

Designing for Aquatic Organism Passage at Road-Stream Crossings

11. Construction

CONSTRUCTION - SECTION 11

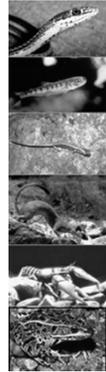
AOP PASSAGE STRUCTURES

Bob Gubernick
USDA Forest Service
Tongass N.F.

Kim Johansen (Retired)
USDA Forest Service
Willamette/Siuslaw N.F.



Stream Simulation Design Process



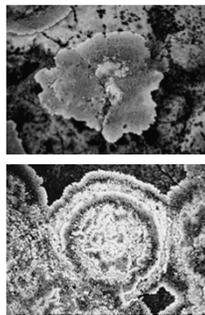
- Initial Assessment
- Site Assessment
- Stream Simulation Design
- Final Design and Contract Preparation

Phase 5

- Construction
- Maintenance and Monitoring

Acknowledgments for photos and materials

- Traci Sylte - LoLo N.F.
- Tongass National Forest
- Anne Connor - Clearwater N.F.
- Willamette/Siuslaw N.F.
- Watermark Consulting, LLC
- Wildland Hydrology, Inc.
- Brian Bair -TEAMS



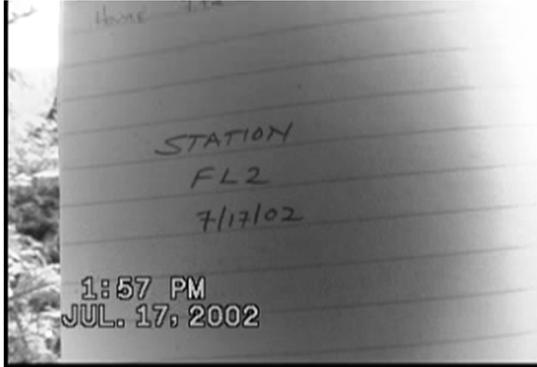
Discussion Topics

- Inspection Fish removal
- Traffic
- Soil and Erosion Control
- Dewatering
- Bed preparation
- Banding Culverts
- Material Placement in Culverts
- Bed Structure Construction
- Grade Control structures
- Internal appurtenances



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40000-3.337MP Mitkof Island Southeast Alaska



MPEG by T.Dunklin, M.Furniss

INSPECTION

- ✓ All fish pipes should have 100% inspection by qualified inspectors
- ✓ Contractors are not mind readers show them how you want it.
- ✓ Remember if it is not in the contract you can't enforce it without more \$\$\$\$\$



- ✓ Not all contractors have the same skill level. Fish pipe construction requires Contractor training.
- ✓ Enforce all specs from the start, and let the Contractor know of unacceptable work
- ✓ Know your contractual authority

Excavation & Accurate Surveys

Survey errors can lead to:

- Inadequate structural cover for culverts
- Shallow foundations
- Difficult fabrication or complete rejection of installation
- Inability to reconstruct road fill as designed



Survey/Contractor error leaves footing 18" higher than designed. Vulnerable to scour.



Survey error creates 18" hump to get minimum cover. Speed bump?

TRAFFIC CONTROL

- ✓ Sign in accordance with MUTCD
- ✓ Use flaggers and barricades as required



Photo by www.coates.com

- ✓ Notify the public, post in papers, radio, scanner, etc.
- ✓ Ensure road is closed and access is blocked off after Contractor is done for the day

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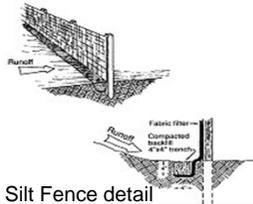
Sediment Control



Straw bales



Sedimat Coconut fabric



Silt Fence detail



Coir logs

Dewatering

Fish & Water Quality Issues during Construction

- Method of fish removal (trapping, electro-fishing)
- State fish salvage permits (required?)
- Fish Timing/Instream Work Windows
- State/Federal Water quality requirements from diverted water

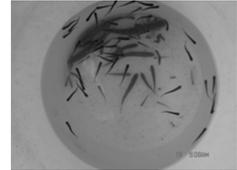


Photo by N.C. Watershed Coalition

Dewatering

Issues during Construction

- How will you do it? Pump or by-pass channel?
- What is the terrain layout (confined or unconfined)?
- How long will the installation take?
- What flows do you expect
- What kind of materials are you working in? (coarse or fine grained)
- Where will you locate outflow, inflow, filtration systems?



Do you have enough Pumping Capability or Diversion Capacity?



Inspect and make sure everything. Ensure all materials are on site before you need them!

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DEWATERING CALC'S

1 CFS = 449 GPM

Example:

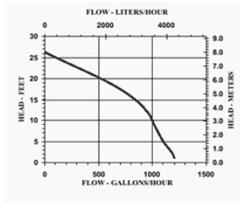
A 1600 GPM 6" trash pump can handle how many CFS???

$$\frac{1600 \text{ gpm}}{449 \frac{\text{gpm}}{\text{cfs}}} \approx 3.6 \text{ CFS}$$

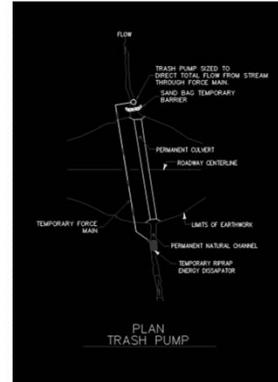
Anticipated discharge will drive how the site is dewatered.

Elevation head changes pump capacity.

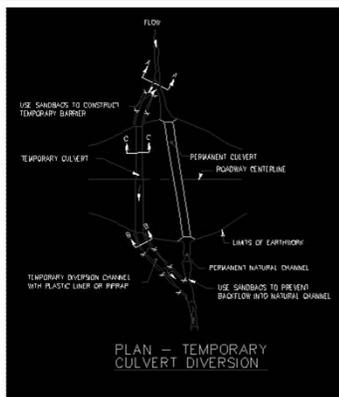
Beware of water pumps and old pumps!



TRASH PUMP DEWATERING PLAN



CULVERT DIVERSION DEWATERING PLAN



Diversion Dam and Transport Pipe

A common method, large & small projects

This pipe is longer than normal

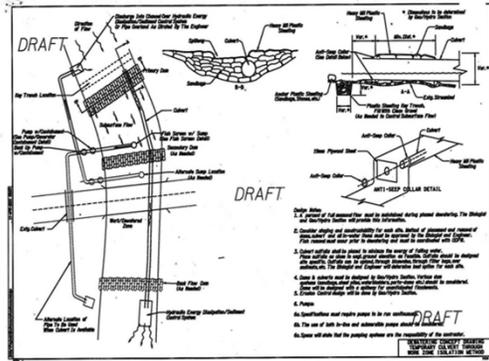


Don't forget about culvert cover on bypass roads

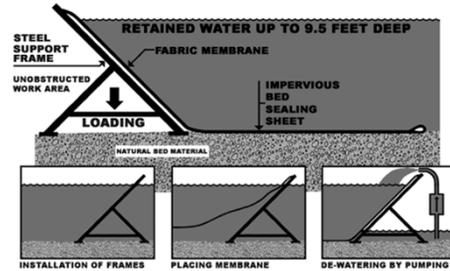
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DEWATERING - PLANS & DETAILS

Cater them to the complexity of the site!



DEWATERING - PLANS & DETAILS

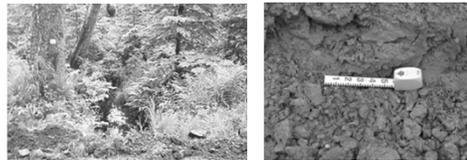


WATER BLADDERS COFFER DAM



Photo by R.Reeves Ore. DOT

DEWATERING IN FINE GRAINED SYSTEMS



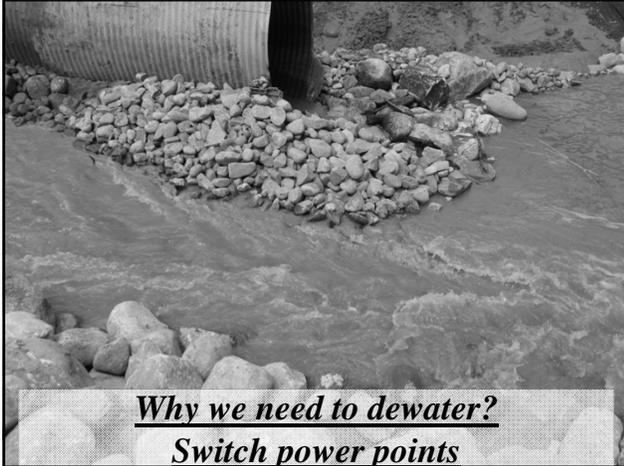
Silt and minor amount of fine sands

- Contain H₂O and prevent mixing with Excavation
- Pump contaminated H₂O away from site thru filters (Veg, fabric, & hay bales)
- Flocculants are available if in a settlement pond situation



6235-0.19MP Mitkof Island Alaska

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Why we need to dewater?
Switch power points

Sumps and Pumps

- Many sites clear up after excavation is completed
- Be sure pumps are available to handle storms flows.
- Central power for electric pumps with automatic float controls are convenient, quiet, and reliable.
- The downstream sump is the last chance to catch dirty water. Think storm event. They happen.
- Be prepared for fuel or oil spills...have a spill kit handy
- Most sumps and small trash pumps do not have sufficient capacity to divert stream flow or handle sump flow during storm events.
- Consult your hydrologist for help in estimated flows in your project.



Sediment Treatment Options

- For fine sand and larger particles,
 - Pump contaminated H₂O away from site thru filters (Veg, fabric, & hay bales).
 - Use an active or passive commercial filter cartridges.
- For silt and clay removal
 - Use flocculants to remove silt & clay fines.
 - Construct large settlement ponds to allow time to settle, use flocculent to speed settlement.
 - Disperse with irrigation sprinklers or drain pipes.
 - Construct a sand filter.

<p>Natural or aided filtration</p>	<p>Water Distribution</p>
<p>Flocculant Sock (in green)</p>	<p>Geotextile filter bag</p>

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Excavation: wide, suitable, and safe?



BED PREPARATION

- ✓ Check construction survey and design for errors
- ✓ Excavate unsuitable material, make sure the bed is wide enough
- ✓ Place base course (bedding material)
- ✓ Survey for grade
- ✓ Compact
- ✓ Sculpt the bed for arches or when bedrock is encountered
- ✓ Resurvey for final elevation
- ✓ Place and align the pipe



Inspect Materials before they are Installed!
You may need to reject them!



Excess preservative on bridge materials not in accordance with WWPA Standards



Culvert showed up with active corrosion

BANDING CULVERTS

- ✓ Water tight gasket seal
- ✓ Align the corrugations
- ✓ Space band equally
- ✓ Clean rocks out of corrugations



✓ Tighten evenly, don't over tighten

✓ Expect some gaps in pipe arches, fill with foam or extra gasket materials if fill is fine grained

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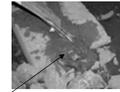
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Good tight fitting bands and gasket are critical to prevent piping failure. Occasionally you will have poor fitting pipes due to rerolling the end. Fill large voids with foam



Multiplate Pipe Assembly

- Assembly – study twice, assemble once, three plate junctions can be tricky, some shape easier than others. Use pry bar, align corners then intermediate bolts.
- Keep plates loose until all are connected. Follow the manufacturers tightening requirements
- Channel type anchors are more difficult to align. Grouted slots allow wiggle room.



(Grout doesn't have to be pretty to work well)

MATERIAL PRODUCTION

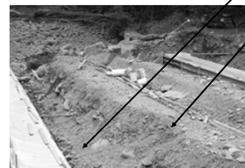


Material can be screened, crushed or equipment sorted.

- All gradations and size must be specified in the contract
- Ensure thorough mixing and prevent segregation
- Inspection required or you don't know what you will receive!



Sources for Stream Bed Materials



- ✓ Existing gravel pits or rock quarries
- ✓ Salvaged materials from: removal of aggraded channel sediments
- ✓ Uncovered streambed kept in place.
- ✓ Old bedding reused as backfill.

Make sure it has the proper gradation and is properly mixed before placing it inside the culvert

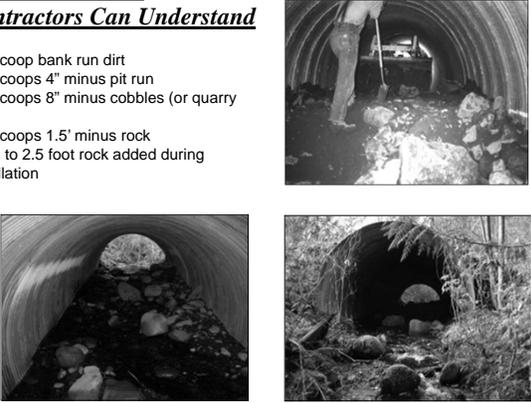
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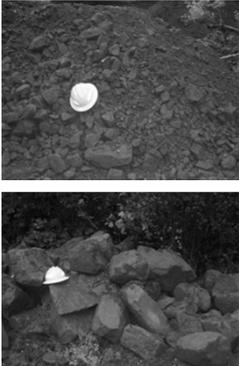
Bed Material Mix
Contractors Can Understand

- 1 scoop bank run dirt
- 4 scoops 4" minus pit run
- 4 scoops 8" minus cobbles (or quarry rock)
- 2 scoops 1.5' minus rock
- 1.5 to 2.5 foot rock added during installation

W FK Stossel Cr - 6.4% slope



Why use this pebble count tool?



- When importing stream simulation material, sieve conversion makes it easy to order portions of the design mix from a quarry.
 - Learn to do a pebble count of a stockpile with a hydrologist to verify mixing and delivered materials
 - Important to obtain a well graded mix.
 - Don't skip sizes
 - Measure other key pieces, don't guess;
 - medium diameter is not maximum diameter

Quality Control &/or assurance

- **Stream Simulation Rock Specifications can require testing, by pebble count methods (testing subcontractor)**
 - Know how to review results, make corrections, allowing a tolerance within stability objectives
- **Standard Method of Determining Riprap Gradation by Wolman Pebble Count FLH Designation: T 521-08 (modified)**
 - Simply a pebble count done on a stockpile like might be done on a dry gravel bar

MATERIAL PLACEMENT



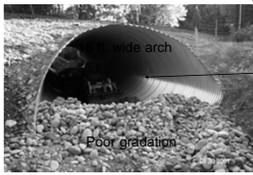
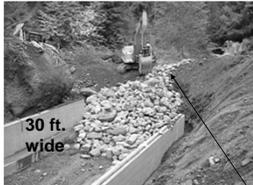
- ✓ Method depends on size of pipe and materials.
- ✓ Weirs and Banks require hand placement
- ✓ Make sure there is air flow (fans) with gas equipment

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Material Mixing, Placing, and Compacting

at Large Crossings (Bottomless & SPPA)



excavator, mixing in place
rubber tired Bobcat

Mixing in place is difficult to do well. Mix at source, haul and remix at site.

Stream Simulation Bed Placement

Layer Thickness – depends on D100 – not greater than ~1.5 to 2 feet



Place First Layer



Compact First Layer



Wash in Fines and Seal Bed



Repeat Procedure

INFILL PLACEMENT & STAGING



8578-0.219mp Chichagof Island - 1.8M CMP, bury 40%, no banks constructed, grade = 6%, Pipe/Bankfull width ~1.1



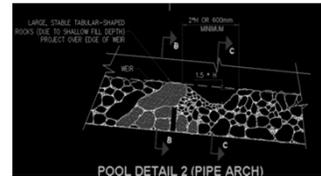
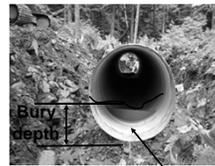
AFTER
BANKFULL
FLOW



Bed Configurations

High Gradient

Dissipate energy the same way the natural bed does!



Gravel retention sill

Step pool



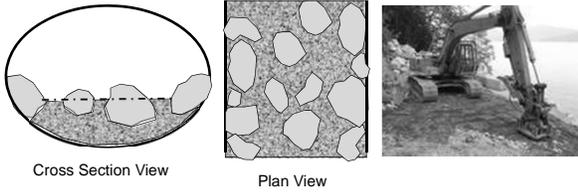
Constructed rock steps and pools inside culvert with Step retention weirs (low flow conditions)

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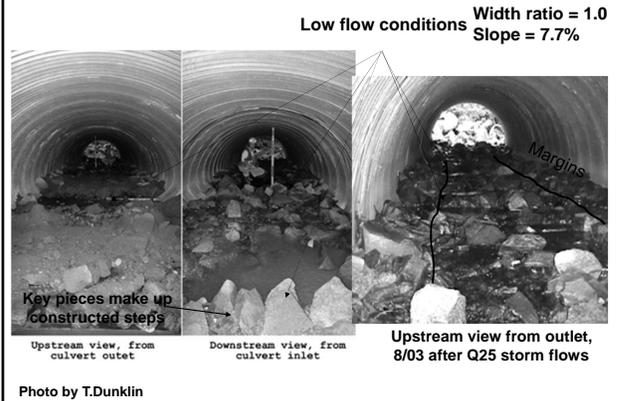
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Cascade Reach Construction

- Vary distribution of boulders. (Lower spatial and elevation tolerances for placement, but maintain about half rock diameter burial)
- Machine placement for good particle interlocking.
- Construct downstream to upstream, Compact as you go
- A vibration plate "Hoe Pack" for large sites, small plate or jumping jack for small sites
- Additional bed sealing may be required



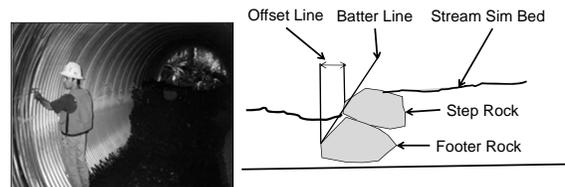
Step pool Construction



Bed materials continually modifies itself with key structures (rock step) maintaining bed form.



Step Pool Construction Hints – Profile View

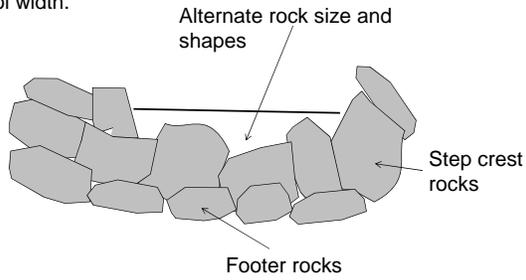


- Mark step locations and thalweg/bank elevations on culvert wall or concrete footing
- Select specific step and footer rocks... Be picky shape matters
- Step rocks need to fit together tightly and may require trying rock placement a couple of times
- Batter and offset slightly each row of rocks from the lower row.

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Step Pool Construction – Cross Section View

- Construct uneven and ensure gaps for complexity and flow convergence
- Don't make a stone masonry table top.
- Ensure the step width is narrower than pool width.



Success: 22 year old Hehe Creek bottomless arch



Structure 18' x 9' open bottom arch, BFW 17', 6% slope, d-84 ratio 1.15,
 Channel: Rosgen A2-A3, 6%, step pools

Steep Fish Passage Options

Constructed step pool morphology



Kupreanof Island
 Width ratio = ~1.2
 Slope = 15.2%
 Wire wall abutment
 15ft Glulam Slab
 bridge

Margin and Bank Construction



Prince of Wales Island, Alaska

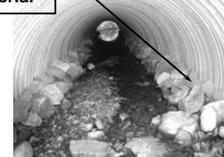
- Tie into up and downstream
- Construct dependent on use (Critter travel , roughness or both?)



>D100+ material



Upstream views inside CMP



Downstream inside CMP

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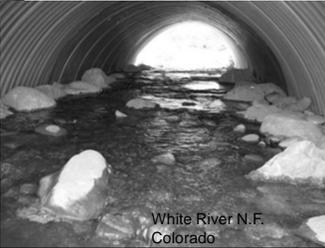
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Tongass N.F.
Alaska

Margin and Bank Construction

Uneven, sized for stability, and don't forget the key features / roughness elements in the streambed



White River N.F.
Colorado



Downstream reference reach

Wrangell Island Alaska

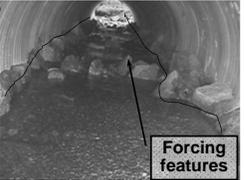
Wood & cobble Step morphology
Stream D84 = 2.6"
Key pieces = 6"
Design Key pieces = 8" to 1ft
Class 2 riprap and stream material blend used
Pipe grade = 3.6%
Stream grades = 2 to 8%
Pipe/BFW = 1.5 Note BFW = constructed channel width



Tie into stream



Cobble steps

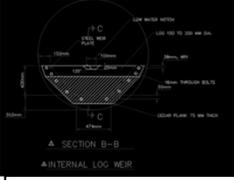


Forcing features

INTERNAL LOG WEIRS



Pipe Grade = 10.8%
Stream grade = 6-15%
Weir spacing = ~5ft
Weir drop = 0.53 ft



Existing channel is a wood forced step pool system w/ 0.7 - 1ft step heights, fine grain alluvial fan system, D84 = 1"





Backfilling and Compaction



Pipe arches and culverts can "float" when backfilling under haunches.

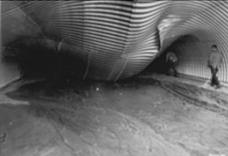
Weigh or anchored down before compaction.



Alternative low strength concrete



Controlled compaction and quality backfill is critical for large structures.



Provide adequate cover before loading, or else...

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Grade Control Outside the Structures



Log Weirs





Boulder Weir

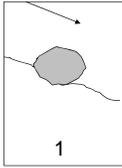
Construct non-uniform surfaces

Use footer rocks with boulder weirs and key in materials

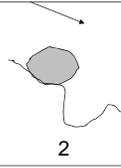
Bury full span log weirs in each bank 2m+ or 1/2BFW which ever is greater. Transport reaches only!

Seal all structures with smaller materials

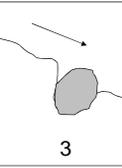
A Principle of Scour & Settlement Protection



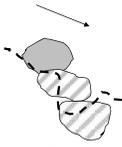
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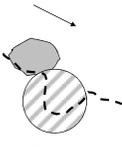
2



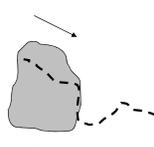
3



This



This...or...



This....will work.

Courtesy of T. Sylte

ROCK STEP POOLS

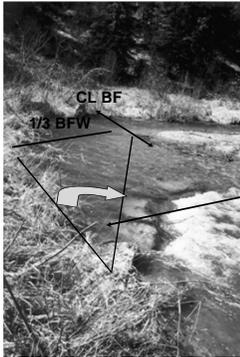


CONSTRUCT THE EDGES HIGHER THAN THE CENTER

Courtesy of T. Sylte

UPSTREAM J HOOK ROCK VANE

AFTER REVEGETATION



CL.BF

1/3 BFW

~20-30°
FROM BANK
2 TO 7% SLOPING TO
BFD

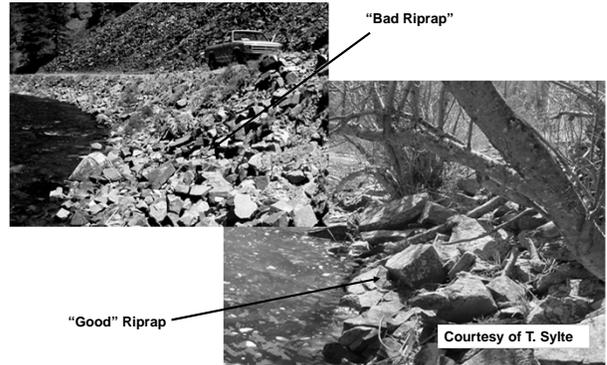
Photo by T. Sylte

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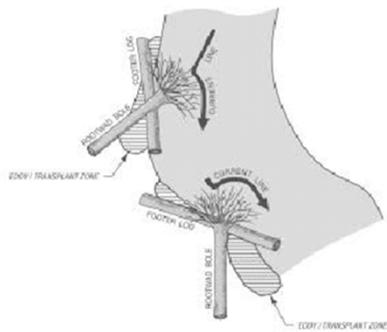
ROCK CROSS VANE



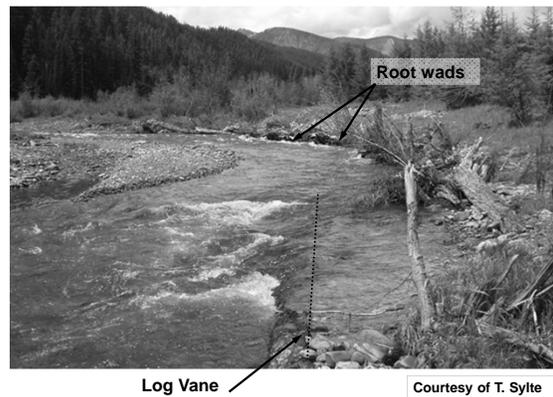
Some Bank Stabilization Techniques & Principles



ROOT WAD BANK PROTECTION



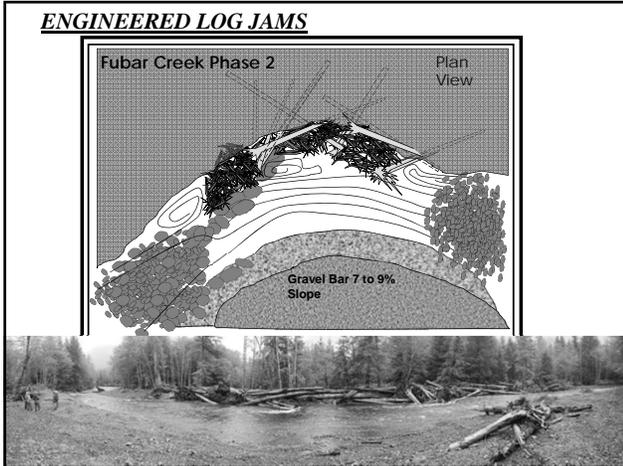
LOG VANE J-HOOK



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ENGINEERED LOG JAMS



Rewatering

- Keep it slow and easy (Don't break the coffer dam!)
- Stage, depending on water quality requirements.



- Wash sediments into stream simulation material before releasing stream flow. This can be done before the downstream sump is filled back in.
- The turbid water must be recycled or captured and treated during this process.

Cleaning Up

- Final surface should be rough to collect seeds and moisture
- Watering vegetation for survival
- Final erosion control measures
- Clean roads and stockpile areas as required in contract.
- Site review – share what was learned with everyone.



Summary

- Be familiar with the project site, objectives, drawings and contract before construction begins.
- 100% inspection or darn close will save your bacon.
- Coordinate and develop good working relationships with contractor and design team if you or they have not done so already
- Run any design changes by the design team first.
- Don't forget to cleanup and don't final until construction is approved by design team.
- Share what you learned with others.
- Have a good time.

Middle Skip Creek
Stream Simulation
~20 years old
Note: Multiple pipes are not recommended for stream simulation

