CHAPTER 4
MAINTAINING THE CULVERTS

Existing culverts need to be well maintained or they will be subject to eventual failure. It is important to distinguish between stream culverts and ditch relief culverts. In the case of all stream culverts, disturbance to the stream banks and streambed should be minimized during stream crossing construction and maintenance. Culverts within anadromous fish-bearing streams now have special fish passage requirements for both adult and juvenile fish based on guidelines by NMFS and DFG. Ditch relief culverts – to remove water from an inside ditch to an outside area - have less stringent standards because they do not involve work within the active stream channel. However, ditch relief culverts can still fail or cause problems if they are installed improperly or not maintained. Each county has, or will soon have, a Culvert Fish Migration Barrier Inventory to help it develop priorities for a Capital Improvement Program. Supplemental funding will likely be needed to upgrade many of the culverts for fish passage.

The primary goals for this chapter are:

- Maintain public safety and open roads
- Restore access for fish movement at stream crossings
- Prevent or minimize the interruption of normal runoff into streams

4-A Culvert Cleaning

4-B Culvert Improvement and Repair

4-C Culvert Sizing

4-D Culvert Replacement

4-E Ditch Relief Culverts

4-F Temporary Stream Diversions

4-A CULVERT CLEANING

Description: This action includes clearing of sediment and debris from all culvert inlets and outlets to restore function, and repairing of damaged passing devices (culverts, siphons, and box culverts, catch basins, drop inlets). Culvert cleaning is done by equipment including backhoe, vactor/jet router (a machine with a high-pressure hose and/or powerful vacuum), and shovels. Culvert cleaning can be performed in all weather. Culvert/inlet cleaning also includes removal of beaver dam material that clogs culverts to prevent flooding and culvert failure. See Appendix B-3.2 for types of culvert plugging hazards.

Sediment traps can be used to significantly reduce the amount of upslope and road-generated sediment capable of reaching streams if a constant maintenance schedule is employed to keep the associated sediment basins from reaching maximum capacity. If the sediment basin reaches maximum capacity (i.e., the sediment fills the basin to the elevation of the water inlet), then the sediment trap will no longer serve its purpose. The culvert can then become plugged and suffer reduced capacity and longevity. Furthermore, maintenance costs to clear a plugged culvert inlet are considerably higher than clearing a sediment basin. However, sediment traps can only be used in drainage sites where they will not block fish.

Environmental Concerns:

- Discharge of sediment and debris into a stream or storm water drainage system.
- Altered flows, flooding, or washout of road due to plugged culvert
- Blocking of fish passage by debris at the inlet
- Stranding of juvenile or adult fish during operation.

Best Management Practices: See Appendix B-3

1. Remove material from culverts and sediment traps and endhaul to safe, stable disposal sites away from the stream channel and its floodplain where there is no chance of the material returning to a stream network. (See: 5-A Spoil Disposal)

2. During any in-water work, minimize sediment impacts and ensure that no fish stranding occurs. [See: 4-F Temporary Stream Diversions and Appendix B-8 and B-9]

3. Perform culvert cleaning on a regular basis, usually during the dry season before the wet season begins around October 15th as well as during and after any large storm event. Focus on those sites with the highest risk of plugging during the winter season.

4. Target culverts with chronic plugging problems for replacement, based on the County Road Erosion Inventory and field experience in setting priorities. Ensure the correct size and adequate grade of the culvert to minimize culvert plugging. (See: 4-D Culvert Replacement)

5. Examine and address sources of erosion within the culvert's drainage area (including contributing ditches) if within the county's jurisdiction to operate. Outside of this jurisdiction, encourage upslope landowners to address sediment sources on their property. (See: 3-A Grading Practices)

4-A CULVERT CLEANING

6. Excavate excess material in the channel above and below a stream culvert only to the original baselevel of the streambed, not below it. If too much is removed, a new channel is created causing headcuts to migrate upstream within the floodplain and altering the ability of the floodplain to store fine sediment. This practice is particularly critical where roads cross forested floodplains and floodplain fans where sediment is stored at the mouth of small ephemeral tributary canyons.

7. Use sediment traps only where excessive sediment and debris is a chronic problem and not as a remedy for a poorly designed culvert. Do not use in drainage sites where fish passage is needed. [See Appendix B-3.8]

8. Make sure that the amount of sediment removed is similar to the amount accumulated over the maintenance period to assure proper function of the sediment trap. This removal practice will assure that such contributed sediment will not enter the stream system.

9. Design inlets on sediment traps to be similar in area to the culvert inlet.

Permits Possibly Needed:

- DFG 1601 agreement
- Coastal Zone: Exempt from coastal development permit unless subject to review under Section 1601 of the Fish and Game Code, or excavation or disposal of fill is outside of the roadway prism.

A culvert that needs cleaning. See also: Hazardous Materials

Photo source: Caltrans, Tehama County, CA (2002)

4-B CULVERT IMPROVEMENT & REPAIR

Description: Culvert improvement and repair addresses erosion and fish passage issues through the rehabilitation or retrofit of existing culverts. It includes the installation of baffles to slow the water velocity or weirs to increase the water depths within the culvert or downstream of the culvert in an anadromous fish-bearing stream. However, such modifications will decrease the culvert's ability to convey water that could increase the risk of flood damage above or below the site. Fish passage adjustments to the existing culvert should be seen as temporary, beneficial solutions until appropriate, longer term solutions (culvert replacement, bridge, or other remedy) can be put into place. Guidelines and criteria for culvert retrofit are provided by DFG and NMFS. See County Culvert Migration Barrier Inventory for location and description of problem sites and priorities.

Environmental Concerns:

- Discharge of sediment into the stream or storm water drainage system.
- Prevention of fish passage through the stream crossing due to excessive velocities, inadequate depths, or excessive outlet perch/ jump heights.
- Removal of riparian vegetation.

Best Management Practices: See Appendix B-3: Culvert BMP Design & Procedures

1. Install erosion/sediment control during culvert trash rack replacement, where erosion control devices can feasibly be installed. Do not install trash racks near culvert inlets in fish-bearing streams or debris will accumulate and restrict fish passage.

2. Add large, competent rock to the catchment areas below pre-existing shotgun culvert outlets since the falling water often produces a substantial amount of erosion. Avoid placing new shotgun installations without energy dissipation structures in the future. Seek supplemental funding, if needed, to correct problem sites.

3. In anadromous fish-bearing streams, use baffles as a last resort to correct the problem of excessive water velocities within culverts when other improvements are not feasible. Alternatives to baffles may be called for. Install baffles within culverts only after consulting with DFG and a qualified engineer to ensure that the change will be beneficial and not increase flood risk or contribute to channel instability. Since baffles decrease the culvert capacity and increase the potential for debris clogging, they can decrease the life of the culvert. To compensate for the loss of hydraulic capacity, inspections and maintenance may have to occur more often.

4. Use fish passage improvements on existing culverts as temporary solutions until a proper culvert installation, bridge, or other remedy can be done. Install fish passage improvements in existing culverts on anadromous fish-bearing steams where there is at least 20 years of culvert life remaining, and where county or supplemental funding is available. [See also: Appendix B-6 Fish Ladders].

5. Replacing the existing culvert with a bridge, a natural bottom system, or a properly designed and installed culvert is desirable when a high jump and/or the velocity of the water in a culvert may result in a probable fish migration barrier (usually less than 1 foot).

6. The problem of jump barriers in anadromous fish-bearing streams can often be corrected by installing back-flooding weirs. Weirs can be constructed using either logs or boulders. The weir directly below the culvert should be of sufficient height to back-flood the culvert to a depth of 12 inches. Each subsequent weir, downstream of the culvert, should be no more than 12 inches below the previous weir. Obtain approval from all property owners or engineer the weirs to avoid flooding of adjacent property. [See Appendix B-3.3]

7. For pipes that are to be replaced, design for anadromous fish passage as per the most recent NMFS and DFG guidelines. [See: 4-C and 4-D]

8. Minimize disturbance of riparian vegetation during culvert improvement and repair operations and replace lost plants if needed to provide critical shade cover.

Permits Possibly Needed:

- NOTE: On natural channels with anadromous fish habitat, fish passage capability for adults and juveniles through the culvert is required as condition of state and federal permits. DFG's Fish Passage Criteria and Guidelines address the passage needs of all aquatic animals, not just anadromous fish. NMFS's Guidelines for Salmonid Passage on Stream Crossings address the needs of migrating salmonid fish.
- DFG 1601 Agreement
- CWA 404 permit from COE as either: (a) Nationwide General Permit No. 14 – "Linear Sediment Reduction Projects at Water Crossings", or 9b) Regional General Permit (RGP 1) – "Fish Passage / Sediment Reduction Projects at Water Crossings"
- CWA 401 permit from RWQCB

Class II stream crossing with a nicely installed inlet, not a fish-bearing stream
Orr Springs Road, Mendocino County

4-C CULVERT SIZING

Description: Correct culvert sizing is important for preventing road washouts and erosion, and for providing fish passage in fish-bearing streams. It involves determining the proper diameter and length of the culvert needed for a given stream crossing to pass flood flows (with debris) and fish. Determining the proper diameter requires estimating the magnitude of runoff that would occur at each stream crossing during the most probable 100-year flood and then calculating the size of the culvert crossing which would handle that flow. A culvert is a portion of the stream crossing, and sizing must include the capacity of the stream crossing – in most cases at least spanning the active channel width. Estimating the culvert length is based on road width, slope steepness, and fill depth. In anadromous fish streams, culverts now have to be designed to provide passage for both adult and juvenile fish according to the NMFS & DFG fish passage criteria and guidelines. See also the County Culvert Migration Barrier Inventory for a description of problem sites and priorities.

Environmental Concerns:

- If the culvert diameter is too small, it may create a velocity barrier for fish, increase outlet downcutting, and wash out the road, causing discharge of sediment to the stream.

- If the culvert length is too small, then the culvert inlet and outlet will not extend sufficiently beyond the base of the fill and may result in sediment delivery to the stream.

Best Management Practices:

1. Size crossings to handle most probable 100-year flood flows and associated debris and bedloads, given the watershed and specific conditions present in each county. Site-specific constraints may warrant a different standard.

2. See the County Engineer for determining the correct culvert diameter and length for a given stream crossing to meet hydraulic capacity requirements for flood risk and channel stability.

3. Refer to the latest NMFS and DFG fish passage guidelines and criteria to size replacement culverts for fish passage in anadromous fish-bearing streams. Consult with NMFS and DFG early in the design process. [See Appendix C]

Tools:

- "FishXing" software is intended to assist engineers, hydrologists, and fish biologists in the design and evaluation of culverts for fish passage. (www.stream.fs.fed.us/fishxing)
  - Allows for comparison of multiple culverts designs within a single project.
  - Calculates hydraulic conditions within circular, box, pipe-arch, open-bottom arch, and embedded culverts.
  - Contains default swimming abilities for numerous North American fish species.
  - Contains three different options for defining tailwater elevations.
  - Calculates water surface profiles through the culvert using gradually varied flow equations, including hydraulic jumps.

- Outputs tables and graphs summarizing the water velocities, water depths, outlet conditions, and lists the limiting fish passage conditions for each culvert.

Permits Possibly Needed:

- Sizing is determined as part of the practices described in Section 4-D Culvert Replacement
- Note: DFG's Fish Passage Criteria and Guidelines (also in DFG's 2002 updated California Salmonid Stream Habitat Manual) address the passage needs of all aquatic animals, not just anadromous fish. NMFS's Guidelines for Salmonid Passage on Stream Crossings address the needs of migrating salmonid fish (http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF).

Measuring an existing culvert for size and slope

4-D CULVERT REPLACEMENT

Description: This action addresses culvert replacement only, while the rehabilitation or retrofit of existing culverts is addressed in section 4-B. Key practices involve determining the correct type and size of culvert to use at a given stream crossing, planning for failures, culvert alignment, and streambed impact minimization. Incorrect installation of culverts can prevent fish passage through a stream crossing. Culverts must now be designed and placed to provide passage in anadromous fish streams for both adult and juvenile stages. See County Culvert Migration Barrier Inventory for fish passage problem sites and priorities and the County Road Erosion Inventory for potential sediment problems related to culverts and for priority culverts to replace.

Additionally, County road managers and engineers must consider other important factors when making decisions about culvert replacements. They must consider possible effects of the change on: downstream flooding and potential property damage, upstream channel change, property access, future floodplain development, and legal liabilities. The County is usually not responsible for upslope sources of culvert problems (such as debris or increased flood flows) but must deal with the effects.

* See also Five County website for examples of projects in other counties://www.5counties.org
* Refer to Appendix B-3.1 for terms related to culvert hydraulics.

Environmental Concerns:

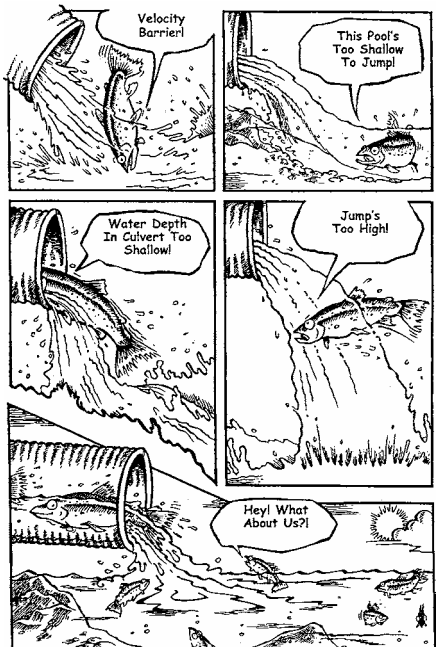
- Discharge of sediment into the stream or storm water drainage system.
- Prevention of fish passage through the stream crossing.
- Removal of riparian vegetation.

Best Management Practices: **See Appendix B-3 for BMP designs**

1. Consider a single span bridge as the first option for culvert replacement in anadromous fish bearing streams. Bottomless arch culverts or partially buried "embedded" culverts are preferred over non-embedded culverts for fish passage purposes. Baffled culverts or fishways (> 0.5% slope) are the least preferred of the passage improvements.

2. Avoid the conditions in the diagram which are detrimental to fish passage at stream crossings: (A) high water velocities, (B) shallow water depths within the culvert, (C) a lack of adequate resting pools above and below culvert outlet, (D) culvert outlets too high above water surface, and (E) inadequate juvenile fish passage.

3. Coordinate closely with NMFS and DFG about replacement of culverts identified as requiring fish passage. Early consultation can avoid timing problems with permitting.



Source: Oregon Watershed Assessment Manual

4-D CULVERT REPLACEMENT

4. Ensure that all replacement culverts on anadromous fish-bearing streams meet the most recent version of the NMFS & DFG fish passage criteria and guidelines. Variances can be allowed where meeting the guidelines can be shown to be unreasonable or impractical, based on biological and/or hydrologic rationale.

5. Have the County Engineer evaluate the site to be sure that the proposed replacement structure will not increase the flood risk or cause sediment routing problems.

6. Only install replacement culverts in a dewatered site, with a sediment and flow routing plan. [See: 4-F Temporary Stream Diversions]

7. Store excavated spoils and equipment in a location that will prevent sediment delivery to watercourses. [See: Chapter 5 - Spoil Disposal]

8. Maintain equipment to prevent leaks that may reach streams and clean before use near watercourses. Keep all fuel storage and staging materials out of the riparian area.

9. Place spill contingency resources to contain a small to moderate spill (1-10 gallons) at each job site where equipment is used. Install oil absorbent materials downstream of in-water work sites to trap accidental spills or leaks into streams from equipment. Keep a Notification Checklist for hazardous spills on site and use if spill into stream occurs. [See: 8-C Accident Clean-up.]

10. Fully restore disturbed sites within the riparian area with a mix of native, riparian plant species where disturbance of the shade canopy was significant due to the replacement project. If bare dirt sites result, apply erosion control measures. [See: Appendix B-4]

11. To design for the possibility of conduit failure due to blockage or other problem, include additional surface routes which will redirect flood waters into the natural drainage course at non-erosive velocities as soon as possible.

12. Align culverts and other structures with the stream, with no abrupt changes in flow direction upstream or downstream of the crossing. This can often be accommodated by changes in road alignment or slight elongation of the culvert.

13. Place bottomless arches and embedded culverts at or near the same gradient as the natural streambed and wider than the active stream channel. The active channel is considered to be the wetted channel up to the ordinary high water marks. Minimize the possibility that the new culvert will not cause any existing downstream channel enlargement to migrate upstream.

14. At stream crossings, place embedded culverts at least one foot deeper than the streambed grade, or embedded at least 20% of its height; whichever is greater. If the culvert is placed too low, the inlet can easily plug and overflow. If the culvert is placed too high in the fill, flow could potentially undercut the inlet, and erode the streambed and fill at the outlet.

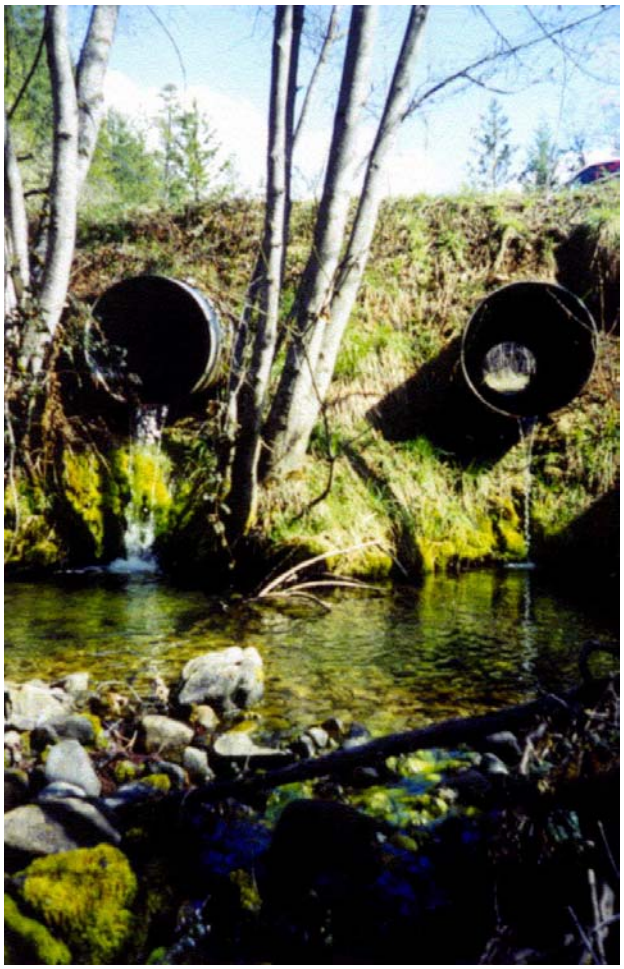
15. Protect both the inlet and the outlet with armor to protect from scour, if feasible. [See: Appendix B-3]

16. Avoid installing shotgun culverts.

Permits Possibly Needed:

- NOTE: On natural channels with anadromous fish habitat, fish passage capability for adults and juveniles through the culvert is required as condition of state and federal permits.
- DFG 1601 Agreement
- CWA 404 permit from COE as either: (a) Nationwide General Permit No. 14 – "Linear Sediment Reduction Projects at Water Crossings", or 9b) Regional General Permit (RGP 1) – "Fish Passage / Sediment Reduction Projects at Water Crossings"
  - As part of CWA 404, NMFS consultation is triggered under Section 7 of ESA for federally-funded and permitted activities. Take permission is required if take of listed salmonid species will occur and culvert replacement is outside of agreed upon take limits.
- CWA 401 permit from RWQCB
- CESA 2081 incidental take permit from DFG if state-listed endangered or threatened species is in the stream and if a ESA Section 4, 7, or 10 incidental take permit has not already been obtained.

4-D CULVERT REPLACEMENT



Culverts needing replacement to provide fish passage

A successful culvert replacement (Morrison Gulch, Humboldt County)

4-E DITCH RELIEF CULVERTS

Description: Ditch relief culverts are needed to divert ditch water from the inside of a road to a location on the outside of the road where concentrated flow can be safely dispersed downslope beyond the outer edge of the road fill. This section describes those additional factors that should be considered in the location, stabilization, and maintenance of ditch relief culverts as opposed to stream culverts. Right-of-way or ownership issues can be a problem in locating sites for downstream drainage off of county roads. It is important to avoid concentrating flow into ditches in the design of roads whenever possible, which would minimize the need for ditch-relief culverts. However, rolling dips and outsloping may not be a feasible drainage option for certain county roads due to the public safety issue. Fish passage is not an issue in these off-stream culverts.

Environmental Concerns:

- Discharge of sediment into a ditch, which may discharge into a stream or storm water drainage system that contains fish or contributes resources that support fish.
- Discharge of sediment into a stream from erosion within the ditch or below culvert.
- Road surface erosion or roadway failure from a plugged ditch relief culvert or outlet flows.
- Surface erosion or failures resulting from concentrated ditch water.

Best Management Practices: See: Appendix B-3

1. During reconstruction of unsurfaced roads, consider out-sloping the road instead of installing inboard ditches, which require ditch-relief culverts. Safety factors such as traffic use, maximum safe speed, slipperiness of surface material, and winter conditions need to be considered in the determination as this design is not always practical on public roads.
   [See: 3-A-1 Shoulder Blading and Rebuilding]

2. Divert ditch water through ditch relief culverts, where feasible and practical [See Appendix B-3.6 for a standard design.]. The location of a ditch relief culvert depends on water volume and velocity, soil types, hillslope aspect, elevation, vegetation, rainfall intensity, the incidence of rain-on-snow events, and the downslope conditions. With so many factors influencing the location of ditch relief culverts, it is not recommended that tables alone be used. Instead, use site-specific guidelines for all ditch relief culvert locations:

   a. Do not locate ditch relief culverts on unstable slope areas.

   b. Generally, mid- and upper-slope roads require shorter ditch lengths between ditch relief culverts than do valley bottom roads, primarily due to the steeper ditch gradients and fewer well defined stream channels on the slopes.

   c. Typical locations for ending the ditch at a ditch relief culvert are:
   - at the top of a steep gradient. The intent is to disperse ditch water before volume and velocity increase downgrade, resulting in accelerated ditch, subgrade and cutbank erosion.
   - at seepage zones.

- at zones that have localized flow with no defined channels. It is critical to ensure that ditch water is diverted at the downgrade side of these zones. Otherwise, water flow will carry on to the next segment of ditch, thereby increasing the flow and potential for erosion.
- at low points in the road profile.
- where right-of-way or ownership issues are not a problem for downstream drainage.

d. See Table 3-A-1.1 for suggested road surface drainage spacing based on road gradient and soil type. Combine these spacing suggestions with the above criteria to best place ditch relief culverts.

6. Direct ditch culvert outlets past the end of the road fill and onto erosion-resistant areas, or onto outlet protection such as rock rip rap. Never direct outflow water onto unprotected loose erodible fill.

7. Retain water in the drainage of origin whenever possible. When choosing the location for ditch relief culverts, minimize the transfer of water by ditches to other drainages, where feasible, practical and consistent with downstream ownership or use.

8. Seat ditch relief culverts on the natural slope like stream-crossing culverts, if possible. Make sure that bedding and fill material are free of rocks and debris that could puncture the pipe.

   a. Compact backfill materials from the bed in accordance with County standards. Extend the outlet beyond the base of the road fill (or a flume downspout if used) and empty onto an apron of rock, gravel, brush or logs.
   b. Install at a 30-degree angle to the ditch to lessen the chance for inlet erosion and plugging. Use a slope of 2-4 percent more than the ditch grade, or at least 5 inches every 10 feet to ensure sufficient water velocities to carry sediment through the pipe.
      [See: Appendix B-3.6 for a standard design]

9. Install ditch blocks to direct water into the culvert inlet. Construct ditch blocks of erosion-resistant material, with the crest being approximately 1 foot lower than the adjacent road grade. This last step is critical because if the culvert becomes plugged and the water rises above the ditch block, then the flow will continue down the next section of ditchline rather than being directed onto the roadway surface over the ditch block.

10. Inlet protection for ditch relief culverts may often include drop inlets or sediment traps to trap sediment and debris. For ditch relief culverts on steep road grades, lining the ditch block and the bottom of the culvert channel with rock may be necessary to minimize scouring.

11. Avoid installing shotgun ditch relief culverts! (See #8 above.)

Permits Possibly Needed:

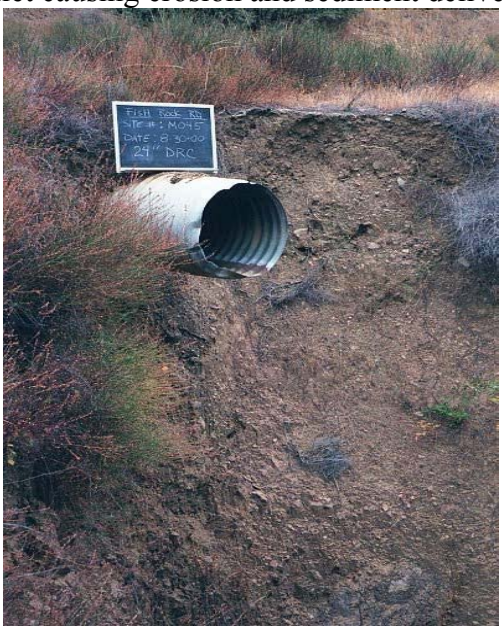
- None usually required to install new ditch relief culverts in uplands (not "Waters of the US").

4-E DITCH RELIEF CULVERTS

- If placing outlet protection at discharge in a stream below "Ordinary High Water Mark" (see Chapter 2 under CWA Section 404) :
  a) COE 404 – Nationwide Permit 7 (Outfall Structures & Maintenance) will apply
  b) RWQCB 401 permit
  c) DFG 1601 agreement
- Maintaining the ditch relief culvert may require permits if the ditch conveys natural waters (e.g., the ditch picks up an ephemeral stream). [See: 3-A-3 Ditch Shaping & Cleaning]

The Bad & the Good

Shotgun outlet causing erosion and sediment delivery to stream



Downspout to a Class I stream

4-F TEMPORARY STREAM DIVERSIONS

Description: Temporary diversions are often required during in-stream projects designed to maintain fish passage and water quality. Culvert replacements commonly need temporary or short duration stream channel diversions. A stream reach may be temporarily dewatered after the fish are removed and relocated upstream of the work area, and then excluded from the site until the project is completed. Fish exclusion of listed species is done only under the supervision of an agency, or other qualified, fishery biologist with an "incidental taking permit" from NMFS and DFG.
* See Appendix B-5 for specific Fish Exclusion practices.

Environmental Concerns:

- Discharge of sediment and debris into a stream or storm water drainage system.
- Stranding and loss of juvenile or adult fish, and affecting instream habitat.
- Loss of riparian vegetation due to temporary lack of water.

Best Management Practices: See Appendix B-5 for Fish Exclusion BMPs

1. Make sure the temporary diversion channel is capable of carrying the anticipated streamflows during the construction period.

2. Where anadromous fish are present, work closely with a qualified agency or consulting fishery biologist who has the needed permits. For listed species, the incidental and direct take permits will require reasonable and prudent measures (RPMs) to be used. Follow these permit requirements under the supervision of the fishery biologist.

3. Have the supervising biologist remove all fish out of the affected area before dewatering any stream section. If fish are still found stranded in the dewatered channel, immediately transport them to the active channel following the directions of the biologist (usually by netting, electrofishing and/or pumping the fish with an approved fish-friendly method).

4. Complete the diversion before or after typical upstream fish migration periods (see Table 1-2 and ask local DFG fishery biologist for local timing). If this is not possible, install a diversion pipe capable of passing fish or other method approved by DFG. [See: Appendix B-3.4 for baffle designs]

5. Maintain fish passage in the new channel at all times and make sure that the water pumping hose/culvert has an adequate screen to avoid fish entrainment, unless otherwise approved by NMFS and DFG. [See: 3-B-3 Water Drafting for temporary screening practices.]

6. Isolate the diversion channel from the natural channel during excavation.

7. For each job site where equipment is used:

a) Install oil absorbent materials downstream of in-water work sites to trap accidental spills or leaks into streams from equipment. Store excavated spoils and equipment to prevent sediment delivery to watercourses. [See: Chapter 5 – Spoil Disposal]

b) Ensure spill contingency resources to contain a small to moderate spill (1-10 gallons) are in place.

8. Line diversion channel with filter fabric, visqueen or a similar material and anchor with rock or sandbags to hold it in place. The purpose is to prevent the bed and banks of the diversion channel from eroding at expected flows.

9. When diverting the flow into the temporary channel, first remove the downstream plug of the temporary channel, followed by the upstream plug. Next, close the upstream end of the natural channel and then close the downstream end.

10. If a tributary enters the former channel within the diversion area, connect the tributary to the new dewatering channel. If any channel change is done to intercept a tributary, move the channel back to its original shape and location at the completion of the temporary diversion.

11. To restore flow to the natural channel, first remove the downstream and then the upstream plug of the natural channel. Next, close the upstream end and the then the downstream end of the diversion channel.

12. After removing any man-made material, backfill the diversion channel and stabilize the stream banks. Revegetate disturbed riparian areas with naturally occurring plants and grasses.

13. An alternative to a temporary stream diversion channel is to impound the flow and transport the flow around the site via pumps and piping (see pictures below). This practice requires screening of the stream at the pumps and removal of any fish from the dewatered site after installing fish blocking screens above and below the site.

Permits Possibly Needed:

These permits may already have been obtained for the project which the temporary stream diversion is part of , such as culvert replacement:

- DFG 1601 Streambed Alteration Agreement
- CWA 404 permit from COE: (a) Regional General Permit 1, or (b) nationwide General Permit No. 12 – "Utility Line Activities"
- CWA 401 permit from RWQCB
- ESA Section 4 or 7 consultation incidental take or Section 10 incidental take permit, and Section 10 direct take permit for the supervising biologist
- CESA 2081 incidental take permit from DFG if state-listed endangered or threatened species is in the stream and if a ESA Section 10 incidental take permit has not already been obtained.

4-F TEMPORARY STREAM DIVERSIONS

Two methods of temporary stream diversion