2025 Salmon Restoration Federation Roads Workshop
Fundamentals of Road Impacts, Identifying and Characterizing Road Related Erosion and Sediment Delivery

Pacific Watershed Associates

Impacts from Poorly maintained roads
(Road surfaces)

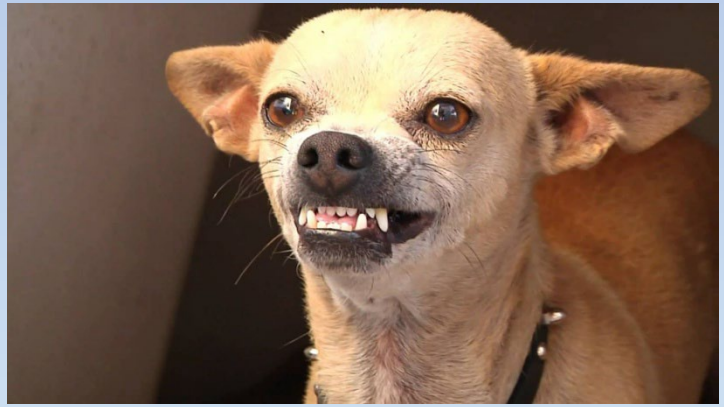
Environmental Impacts and/or Maintenance Impacts

Impacts from Poorly maintained roads
(Road surfaces)

- *Environmental Impacts*- Impacts that cause adverse conditions to the natural environment or adverse impacts to fish or wildlife.
- *Maintenance Impacts*- Impacts that adversely effect the ease of driving on the road or impacts that result in unnecessary expenditures of road maintenance funds.
- *You're Irritating Your Neighbor Impacts*- Impacts that cause anxiety and irritation to neighbors or landowners who you have easements through.

Cumulative impacts…AKA (The tragedy of the commons) (Death by a thousand cuts) (Mauled by a pack of chihuahuas)

- Individuals acting independently and quasi-rationally according to each's self-interest behave contrary to the best interests of the whole group by depleting some common resource such as water volume, water quality, or fisheries resources



Impacts from Poorly maintained roads (Road surfaces)

Road Related Sediment Discharge

Impacts from Poorly maintained roads (Road surfaces)

Turbid water in an anadromous fish stream

Impacts from Poorly maintained roads (Road surfaces)

Hillside gullies

Impacts from Poorly maintained roads (Road surfaces)

Road related landslides

Impacts from Poorly maintained roads (Road surfaces)

Road related landslides

Primary and Secondary Impacts from Roads

- Accelerated sediment delivery
  - Episodic erosion and sediment delivery (typically a mix of coarse and fines)
  - Chronic erosion and sediment delivery (typically fine grained sediment)

- Altered surface and ground water hydrology
  - Road cutslopes can drain shallow ground water
  - Road runoff can reduce groundwater recharge
  - Road runoff can put peaks in the watershed hydrograph

Accelerated sediment delivery from roads can impact downstream beneficial uses

- *Episodic erosion and sediment delivery*- This typically results from high intensity storms that cause local and regional stream crossing washouts and landslides, this type of erosion is relatively easy to identify and is manifest as large gullies, major washouts and fillslope mass wasting.

- *Chronic erosion and sediment delivery (Stealth sediment)*- This typically results from small to moderate rainfall events that wash dust and ground up earthen material off the road surface and into the streams, it is often hard to observe during the dry season.

Benefits of maintaining an environmentally protective road

1) Decreased long term road maintenance costs
2) Normalization of ecosystem services
3) Friendlier neighbors
4) Reduced down time or emergency repairs of large road failures
5) Decreased scrutiny by regulatory authorities
6) More reliable maintenance vehicle access during winter conditions

All of these benefits can result in enhanced environmental protection but also cost-savings!

Remember, an environmentally protective road will exhibit more durability during storm events
And typically requires less long-term maintenance….This saves money and time……

Road surface observations that indicate something must change and treatment prescriptions need to be developed

(1) The road exhibits chronic rilling, gullying, or rutting
(2) Water is constantly trapped on the road driving surface
(3) The road requires constant grading
(4) The inside ditches are incised or aggraded with sediment
(5) The ditch relief culverts are plugged or don't meet design performance standards
(6) The road surface water discharge is causing erosion of the adjacent hillside
(7) Potholes keep forming on the road surface
(8) The road is washboarding
(9) The road surface shows signs of significant wear
(10) The road exhibits excessive hydrologic connectivity with the stream system

Identifying the Problems
(Road Surface Rilling)

Signs your road needs upgrading (Identifying Problems)

Road Surface Rilling and Gullying

Signs your road needs upgrading (Identifying Problems)

Road Surface Gullying in "fall line" road

Identifying the Problems
(Road Surface Rutting)

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Identifying the Problems
(Water trapped on road driving surface)

Identifying the Problems
(Water trapped on road surface by berms)

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Identifying the Problems

(Heavy sedimentation in the ditches)

Hydrologic Connectivity?.....Connected!

Identifying the Problems
(Heavy sedimentation in the ditches)

Identifying the Problems

(Heavy sedimentation in the ditches)

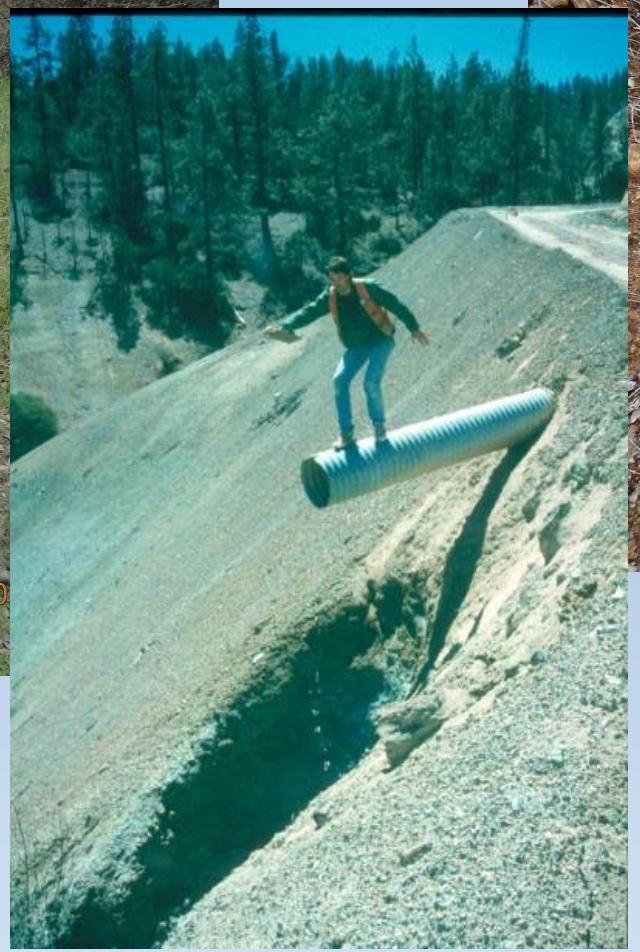
1) Reduces capacity of ditch to convey water
2) Plugs surface water drainage infrastructure
3) Has potential environmental impacts

Sedimentation from road reducing ditch capacity and plugging culvert inlet

Identifying the Problems
(Ditch Erosion)

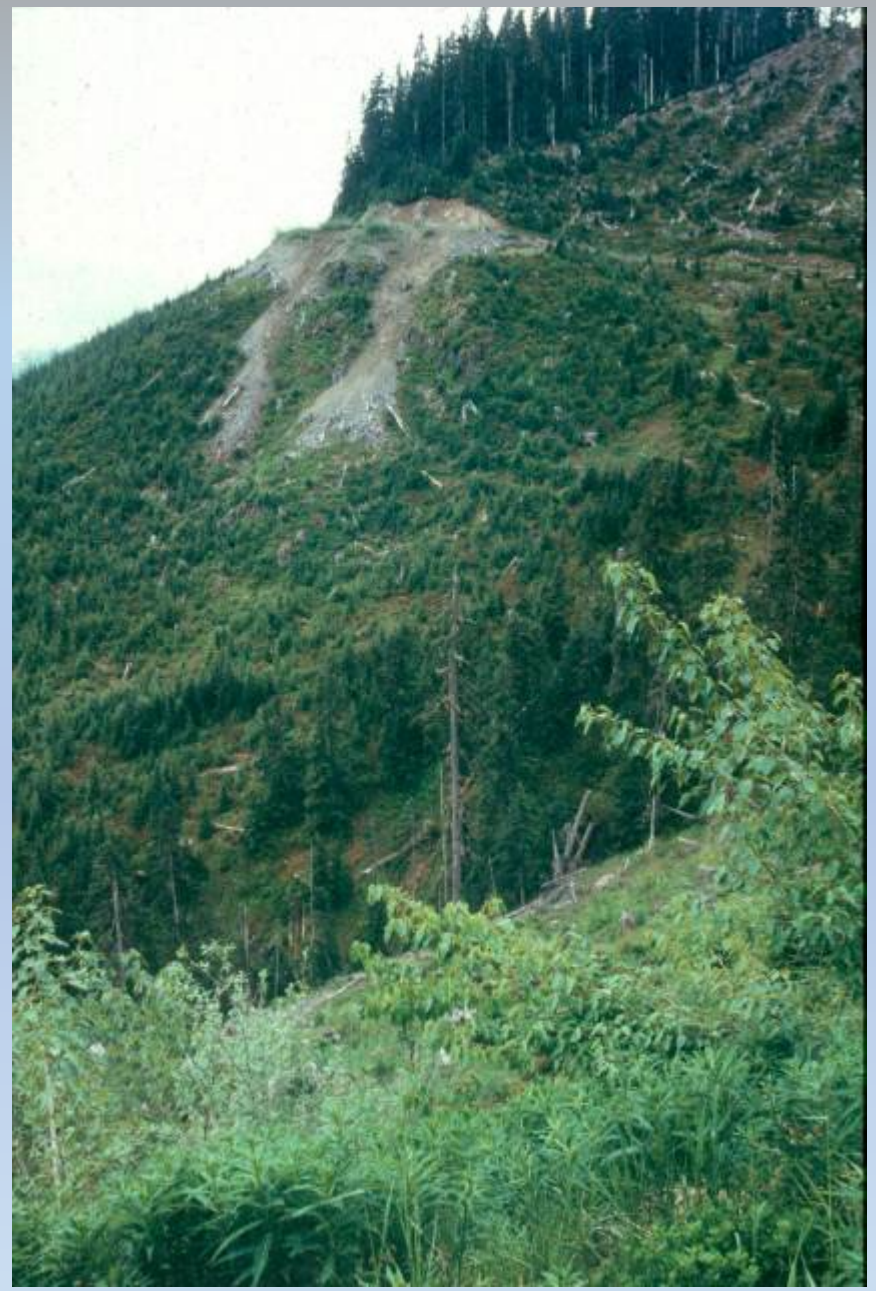
Identifying the Problems

(The ditch relief culverts are plugged or don't meet design performance standards)



Identifying the Problems

The road surface water discharge is causing erosion of the adjacent hillside



Identifying the Problems

The road surface water discharge is causing erosion of the adjacent hillside

Signs your road needs upgrading
(Identifying Problems)

Pot holes – poor road drainage

Signs your road needs upgrading (Identifying Problems)

The road surface shows signs of significant wear

Signs your road needs upgrading (Identifying Problems)

The road surface shows signs of significant wear

Signs your road needs upgrading (Identifying Problems)

The road surface shows signs of significant wear

Identifying Problems
(Excessive mechanical road surface erosion)

Signs your road needs upgrading
(Identifying Problems)

Hydrologic Connectivity and sediment delivery

Hydrologic Connectivity

Sediment delivery occurs where the road prism, including road surfaces and ditches, are connected to stream channels via overland water flow……This allows turbid water washed off the road to impact aquatic ecosystems throughout the watershed…..

Signs your road needs upgrading (Identifying Problems)

Hydrologic Connectivity?.....Connected!

Signs your road needs upgrading (Identifying Problems)

Hydrologic Connectivity?.....Connected!

Signs your road needs upgrading (Identifying Problems)

Hydrologic Connectivity?.....Connected!

What to look for… *(identifying hydrologic connectivity)*

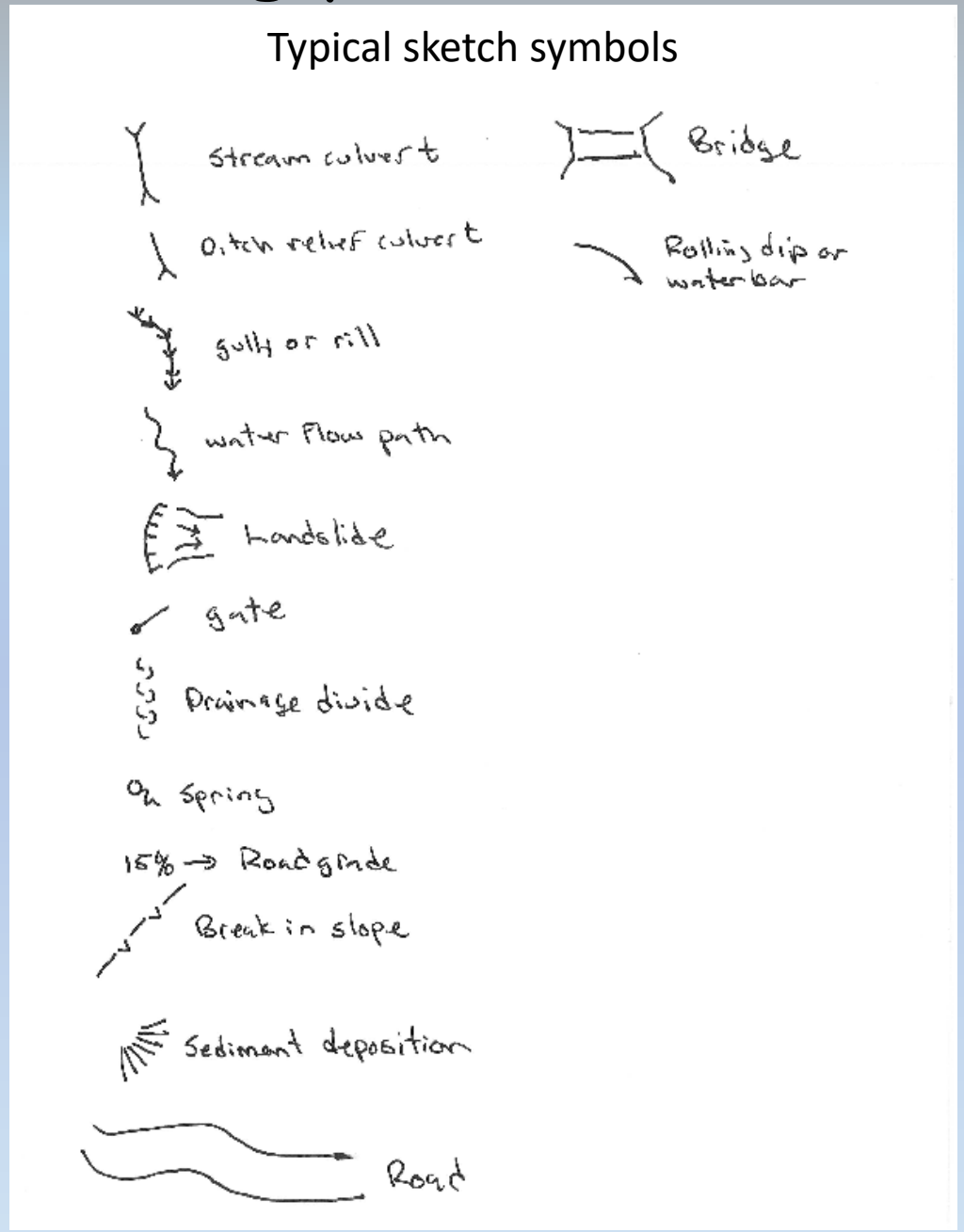
- Road surface and/or ditch draining into or leading to a stream crossing drainage structure inlet or outlet;
- Evidence of surface flow between the drainage structure outlet and a natural stream channel/flood prone area;
- A channel or gully that extends from a road drainage structure outlet to the high water line of a defined channel or a flood prone area;
- A sediment deposit that reaches the high water line of a defined channel or a flood prone area;
- Observation of turbid water reaching the watercourse during runoff events; or
- Indications of channel widening and/or incision below a drainage structure resulting from increases in flow.

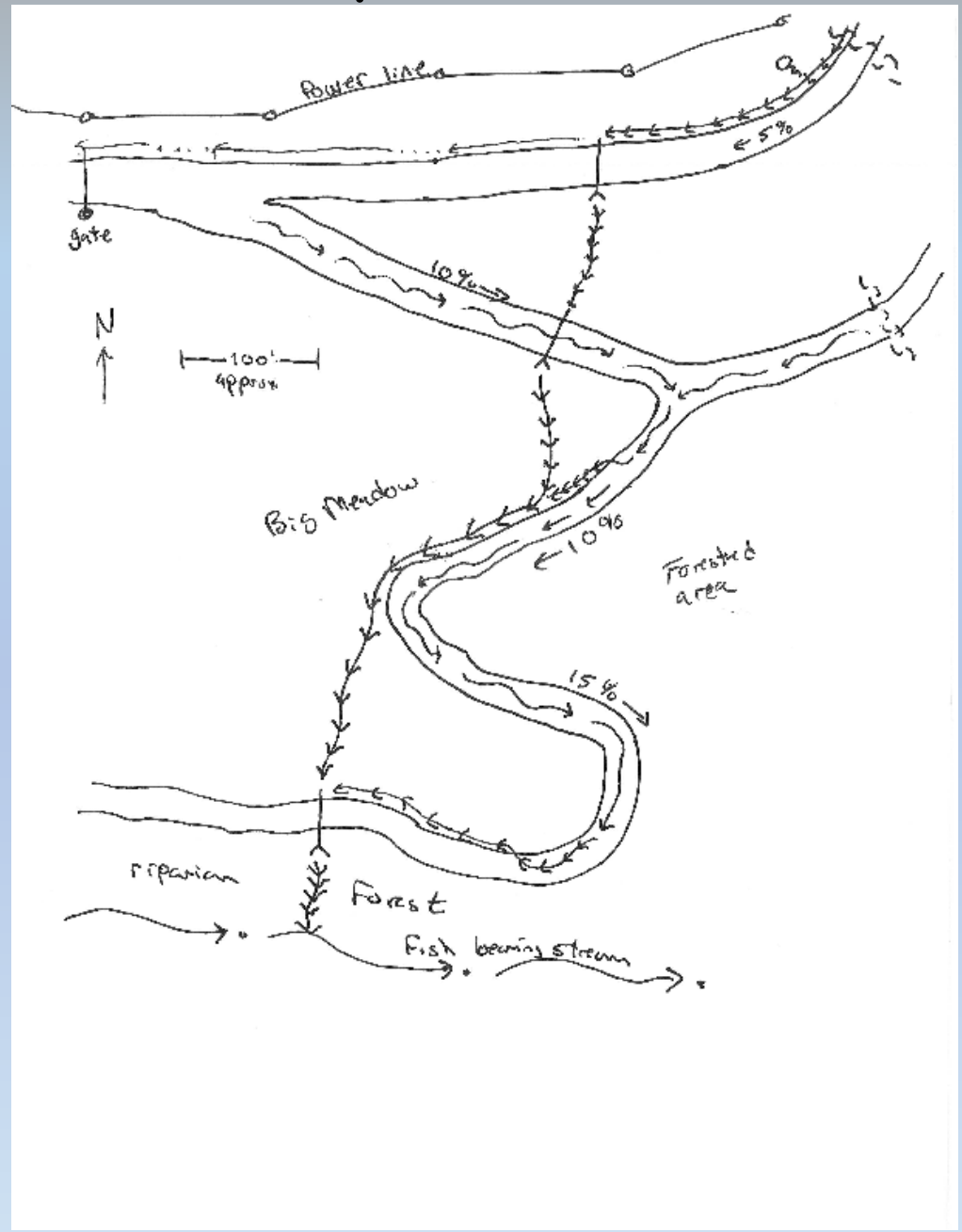
Characterizing your road surface related problem

(1) Developing a good site sketch
(2) Recognizing the cause and sources of your problem
(3) Describing and quantifying the magnitude of your problem
(4) Estimating your problems relative significance

Characterizing your road surface related problem

Developing a good site sketch



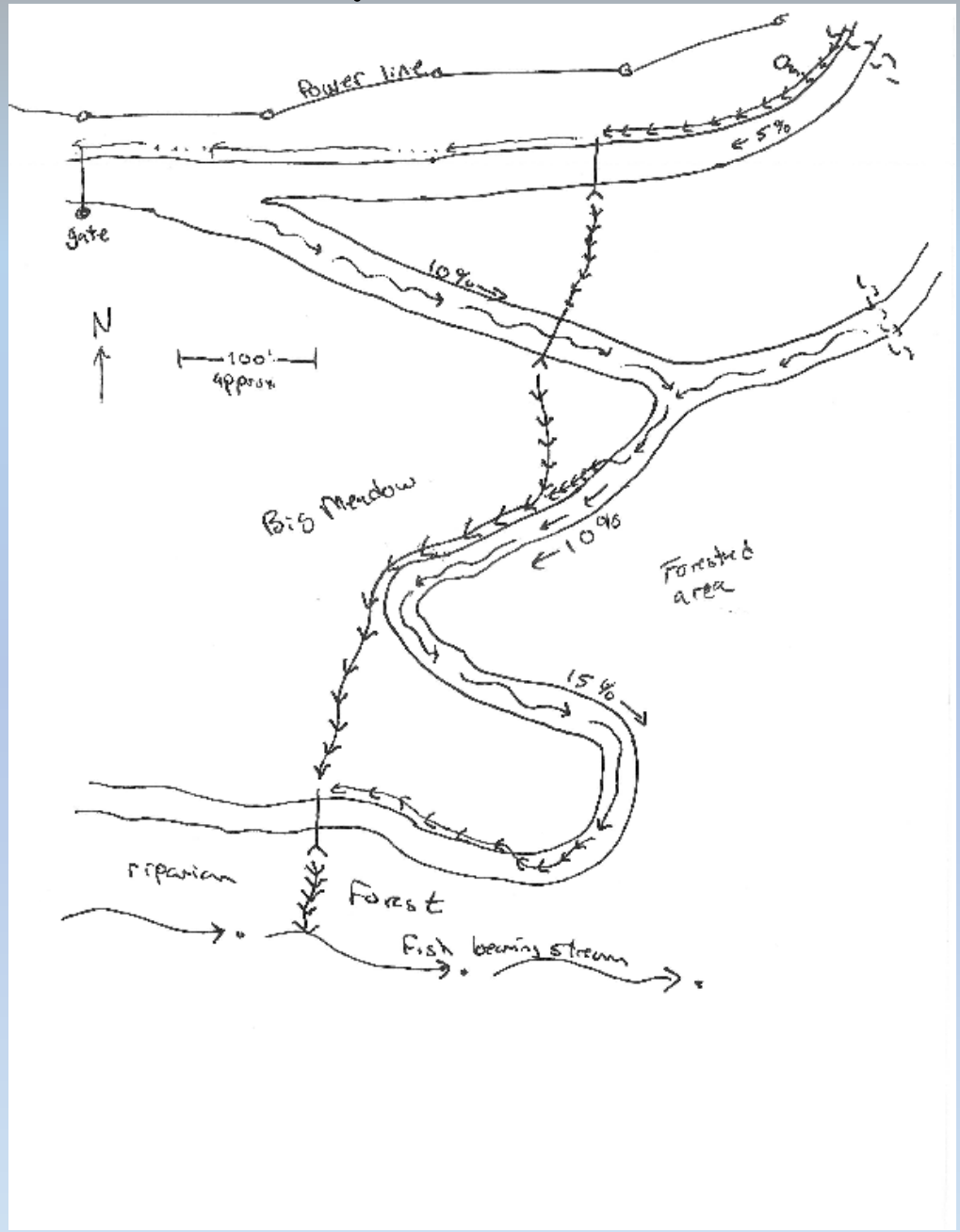


Characterizing your road surface related problem

Recognizing the cause and sources of your problem

More often than not, road surface erosion is related to deranged surface water hydrology

You should conduct your inventory from the top down to help you understand all the surface water inputs



Characterizing your road surface related problem

Typical PWA dataform

PM CHECK **BIG RIVER PWA ROAD INVENTORY DATA FORM** (1/25 version) Access DB: _____ PWA Stream: _____

GENERAL	Site No:	Watershed:	Subwatershed:	Onsite data form staff check: _____	Sketch (Y)			
	Photo/Map #:	Road:	Mileage:	Landowner: State Parks				
	Inspectors:	Date:	Year Built:	Surface - rocked, native, paved, chip seal (R, N, P, C):				
	Maintained	Un-maintained	Decommissioned	Road use: (Year round, Seasonal, No recent use (>5 yrs))	Drivable, quad, walk (D, Q, W)			
PROBLEM	Stream xing	Landslide	Roadbed (bed, ditch, cut)	DRC	Spring	Channel scour	Bank erosion	Other
	Road related? (Y, N)	Geomorphic Association: SS, IG, ST, SW, HD, BIS, Other						
ROAD/ DITCH INFO	Left road/ditch length (ft): _____	Surface erosion rating (H, M, L)	Right road/ditch length (ft): _____	Surface erosion rating (H, M, L)	Left road grade (%): _____	Right road grade (%): _____	Driving surface width (ft): _____	
LANDSLIDE	Road fill	Landing fill	Cutbank slide	Hillslope debris slide (>50% original ground)	Deep seated, slow	Past failure	Potential failure	
	Slope shape: (convergent, divergent, planar, hummocky)	Natural slope (%): _____	Distance from toe to stream (ft): _____					
STREAM	CMP	Bridge	Humboldt	Fill	Ford	Armored Fill	Pulled xing	% pulled: _____
	CMP diam (in): _____	Culvert type (P, S, A, C)	Inlet (O, C, P, R)	Outlet (O, C, P, R)	Interior (O, C, P, R)	Separated (Y)	Check CMP size (Y)	
	Plug potential (H, M, L)	Headwall (in): _____	CMP slope (%): _____	Rust/silt line (in): _____	CMP appears undersized: (Y, M, N)	Woody debris in transport: (H, M, L, None)		
	Stream class (1, 2, 3)	Sed trans (H, M, L)	Ch grade (%): _____	Bankfull channel width (ft): _____	Bankfull channel depth (ft): _____			
EROSION	Diversion potential? (Y, N):	Currently diverted? (Y, N):	Past diversion? (Y, N):	**Fish barrier assessment needed? (Y, M, N):**				
	E.P. (H, M, L):	Potential for extreme erosion? (Y, N):	Volume of extreme erosion (yds³): <500, 500-1000, 1-2K, 2-5K, >5K					
Past Erosion	Is the stream crossing washed out? (Yes, No) _____%	Past stream crossing erosion (yds³): _____						
Future Erosion	Total future erosion (yds³):	Future delivery (%):	Total future yield (yds³):					
	Future width (ft):	Future depth (ft):	Future length (ft):					
TREATMENT	Treat (Y, N)	ASAP (Y, N)	Immediacy (H, M, L)	Complexity (H, M, L)	Upgrade	Decommission		
	Excavate soil	Critical dip	Trash rack	Install bridge	Other treatment? (Y)	Mulch (ft²):		
	Wet crossing (ford, armored fill)	Armored fill hgt (ft): _____	Armored fill/ford top width (ft): _____	Armored fill/ford bottom width (ft): _____	Armor size range (ft): _____	Armor vol (yds³): _____		
	Install culvert	Replace culvert	CMP diameter (in): _____	CMP length (ft): _____	Couplers (#): _____	Pipe-arch/oval CMP: (Y, M, N)	Clean CMP (inlet, outlet, both)	Repair CMP
	Install flared inlet: (Y, N)	Flared inlet diam (in): _____	Xing downspout diam (in): _____	Xing downspout length (ft): _____	Couplers (#): _____			
	Armor (ditch, headcut)	Armor fill face: (in, out, both)	Armor area (%): _____	Armor size range (ft): _____	Armor vol (yds³): _____			
	Install DRC (#): _____	*Replace DRC (#):* _____	*DRC diameter (in):* _____	*Total DRC length (ft):* _____	*Total DRC couplers (#):* _____			
	DRC downspouts needed (#): _____	DRC downspout diameter (in): _____	Total DRC downspout length (ft): _____	Total DRC downspout couplers (2 per elbow needed) (#):_____	Total DRC elbows (#): _____	DRC elbow angle(s) (deg): _____		
	Outslope & Remove ditch (ft): _____	*Outslope & Retain ditch (ft):* _____	*Inslope road (ft):* _____	*IPOS (ft):* _____	*EPOS (ft):* _____			
	Rolling dip (#): *Left* _____ *Right* _____	*Remove berm (ft):* _____	*Berm width (ft):* _____	*Berm depth (ft):* _____	Engineered fill			
	Clean or cut ditch length (ft): _____	*Armor ditch W x D x L (ft):*_____	*Ditch armor size range (ft):*_____	*Ditch armor vol (yds³):* _____	*Remove ditch (ft):* _____	*Cross road drains (#):* *Left* _____ *Right* _____		
	Rock Road W x D x L (ft): _____	*Rock road-(ft²):* _____	*Underground utilities present: (Yes , No)*					
Road Opening (To this site from last site)	*Vegetation:* brush small trees large trees	*Landslides inhibiting access:* cutbank, road fill	*Other road opening obstacles:*	*No road opening costs*				

COMMENT ON PROBLEM: (i.e. What is causing the erosion? How active is the erosion? Where is the erosion currently occurring or where could it potentially occur?)

EXCAVATION VOLUME	Total excavated (yds³): _____	Vol put back in (yds³): _____	Volume removed (yds³): _____	
	Vol stockpiled (yds³): _____	Vol endhauled (yds³): _____	Dist endhauled (ft): _____	Excav prod rate (yds³/hr): _____
EQUIPMENT HOURS	Excavator (hrs): _____	Dozer (hrs): _____	Dump truck (hrs): _____	Grader (hrs): _____
Exc: _____ Inst: _____ Bf.: _____ Armor: _____ Downspouts: _____	Loader (hrs): _____	Backhoe (hrs): _____	Labor (hrs): _____	Other (hrs): _____
Roadbed post exc: (lower, raise, same elevation)	Lower/raise (ft): _____	Road alignment post exc: (move in, move out, same location)	Move in/out (ft): _____	Fill rebuild angle IBF rebuild angle (deg): _____ OBF rebuild angle (deg):_____

COMMENT ON TREATMENT:

Stream Profile Through Crossing (begin at top of profile) *Xing type 1, 2, 3, 4* Profile shot (As is, As was)

Angle (deg) (downslope = "-")	Distance (feet)	Code (UES, **TOP, IBF, OBF, BOT XS1, XS2,..**,LES)	Comment
0	0	UES, TRN	In natural channel

Cross Section(s) (begin on left bank)

xs#	Angle (deg)	Distance (feet)	Code (LRP, **LEC, CLP, REC,** RRP)	Comment
1	0	0	LRP, TRN	Base of cutbank/open

Computer volumes - 1. Computer erosion volume (1:1): _____ 3. Humboldt excavation volume (1:1):_____

2. Culvert excavation vol (add/repl - 1:1): _____ 4. Decommission volume (2:1): _____ 5. Excav/decom decompaction volume (_____ x 1.2) = _____

Site Sketch - Site No: _____

Characterizing your road surface related problem

Lets look at some filled out data forms

Characterizing your road surface related problem

Quantifying some typical road erosion features

Past erosion vs future erosion

Past erosion is pretty straight forward, predicting future erosion requires a little more reasoning

Characterizing your road surface related problem

Quantifying some typical road erosion features

Gullies and rills
Landslides
Road surface lowering

Characterizing your road surface related problem

The “Lumper” vs
“Splitter” conundrum

Sediment Production

versus

Sediment Delivery

Washed-out stream crossing

The crossing fill is still eroding but the road surface is grassy and stable

Cutbank surface erosion

Estimate erosion using surface lowering (don’t measure every rill)

Estimating road surface erosion

Not much rilling going on here, but there is clearly erosion taking place

Estimating road surface erosion

Doesn’t look like much erosion is going on here

Estimating road surface erosion

But erosion can add up and small amounts of turbid water can pollute long stream reaches

Predict future erosion using surface lowering estimates

Estimating road surface erosion

Let nature guide you when estimating past and future erosion

Estimating road surface erosion

Estimate future erosion like a gully

What is the future erosion at this site?

Outsloped road with small berm retaining water on road running surface

Shallow thru-cut on flat meadow easement road

Shallow thru-cut on flat meadow road

Shallow thru-cut on flat meadow road

Shallow thru-cut on ridgeline road

Steep, insloped, bermed road on hillside

Thru-cut road leading to
to a stream in a flat meadow