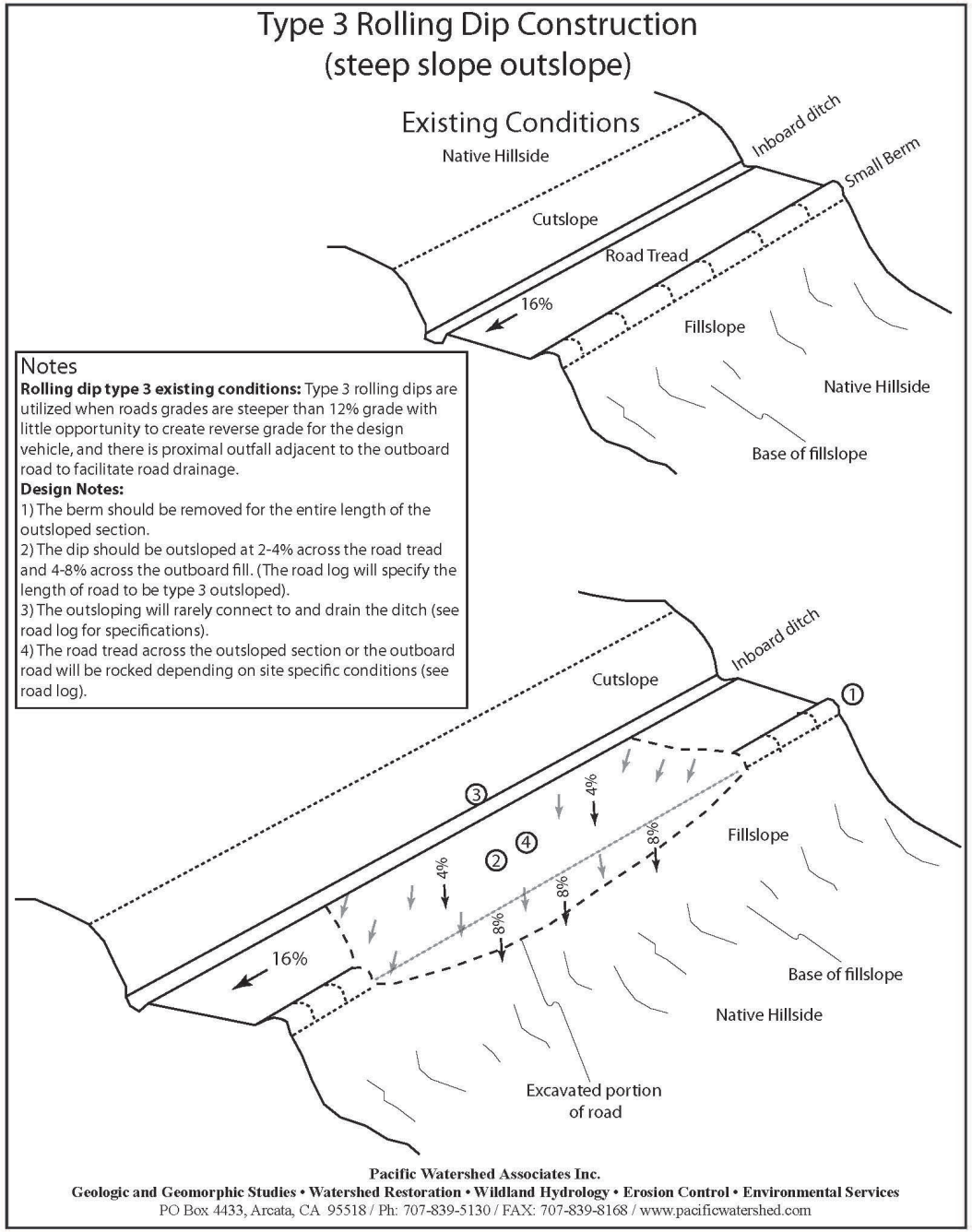


# Rolling dip-Type 2




PWA Typical Drawing #19b

# Rolling dip-Type 3




PWA Typical Drawing #19c

Lets look at some examples of road reaches upgraded with road shaping and rolling dips

Note:

(1) There are several rolling dips on this photo

(2) The final road approach is heavily rocked

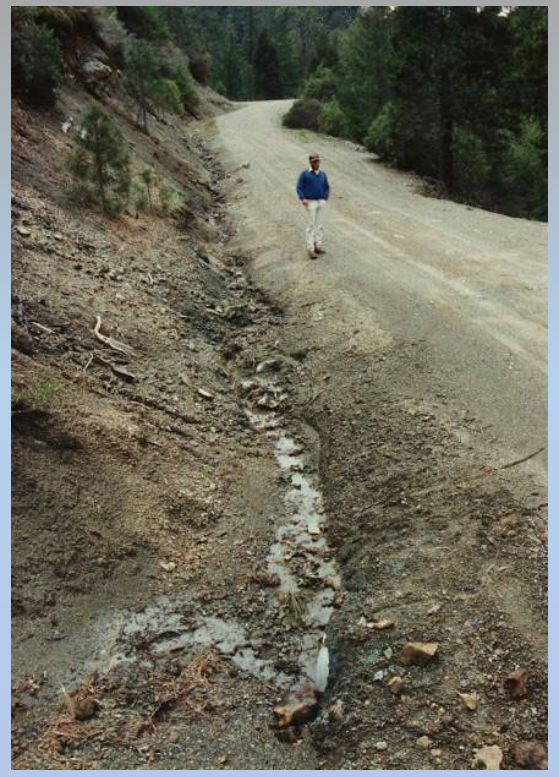
(3) The road is generally shaped to conform to the natural hillside

# Rolling dips on a stream crossing approach

# Adding frequent road drainage structures

Insloped with ditch


Outsloped with rolling dips



**Insloped road with ditch – hydrologically connected**

**Outsloped road with rolling dips – ditch retained**

Choosing rolling dip frequency and discharge locations need to be well thought out

# Where to place rolling dips and other road drainage infrastructure

- On convex surfaces to encourage dispersal and infiltration of road runoff
- On highly vegetated hillsides
- On low gradient hillsides
- As far as practical from the stream network (the closer you get to a stream crossing the more frequent your dips should be)
- On stable geologic surfaces (in other words, not on landslides or hillsides prone to gully erosion)
- On straighter sections of roads (not on or right before a hard turn to the inside of the road)
- On outside turns in the road (like a NASCAR turn)
- On vegetated river terraces when there is no other choice

Maintain a large riparian buffer of vegetation between grading projects and streams.  Steeper and less vegetated hillsides require longer riparian buffer strips to protect water quality.

# Roads where streams should be:

Road Surface and Stream Bank Erosion and no Riparian Buffer

# Roads where streams should be, no riparian buffer

Well spaced and placed rolling dips…
Note: the tight spacing on the dips and the low gradient, grassy hillside they are discharging onto

# Tips for determining the appropriate frequency for rolling dips

(1) Dip frequency should decrease as the road approaches a stream crossing…
(2) In general, steeper road grades and roads proximal to streams require more frequent road drainage structures
(3) Dip frequency should be based on the performance of the existing road drainage, not based on prescriptive measures..
(4) Road drainage performance should be monitored through the winter months and adaptively managed by prescribing more frequent dips where appropriate

# Three typical deficiencies when installing rolling dips

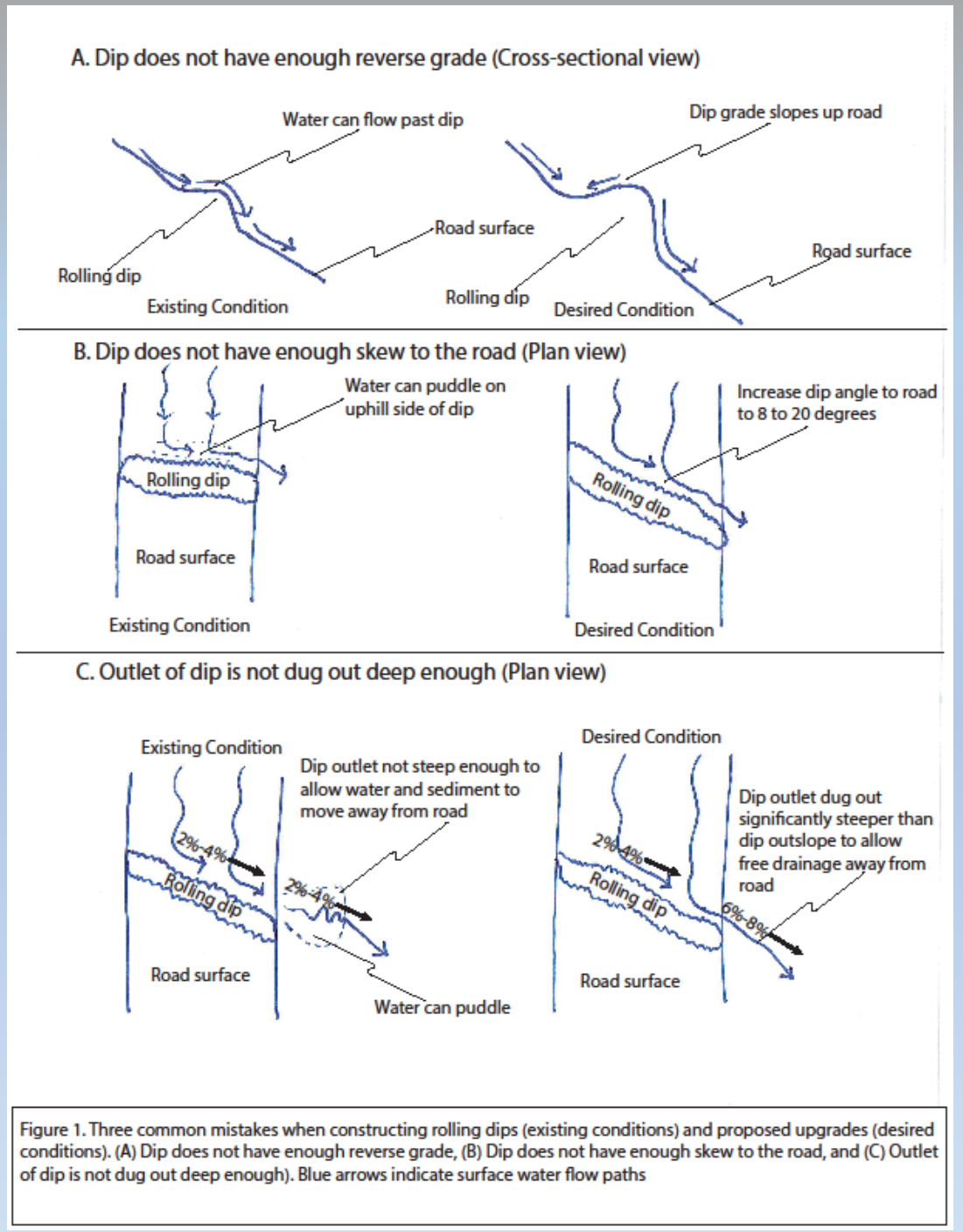



Figure 1. Three common mistakes when constructing rolling dips (existing conditions) and proposed upgrades (desired conditions). (A) Dip does not have enough reverse grade, (B) Dip does not have enough skew to the road, and (C) Outlet of dip is not dug out deep enough). Blue arrows indicate surface water flow paths

# Typical rolling dip construction deficiencies

Outlet of dip not dug out enough…. rock armor installed without a "U" shape allows water to flow around rather than over the rock armor

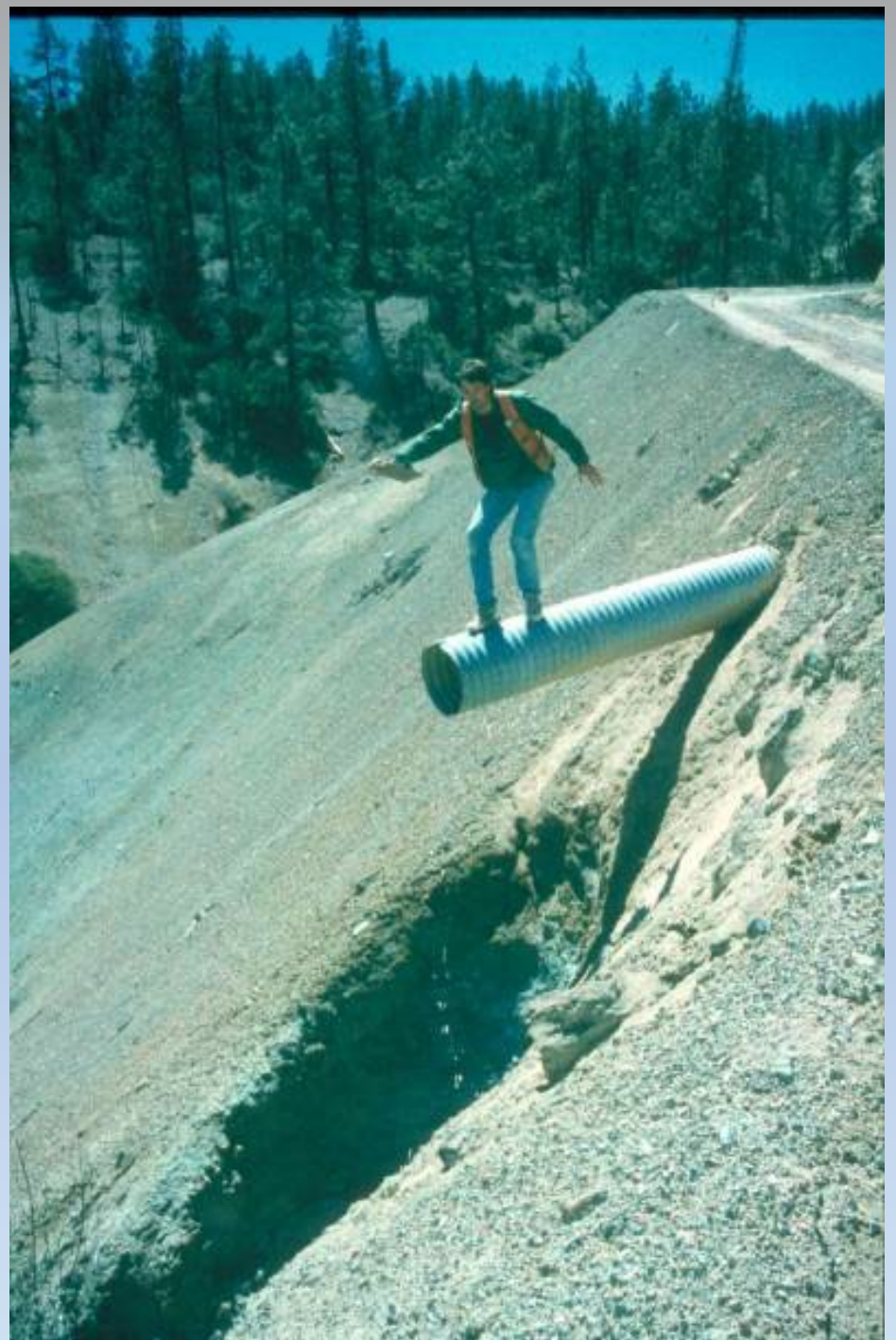
# Typical rolling dip construction deficiencies

Dip does not have enough skew, not enough outslope and lacks fall at the outlet

# Typical rolling dip construction deficiencies

Dip does not have enough outslope

# Ditch relief culverts



# When are inside ditches and ditch relief culverts a good option?

- Wet hillside conditions- In really wet areas or where the ditch is draining a hillside spring, DRCs are a good option…
- On steep road grades- On steep road sections where outsloping or rolling dips are not feasible, ditch and ditch relief culvert can be employed…
- To minimize discharge onto geologically unstable areas- Its best to carry water in a ditch rather than allow it to discharge where erosion and or sediment delivery could occur…
- Where berms are required to assure vehicles stay on the road…
- In areas of run-on from the hillside..
- Any location where you don't want to discharge run off over the fillslope
- On paved road sections….


DRC – no gully


Full-round downspout

Energy dissipation


Perforated DRC flex pipe spreaders

DRC drop inlet

# Berms and thru-cuts


Bermed fillslope

Thru-cut road surface

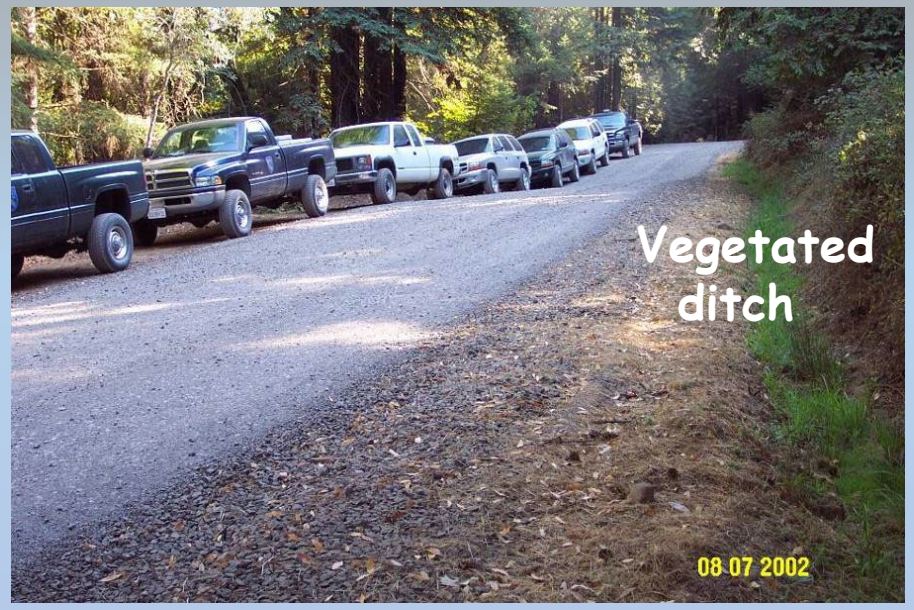

Bermed fillslope protecting stream crossing fill

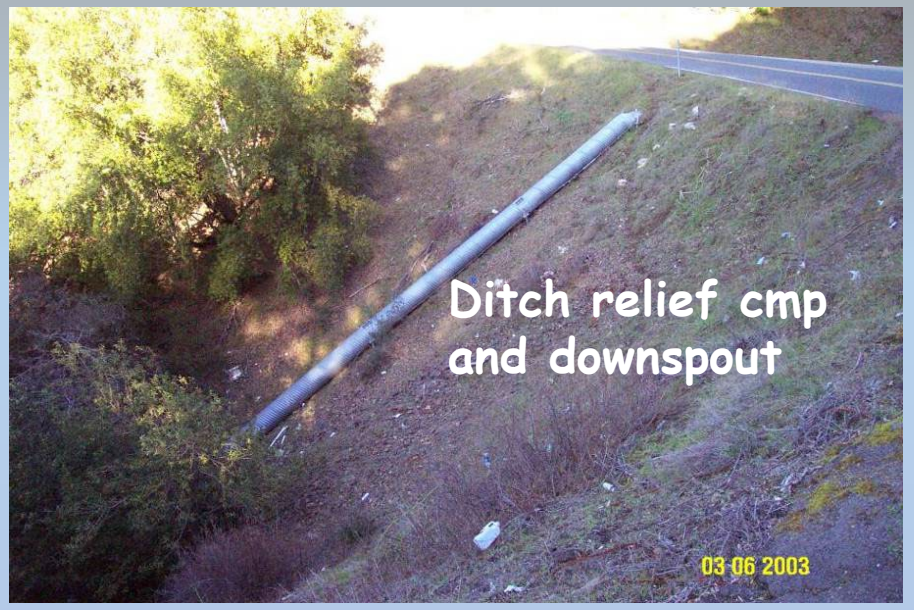

# Berm breaks on a fall-line road

Berm Break defeated after grading

# Drainage cut-out drains road rut

# Other road drainage treatments





# Other techniques and accessories

Slotted road drain and ditch infiltration gallery

Critical dip

After overtopping and directed over critical dip
Note offset of critical dip from stream alignment to protect fill

# Road surfacing

# Road surfacing- tips and techniques

Pit run rock is the best option- Pit run rock is angular and typically contains enough fine grained material to bind the rock together…
River run rock is a less preferable option- River run rock is rounded and will likely be pushed off the road by vehicle traffic. This will decrease the rock surfacing durability and increase the required maintenance of the road…
Crushed river run- better but does not contain the binding fines
When rocking a road moisture conditions of the surfacing material is critical to achieve proper compaction
Vibratory rollers enhance compaction of road surfacing materials
Be careful who maintains your road….