# Best Management Practices
# Culvert Replacement

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# Best Management Practices
# Culvert Replacement

**Definition**
Removal and replacement of road culverts serving as either road-cross-drains or road-stream crossings. This BMP includes removal and replacement of culverts with armored drain swales or armored stream fords (refer to BMP Armored Drainage Structures).

**Synonymous Terms**
Corrugated metal pipe (CMP) replacement, road cross drain (RCD) replacement.

**Purpose**
To improve performance of road drainage structures along park administrative roads. Replacement of culverts will increase discharge capacity, provide continuity for bedload and suspended load transport, eliminate erosion of crossing or road embankment fill, prevent diversion of stream flow onto adjacent road surfaces, and reduce the risk of plugging from large woody debris or sediment slugs. Erosion of stream crossing fill causes direct sedimentation to the drainage network. Steam diversion at road crossings can cause severe gullying on roads and slopes or cause mass movements if flow is directed onto interfluve areas. Stream diversions create a direct linkage between streams and roads, which increases sediment delivery to the drainage network. Failed stream crossings can divert runoff to adjacent sub-watersheds causing increased flow, bank erosion, channel migration, and inner gorge mass wasting. Replacement of improperly placed culverts provides increased passage of aquatic species including threatened and endangered fish and amphibians.

**Planning Considerations**
- Anticipated work-period road use
- Emergency vehicle access during work period
- Accessibility of heavy equipment to all crossing material
- Offsite disturbance caused by temporary spoils storage
- Design and construction of inlet and outlet structures
- Availability of suitable locations or transport for excess fill or buried woody debris
- Removal of large woody debris and boulders from crossing.
- Necessity of fish passage design
- Disposal of old culverts
- Stockpiling of woody debris for post-treatment mulching

**Construction Specifications**

Culvert Stream Crossing Replacement

- An on-site evaluation shall be made by qualified staff experienced in road engineering to determine if a culvert crossing is required at the site. In some cases, other alternatives such as hardened seasonal fords, rock armored crossings, or drain swales may be appropriate. These alternatives are preferable to a culvert due to their low maintenance and they can be constructed without introducing fill into the stream channel.

- The culvert shall be sized to convey a discharge equal or less than the 50-year flow. Determination of the design flow shall be determined using the rational method, or U.S.G.S. regional relationships, or adjacent channel morphology.

- The excavator shall prepare the site by first removing trees and brush growing on the crossing fill along the centerline of the culvert. Trees and brush removed shall be stockpiled and used to mulch disturbed ground following culvert replacement. Trees growing away from the centerline of the culvert may be left, however clearance may have to be provided for excavator maneuvering.

- If the stream is running, water is diverted away from excavation areas to reduce turbidity and eliminate saturation of the crossing fill as it is excavated. A small diversion dam is built upstream and stream flow is piped around the worksite and discharged into the stream below the worksite.

- The excavator begins by excavating a trench down to the existing culvert, exposing it, so that the excavator can remove the old pipe using the bucket and thumb. Old culverts can be cut and crushed to fit in available transport vehicles.

- Following the removal of the old pipe, the trench is excavated to the prescribed width and depth for the new culvert placement. The trench should be straight in both profile and plan view. The gradient of the culvert should match the gradient of the stream running through the crossing and should be set to a depth slightly below (25% of diameter) that of the stable channel bed. This will ensure continuity of bedload transport and provide a natural substrate for animal migration.

- Trenching shall be in compliance with all applicable worker health and safety regulations including but not limited to Sections: 29, CFR 1926.650, 601(b)(6) of the Code of Federal Regulations and Title 8, Sections: 1540, 1541, 1541.1 of the California Code of Regulations (CCR). Trenches shall be properly sloped or benched or shored if personnel are to enter any trench greater than five feet in depth.

- The new culvert is then placed into the trench and the necessary couplings are made. Couplings are critical for culvert performance. All couplings should be assembled according to manufacturers instructions. It is essential to lay the pipe on a well-compacted base that is straight in profile. Any settling or deflection in the pipe can result in separation at a coupling or a rupture in the pipe wall. The culvert shall extend from the inboard edge of the road to beyond the base of the embankment fill. Downdrain assemblies are not recommended for stream crossing sites because they limit migration of aquatic species, aggrade at the inlet, and are prone to scour at the outlet of the pipe.

- As fill is placed back into the trench, compaction is accomplished with a mechanical compactor. The compactor can be mounted to an excavator or can be walk-behind or free standing. Fill shall be compacted in maximum 6" lifts until the trench is refilled.

- In situations where the new culvert cannot be set at the stable stream gradient, an anchored downdrain assembly and an energy dissipater shall be installed to prevent scour at the outlet. The energy dissipater shall be constructed of appropriately sized rock armor and shall have a concave cross section to prevent culvert discharge from scouring adjacent streambanks.

- A headwall or flared inlet shall be installed at the inlet of the culvert to protect crossing fill from saturation and scour and direct flow into the culvert. The headwall can be constructed with sack concrete reinforced with driven rebar or can be poured in place with mixed concrete.

- A trash rack may be installed where large organic debris could be mobilized in the channel causing a plug at the culvert inlet. Many different designs exist for various applications so trash rack designs will be site-specific. Any design chosen should protect the inlet from plugging and maintain flow at or near the centerline of the channel. Designs that could divert flow into the streambanks upstream of the inlet should be avoided.

- The road surface shall be shaped so that a broad dip is formed over the centerline of the crossing. The dip should pitch to the inboard inlet and headwall. This prevents road drainage onto the outboard edge of the crossing fill.

- Where feasible the road shall be regraded and realigned so that the road contours into the stream valley along an alignment that is as upstream as practical. The road can also be narrowed according to the road construction specifications. Reducing the road width and contouring farther up into the stream valley significantly reduces the size and fill volume in the crossing. In the event of a crossing failure, less fill is available for erosion and delivery directly into the drainage network.

Culvert Road Cross Drain Replacement

- An on-site evaluation shall be made by qualified staff experienced in road engineering to determine if a culvert cross drain is required at the site. If culvert replacement coincides with road reengineering many culverts can be eliminated by eliminating much of the inboard ditch. Other alternatives such as hardened drain swales may be appropriate. Where culvert cross drains are used, the location of the drain should coincide with natural drainage features downslope.

- The culvert shall be sized to convey a discharge equal or less than the 50-year flow. Determination of the design flow shall be determined using the rational method, or U.S.G.S. regional relationships, or adjacent channel morphology.

- Similar to a stream crossing excavation, the excavator begins by excavating a trench down to the existing culvert, exposing it, so that the excavator can remove the old pipe using the bucket and thumb. Old culverts can be cut and crushed to fit in available transport vehicles. If the culvert installation is new, the trench is excavated according to the prescription design.

- Following the removal of the old pipe (if present), the trench is excavated to the prescribed width and depth for the new culvert placement. The trench should be straight in both profile and plan view and should be set at a minimum angle of 30 degrees from perpendicular relative to the road direction. The gradient of the culvert should be set to a depth where the pipe exits the embankment fill at the native ground surface.

- Trenching shall be in compliance with all applicable worker health and safety regulations including but not limited to Sections: 29, CFR 1926.650, 601(b)(6) of the Code of Federal Regulations and Title 8, Sections: 1540, 1541, 1541.1 of the California Code of Regulations (CCR). Trenches shall be properly sloped or benched or shored if personnel are to enter any trench greater than five feet in depth.
- The new culvert should extend from the inboard edge of the road to beyond the base of the road embankment fill.
- In situations where the new culvert cannot be set at the base of the embankment fill, an anchored downdrain assembly and an energy dissipater shall be installed to prevent scour at the outlet. The energy dissipater shall be constructed of appropriately sized rock armor and shall have a concave cross section to prevent culvert discharge from scouring adjacent slopes.
- A headwall or drop inlet shall be constructed at the inlet of the culvert to protect crossing fill from saturation and scour and direct flow into the culvert. The headwall can be constructed with sack concrete reinforced with driven rebar or can be poured in place with mixed concrete.
- The road surface shall be shaped so that a rolling dip is formed over the centerline of the culvert. In contrast to stream crossing culverts, the pitch of the road surface is to the outboard edge of the road.

**Mitigation Measures**

Aesthetics

Generally culvert replacement is conducted within the existing road prism so recent excavations have very little effect on aesthetics.

For safety reasons, work areas are closed to the public during construction. Therefore, the public will not view temporary visual effects at construction sites. Interpretive signs shall be posted with information about the project at the nearest public use area and at all project access points. After the worksite closure is lifted, the public will be able to view the work locations, however, the final project condition closely matches normal roadway conditions, and is often unnoticeable by the public.

Trees are removed and scattered on exposed soil as mulch during culvert replacement work. This can present a negative aesthetic effect, particularly in a park setting. The effect is transitory, however, as vegetation decomposition is generally rapid in the north coast region. Because of the thick understory vegetation and dense stands of trees growing adjacent to work sites, work will not be visible from most public use areas.

Air Quality

Diesel exhaust and dust will be produced as part of the heavy equipment work. Air quality in the vicinity of the work is generally high, unless wildfires or prescribed burns are occurring, and the products of the heavy equipment will be rapidly dispersed. The equipment will not be at the project sites for extended periods so any individual site will not receive prolonged exhaust.

Heavy equipment operations may expose workers in the project area and vicinity to exhaust fumes and dust. Heavy equipment operators shall be cautioned to avoid prolonged exposure to exhaust and dust. The cabs of heavy equipment shall be kept in good serviceable condition to provide protection from exhaust and dust. Seals, windows and doors should be kept in good condition to provide

protection when necessary. Detected exhaust leaks shall be repaired immediately to protect workers from exhaust exposure and reduce fire hazard. Project inspectors can position themselves upwind of heavy equipment operations to reduce exposure to exhaust and dust. Dust masks may also be used by operators and inspectors to reduce inhalation of particulates.

Heavy equipment engines and hydraulics generate heat during the work. However, sources of high heat are shielded by equipment covers and do not expose nearby object to high heat. The effects of residual heat diminish rapidly within a short distance of the equipment. Heat shields shall be maintained in good serviceable condition to prevent high heat exposure.

Biological Resources

Stream culvert crossings often pose significant barriers to migration of aquatic and riparian species. Replacement of improperly installed culverts improves habitat function for all aquatic and riparian species. Short-term adverse effects will avoid any negative effects to any listed species to the maximum extent practicable. All appropriate design features and mitigation measures shall be incorporated into project planning. Projects shall be conducted in compliance with all applicable State and Federal threatened and endangered species protection laws and regulations.

The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) shall be requested in writing to provide Technical Assistance under Section 10 of the Endangered Species Act (ESA) in cases when there is a question about whether a specific project has the potential to effect threatened & endangered (T&E) species. Under Section 10, NMFS and USFWS can provide assistance in project planning and design to avoid effects to T&E species. At the State level, the California Department of Fish and Game (CDFG) may also provide informal consultation on projects that may affect T&E species.

When effects to T&E species cannot be avoided by design and mitigation an Incidental Take Permit shall be requested under Section 7 of the ESA. A Federal nexus must exist as a requirement for an Incidental Take Permit from a Federal agency under Section 7. If no Federal nexus exists, consideration will be given to the development of a habitat conservation plan (HCP).

All projects shall be reviewed by the District's State Park Senior Resource Ecologist (SPSRE) to ensure protection of natural, cultural and historical resources. Site visits including the project manager, State Park Senior Resource Ecologist shall occur to develop alternatives that do not negatively affect State Park resources.

The SPSRE shall work closely with the project manager to implement the following practices to protect biological resources:

Plants: Qualified botanists shall conduct rare plant surveys on all culvert stream crossings planned for modification. If any rare plants are located, they shall be avoided to the maximum extent practicable. Rare plants that cannot be avoided may be salvaged and transplanted onto appropriate stable ground.

Trees: All trees, regardless of DBH (diameter breast height), growing along the proposed trench centerline will be removed as part of the culvert crossing replacement process. Limbs of nearby trees may be removed if required for access or equipment maneuvering. Equipment operators shall be required to avoid striking retained trees to minimize damage to the tree structure or bark.

Fish: Stream culvert crossing replacement projects shall occur in the dry season when stream flows are at a minimum or nonexistent. Excavations shall be designed to limit negative effects on water quality to the maximum extent practicable. If the stream is flowing at a slow rate and cannot be captured and diverted, filter structures shall be installed downstream as needed to filter turbid discharge from the worksite. If flow is sufficient to be intercepted, a small diversion dam is built upstream and stream flow is piped around the worksite and discharged into the stream below the worksite. High flows that cannot be piped around worksites shall be isolated from the work area with berms to reduce turbidity in the flow.

Construction activities after October 15th shall proceed only after consultation and approval by NMFS. Work in the rainy season shall occur during dry spells with materials for erosion control on-site at all times. Work shall be conducted so that no more than one-half day's work is active at one time and all work shall be completed by the end of each day. When winterization of access roads is required, all access roads shall be winterized prior to any additional earth moving tasks.

Any soil disturbance adjacent to stream channels shall receive evenly distributed mulch coverage with masticated brush and trees to reduce sheet erosion. Mulch generated during the clearing phase of the rehabilitation work shall be used to the maximum extent practicable.

Birds: Potential habitat for the State and Federally listed marbled murrelet exists in various locations throughout North Coast Redwoods District. To avoid noise disturbances, any work within ¼ mile of the suitable habitat for murrelets shall take place after September 15th. Potential habitat for the Northern Spotted Owl exists in various locations throughout North Coast Redwoods District. To avoid noise disturbances, work within 1000 feet of suitable roosting and nesting habitat for Spotted Owl shall take place after July 10. In most cases, habitat trees will not be affected by road recontouring, however, if trees need to be removed that are potential Owl habitat, protocol surveys shall be conducted prior to construction. No habitat disturbances shall occur within 1000 feet of a nesting site.

The Senior State Park Resource Ecologist shall assess each project for the presence of "fully protected" bird species listed under the California Fish and Game Codes. If the potential exists for the presence of these species, USFWS and CDFG consultation shall occur to develop avoidance measures.

Operations shall occur prior to these dates only if approved surveys indicate the absence of protected species or, incidental take permits are obtained from USFWS. The ¼ mile distance rule will be reduced if geographic features such as a ridge separate the site from suitable habitat (See Technical Assistance Report, April 2001). On sites where background noise is greater than the noise caused by road recontouring equipment, such as adjacent to a major highway, construction may occur prior to the above dates because noise disturbance is no longer an issue.

Amphibians: Qualified biologists shall survey for the presence of suitable habitat for sensitive amphibians and reptiles at stream culvert crossing replacement locations. Amphibian habitat shall be avoided wherever practicable. Following culvert replacement habitat quality and continuity both in the crossing vicinity and in the watershed overall will be greatly increased. If listed species are located and avoidance is not practicable, incidental take authorization shall be obtained from CDFG or USFWS.

If rare species are located the project shall be designed to preserve individuals and their habitat to the maximum extent practicable. If T&E species are encountered the same process outlined under biological resources above shall be used to avoid impacts, obtain a take permit or develop a HCP.

Final reports are required on all biological surveys conducted by consultants or contractors. Consultants shall be requested to list any locally designated species or species of concern, should they exist in the project area.

Exotic Plants: Freshly disturbed ground created by heavy equipment during road treatments may provide habitat for exotic plant species. Heavy equipment may also introduce exotic plant seeds or spread existing seed into the landscape. To minimize potential effects, all heavy equipment shall be pressure washed prior to entering the park or moving from a known infested area within the park to a non-infested area. Anti-fungal wash agents may be specified if the equipment has been exposed to any pathogen that could affect park resources. All heavy equipment contracts shall specify pressure washing of the machines prior to entering the park. Park equipment operators are required to pressure wash equipment before transporting to different units within the District.

In areas where exotic species may exploit disturbed soils and dominate the revegetation, treatments using mulch, seeding, herbicide applications or combinations thereof may be used to reduce the invasion of exotic species.

Wetlands: Natural wetland habitat such as marsh, riparian, and vernal pools will not be filled by stream culvert crossing replacement projects. Some work will occur in riparian corridors at stream crossings. However, equipment will be working within existing road alignments at the crossings and will only affect previously impacted areas. Equipment shall remain on existing road alignments and crossing fill areas to the maximum extent practicable. Equipment may travel off road only when no other alternative is available and after the project inspector and biological consultants have reviewed the route. Where appropriate, the US Army Corps of Engineers shall be consulted for permitting work in the vicinity of wetlands.

Wildlife Corridors: Terrestrial migration corridors may be temporarily altered from the natural migration routes during the heavy equipment work because of daytime noise impacts and excavations in the roadways. However there are many alternative areas available away from work sites for migratory use. Eliminating poorly installed culverts and replacing them with properly sized and placed culverts will improve aquatic and amphibian species migration.

Cultural Resources

Stream culvert crossing removal projects generally will have no impact on significant cultural or historical resources. However some crossings or elements of the crossings could be considered historical. Therefore, review under Public Resources Code 5024 is required to identify any significant cultural or historical resources within the area of potential effect for a proposed project. In the event that avoidance of a cultural resource is not practicable, mitigation measures to decrease the impacts of a culvert replacement project to less than significant shall be proposed. Construction monitoring shall take place to decrease the potential for impacts to cultural resources in areas of moderate to high sensitivity during construction.

In the event that previously undocumented cultural resources are encountered during project construction (including but not limited to dark soil containing shellfish, bone, flaked stone, or groundstone, or deposits of historic trash), work within 100 feet of that location shall stop until a State qualified archeologist has evaluated the area. If any human bones or remains are uncovered,

work shall stop until the County Coroner, State qualified archeologist, and appropriate Native American representatives have evaluated the find. Effects to sacred or religious sites shall be avoided to the maximum extent practicable. If a sacred or religious site exists in a project area, formal State Historic Preservation Office consultation shall occur as well as review by the Native American Heritage Commission.

Geology/Soils

Stream culvert crossing replacement reduces potential crossing failure and channel adjustments by placing culverts at or near natural stream grade. Treatments are designed to improve natural fluvial and riparian functioning and surface hydrology thereby increasing the stability of the crossing and the adjacent channel. Inspectors trained in landform rehabilitation conduct direct oversight of the work to ensure that the treatment designs are complete and have a stable geometry.

Minor fill adjustments and surface erosion may occur after treatment, as soil is re-exposed during the stream culvert crossing replacement. Bare ground shall be mulched with vegetation removed during the work to the maximum extent practicable to minimize surface erosion. Stream culvert crossing replacement will significantly improve the stability of the work sites and reduce surface erosion from the existing condition.

The NCRD lies within a highly active seismic region. Portions of the Northern Coast Ranges Fault System (San Andreas Fault Zone), the Mendocino Triple Junction, and the Cascadia Subduction Zone lie within or near the NCRD. Exposure to strong ground shaking is possible throughout the District. Seismic events will expose workers to direct effects from ground shaking, and possible secondary effects from ground rupture, seismically induced mass wasting, and seismically induced tree failure. However, rehabilitation workers are not exposed to a higher level of hazard than those in other settings. The time-weighted-average exposure to seismic hazards is less at rehabilitation site than it would be in an urban or suburban setting. Due to the remote location of most rehabilitation projects, seismic effects are unlikely to affect park visitors or staff. Conditions for tsunami generally do not exist because culvert replacement project locations are generally inland from water bodies. No volcanic hazards exist in the project vicinity.

Subsidence of land is not anticipated to be a problem at stream culvert crossing replacement locations. Soil and geologic conditions that could result in subsidence such as expansive soils and soluble bedrock do not exist in the NCRD. Stream culvert crossing excavations will not affect unique geologic or physical features.

Hydrology/Water Quality

Water quality will be improved as poorly installed road drainage structures are replaced. However, following rehabilitation work a short-term increase in suspended sediment will occur downstream of the work sites. Sediment is delivered to the stream from ravel along the fill slopes and minor amounts of soil lost downslope during excavation. These effects are limited to the first winter following treatment and in most cases are limited to the first runoff-generating event of the winter. The affect on aquatic habitat is observed immediately downstream of the rehabilitation sites but does not typically extend more than several hundred feet downstream.

The cumulative effect of replacing stream culvert crossings on water quality will be a reduction in sediment scoured from poorly designed outlet structures, improved fluvial-geomorphic functioning, and an improvement in the aquatic habitat throughout the drainage network.

Shallow subsurface flow may be influenced by changes in surface drainage patterns and/or changes in porosity of the soil at rehabilitation sites. Changes in the direction or rate of shallow subsurface flow may be influenced by changes in surface drainage patterns. Stream crossing excavation work may intersect the water table. However, minor amounts of turbidity introduced at the excavation sites are not likely to have a significant effect on groundwater quality. No wells exist that provide direct conduits to the groundwater supply.

Stream culvert crossing replacement projects will not have a significant affect on the amount of groundwater available for public water supplies. Project planning shall identify public water supply and Park water systems that may be affected. Persons responsible for the maintenance of these water systems shall be consulted and if negative effects are anticipated, mutually agreeable mitigations shall be developed.

Hazards and Hazardous Materials

Failure of, or leakage from, vehicles or heavy equipment could result in the release of hazardous substances (primarily petroleum based products) to the ground or water. Equipment is required to be leak free throughout rehabilitation projects. Leaks that develop are repaired immediately in the field or work is suspended until repairs can be made. Spill kits are maintained on site in the event of accidental spillage. Appropriate agencies shall be notified in the event of significant spillage.

The NCRD has adopted a general safety protocol for backcountry heavy equipment operations. The general protocol outlines broad safety issues common to all projects and presents guidelines on how to address those issues. The general protocol also directs project managers to develop a project specific safety plan for each rehabilitation project. The plan shall identify any existing emergency response plans. The project shall be designed and implemented to avoid any conflicts with existing plans and to avoid any increase in emergence response time.

Workers spend most of their work hours in remote wildland settings and may be exposed to natural hazards consistent with that environment (e.g., wild animals, insects, noxious plant, lightning, wind, etc.). All employees are issued first aid kits and are trained how to respond to anticipated and unanticipated incidents. Employees are asked to disclose any sensitivity that might affect their employment tasks.

Heavy equipment can get very hot during the warmer part of the work season; this equipment is sometimes in close proximity to flammable vegetation. Equipment that is not properly outfitted can generate sparks from exhaust systems. Friction between metal parts crushing rocks could also generate sparks. Spark arrestors or turbo-charging (which eliminates sparks in exhaust) and fire extinguishers are required for all heavy equipment. Heavy equipment itself can be used for fighting fire in the backcountry. The safety plan developed for each project is reviewed by all project staff and includes job site characteristics to reduce the potential for fire. Park staff is required to have a State Park radio on site, which allows direct contact to California Department of Fire Protection and centralized dispatch center. Construction crews shall be required to park service vehicles away from flammable material such as dry grass and brush. At the end of each workday, heavy equipment shall be parked over mineral soil to reduce the chance of fire.

Land Use/Planning

Project design shall include review of any General Plan that has been developed for a park unit. The General Plan shall be used to guide the general direction and level of road maintenance efforts. Any reference to a project in a General Plan shall be included in the CEQA document. Projects shall not be implemented if they are in conflict with a General Plan.

All projects shall be in compliance with the Resource Management Directives of California State Parks and all State and Federal environmental laws.

Projects shall be compatible with existing land use in the vicinity of projects. The existing land use on State Park property includes recreation and preservation. Stream culvert crossing replacement will not affect agricultural resources. Agricultural resources on adjoining property will benefit from stream culvert crossing replacement by improving water quality and quantity.

In general, established communities do not exist within the boundaries of any North Coast Redwood Parks. Stream culvert crossing replacement will not disrupt or divide the physical arrangement of an established community. If a project is identified in an established community, alternative transportation routes shall be developed to mitigate the temporary closure of roads at culvert crossings. Community members shall be notified of projects that may have any effect on the community and agreements shall be developed that are mutually agreeable.

Mineral Resources

Stream culvert crossing replacement will not conflict with adopted energy conservation plans. The projects will not involve wasteful and inefficient use of non-renewable resources. Heavy equipment shall be used in as efficient manner as possible and project designers shall continue to research and implement the most energy efficient techniques. Stream culvert crossing replacement will not affect availability of a known mineral resource that would be of future value to the region and residents of the state.

Noise

Noise levels will temporarily increase at the work site, although the noise generally diminishes rapidly with distance. Equipment operation at sites close to campgrounds or residences shall be limited to daytime hours between 08:00 to 16:00 Monday through Friday.

Workers in close proximity to the heavy equipment are exposed to high noise levels. Workers shall be advised to wear ear protection when in close proximity to the heavy equipment. Earplugs shall be provided to all workers and extra earplugs shall be stored in all vehicles and equipment. All operations are in compliance with OSHA regulations.

Population/Housing

Stream culvert crossing replacement will have no cumulative effect on regional or local population projections. Stream culvert crossing replacement will not induce growth of human populations or communities. Stream culvert crossing replacement will not displace existing housing or affect affordable housing.

Public Services

Stream culvert crossing replacement will not affect fire protection abilities unless the trenching is in progress as a road is needed for access. In most cases an emergency temporary road can be constructed to accommodate any emergency traffic. A network of open service roads shall be maintained throughout the North Coast Redwoods Parks to aid in fire suppression.

If stream culvert crossing replacement is planned for a road that is currently open to vehicle traffic, park rangers shall be consulted to determine appropriate mitigation measures to maintain law enforcement access.

Recreation

Stream culvert crossing replacement projects will not directly affect campground facilities within park units. Occasionally if campsites are located close to or downslope of a work site, the campsites may be temporarily closed for public safety. All trails and roads within the Park backcountry that are not within the project area will remain open during the summer work season. Park visitor services and ranger staff shall be informed of any road closures and will affect visitors or other park operations. Closure signs shall be posted at all access points to projects and at campground and visitor center kiosks. Official closure notices shall be obtained and posted during the project implementation and post-treatment recovery phases.

Transportation/Traffic

Traffic by workers to and from the work sites will be required on County roads and State highways. Given logistical constraints of the amount of heavy equipment work that can occur simultaneously in the project the maximum number of round trips required per day will be less than 10 in any given park, which is insignificant compared to current levels of traffic.

Heavy equipment is generally transported on a lowboy transport and is classified as a wide load on State highways. All equipment transport operations shall be in compliance with State and local laws and all permits shall be obtained as necessary. Pilot trucks shall be assigned to accompany the transport as required by State and local laws. Transportation of heavy equipment is common on roads and highways in this region due to logging and gravel mining industries.

Parking capacity will not be affected by stream culvert crossing replacement projects.

Stream culvert crossing replacement does not increase traffic hazards to the public.

Stream culvert crossing replacement will not result in conflicts with adopted policies supporting alternative transportation. They will not result in effects to rail, waterborne or air traffic.

# Glossary for Best Management Practices

**aggrade** - the filling of a stream channel with sediment. This usually happens when the supply of sediment is greater than the stream is transporting. Compare to "degrade" and "graded stream."

**alignment** - the area affected by a road or trail including the fill slopes, road bench, and cut bank. Also a linear representation of features on a map such as a stream channel.

**curvilinear** - a curving line. Refers to a meandering trail that curves around boulders and trees following contours across the land at a flat or oblique angle.

**cutbench -** the portion of a roadway that has been cut into bedrock or native soil. Compare with embankment.

**decommissioning** - the treatment of a road to eliminate diversion potential during periods of nonuse. A road is typically decommissioned when the road will not be used for a period of time but may be used some time in the future. Decommissioning includes the removal of stream crossing fill and partially recontouring or outsloping road segments between crossings.

**degrade** - refers to the erosion of a stream channel. This usually happens when the supply of sediment is less than the amount the stream is transporting. Compare to "aggrade" and "graded stream." Also refers to poor water quality or a disturbed watershed function.

**ditch memory -** subsurface water flow along a former drainage ditch after road removal is completed. This often occurs when ditches have not been ripped. Also see memory.

**ditch relief culvert -** see road cross drain

**diversion potential -** the potential for water to divert down a roadway if a stream crossing becomes plugged. Stream crossings with diversion potential have a high likelihood of contributing massive volumes of sediment to streams if the diversion causes gullies or landslides. Diversion potential is reduced by construction of a fail safe crossing (critical dip with rock armor) or by complete stream crossing removal.

**drain lens -** buried course aggregate wrapped in filter fabric used to drain subsurface water from springs or seeps.

**duff** - partially decayed organic material composed of needles, leaves, and twigs on the forest floor .

**embankment** - fill excavated from the cutbench and used to construct the outboard road bench. This is often referred to as the fill slope or outboard fill material.

**endhauling -** the transportation of excavated material to a stable storage location using a dump truck.

**energy dissipater -** material such as rock riprap or a structure made of logs, metal pipe, or poured concrete that is used to reduce the energy of flowing water below culvert outlets or dips.

**erosion control** - activities that prevent soil from being detached and moved down slope including, but not limited to, road removal, revegetation, mulching with brush, out sloping, and compaction of unstable fill.

# Glossary for Best Management Practices

## (continued)

**erosion prevention -** cost effective techniques used to prevent erosion before it happens.

**fail safe crossing -** a stream crossing that has been constructed in a way that has no potential for diversion. The ultimate fail safe crossing would include an oversized culvert, road approaches that slope upward in both directions, a critical dip that drains back into the stream, energy dissipaters, brush rack, and a headwall.

**fall line** - an imaginary line on a sloped surface that follows the steepest angle. You can think of the fall-line as the line that would be made by a ball rolling down the slope.

**fill** - material used to construct roads and related structures. Fill can include soil, rock, and large organic debris.

**full recontouring** - the treatment of a road that completely eliminates (obliterates) the road from the landscape. Full recontouring is accomplished by recovering all available fill and burying the cutbank until the surrounding terrain is fully matched. This type of treatment is also referred to as road removal or road obliteration. See obliteration.

**geomorphology** - the study of the earth's surface and the processes that shape it. Geomorphology is closely related to geology.

**geomorphologist** - a person who studies geomorphology.

**grade** - the natural, proposed, or planned ground surface. Usually grade is set to match the surrounding topography.

**graded stream** - a stream that, over a long period of time can move as much sediment as is supplied to it. Compare to "aggrade" and "degrade."

**gradient** - the measurement of the angle along the length of a road or a stream. This term is often confused with grade (see grade).

**gully** - a steeply sided channel caused by concentrated surface runoff erosion. Gullies can usually be identified by their location away from natural stream valleys.

**Humboldt crossing** - a stream crossing constructed with logs set parallel to the stream channel and covered with fill.

**hydrology** - the science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rock, and in the atmosphere. This term is often confused with hydrogeology, which is the science of groundwater.

**inboard** - refers to the upslope side of a road, trail or other feature.

**inboard ditch** - a drainage ditch cut along the inboard side of the roadbed to intercept drainage from the slope above or small streams. Inboard ditches usually direct their water through a culvert that crosses under the road.

# Glossary for Best Management Practices

**(continued)**

**large woody debris (LWD)** - also known as large organic debris (LOD), refers to logs and stumps found in stream channels, road fills, etc., having a diameter greater than 12 inches and a length greater than 6 feet.

**legacy road -** a road originally constructed for another purpose that remains in use. Many of today's park roads were originally constructed as logging roads but now serve as backcountry access roads.

**mass wasting -** a general term that includes many types of massive earth movements. These include rock slides, debris slides, debris flows, and earthflows, etc.

**meander -** a series of gentle curves in a stream, road, or trail.

**memory** - a subsurface zone where water will preferentially flow due the presence of a gully or inboard ditch buried in recontoured fill. Also see ditch memory.

**obliteration -** to completely remove the road feature from the landscape. This is accomplished by full recontouring. See full recontouring.

**outboard** - refers to the downslope side of a road, trail or other feature.

**operator** - the person operating heavy equipment or other machines.

**outsloping** - the treatment of a road to eliminate diversion potential along the roadbed during road reengineering. Outsloping includes excavation of some of the road fill along the outboard edge of the road and placing it against the cutbank to eliminate the inboard ditch and provide drainage toward the outside of the road. Outsloped roads are commonly graded and covered with compacted road base to harden the surface.

**partial recontouring -** similar to outsloping, this term is reserved for roads that are to be removed or decommissioned. The partial recontour often has a steeper cross slope on the former roadbed to ensure proper drainage. Partially recontoured roads are not matched at the top of the cutbank like fully recontoured roads.

**permeability -** a measure of the rate at which water can pass through soil.

**ripping -** decompaction of the soil by means of rippers mounted on the rear of a dozer.

**roadbed** - the surface of the road where driving takes place. The roadbed extends from the inboard ditch or cutbank to the outboard slope break or berm.

**road cross drain -** a drainage structure which utilizes a culvert to direct water from an inside ditch to an area beyond the outer edge of the road fill.

**roadway** - the corridor including the cutbank, the inboard ditch, the roadbed, and the embankment.

**rolling dip –** a shallow dip designed to convey water off of the road surface while allowing vehicles to pass at reduced speed. Rolling dips should be located where stable landscape features exist that can carry runoff without causing erosion.

# Glossary for Best Management Practices

## (continued)

**runoff** - rainwater flowing on the surface of the ground. Runoff can be generated by rain falling on saturated ground or from heavy rain that cannot soak in fast enough.

**sediment** - Silt, sand, clay, and gravel that is moved by water and deposited at some location.

**sediment control** - activities that filter dirt out of water, including silt fence and sediment retention basins.

**slope angle** - the angle of the hill slope measured in percent along the fall line.

**soil** - clay, silt, sand, compost, air, water, and weathered rock mixed in various proportions. Soil consists of horizons or layers that display different amounts of weathering and fertility.

**spoils –** soil and organic material that is excavated from stream crossings or road embankments that is used for recontouring or can be end-hauled to a stable storage location.

**stream crossing** - a constructed road section across a natural stream. There are many types of crossings such as bridges, culverts, Humboldt (see definition), and fill crossings.

**surfacing –** rock aggregate or paving that is placed on the road surface to reduce erosion and weather-proof a road for winter use.

**through-cut –** a portion of a road that has cutbanks on both sides with drainage flowing down the road or inside ditch.

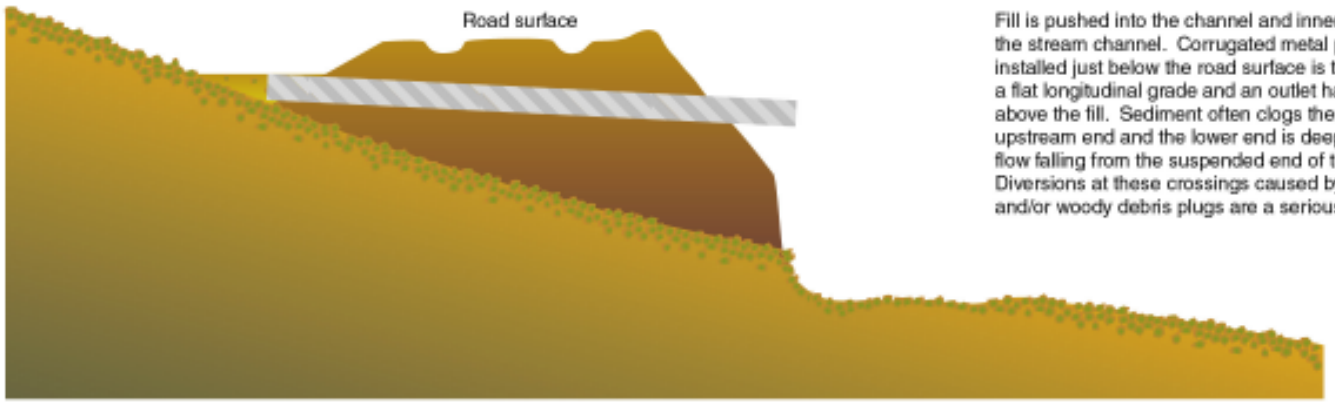
**topography** - the natural shape of the land's surface.

**topsoil -** the uppermost layer of decayed organic matter, seeds, soil, and microorganisms.

**trash rack –** a structure located upstream of a culvert inlet designed to trap floating debris to prevent the culvert from becoming plugged.

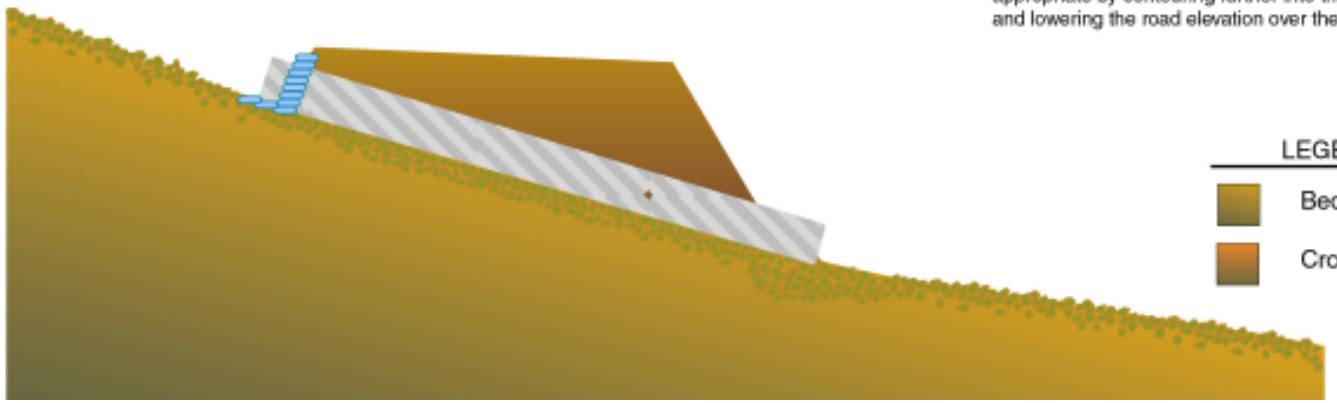
# Stream Culvert Crossing Replacement

## Longitudinal Profile Cutaway




### Before treatment

Fill is pushed into the channel and inner gorge to cross the stream channel. Corrugated metal pipe (CMP) installed just below the road surface is typically set with a flat longitudinal grade and an outlet hanging well above the fill. Sediment often clogs the pipe at the upstream end and the lower end is deeply scoured by flow falling from the suspended end of the culvert. Diversions at these crossings caused by sediment and/or woody debris plugs are a serious erosion threats.




### After treatment

The culvert is replaced with a pipe fitted to a selected design flow (typically 50 yr. storm). The culvert is set at grade and at the level of the stable streambed. The pipe extends from the inboard edge of the road to the base of the crossing fill. The crossing size is reduced where appropriate by contouring further into the stream valley and lowering the road elevation over the stream.

# Road Cross Drain Culvert Replacement

Cross Section Cutaway