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We wish to thank the staff from the North Coast Regional Water Quality Control Board and the California Department of Fish & Game for participating in a pre-consultation site visit and for providing early recommendations on this project.

Thank you to the local landowners and residents who participated in the study, allowed us access to their land, and responded to our surveys.

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1.0 Introduction

The Mendocino County Department of Transportation (DOT) has been tasked with conducting a Feasibility Study to explore the most feasible and cost-effective methods for the County to address impacts to water quality and fish habitat caused by nine ford crossings on Cave Creek along a 2.5-mile segment of Tomki Road. Tomki Road is a remote county road connecting Redwood Valley to Little Lake Valley near Willits. Cave Creek is a tributary of Tomki Creek, which flows into the Upper Mainstem Eel River. Traffic across the fords contributes a considerable amount of sediment into the creek, introduces oil, gasoline, and other pollutants into the stream, and results in direct fish mortality from crossing vehicles. Tomki Road has also been an attraction for off-road vehicle enthusiasts, an activity which generates significant sediment volumes to the creek. The road is often impassable during the rainy season, and nearly every winter vehicles are stranded in the creek when drivers attempt to cross.

Funding for the Feasibility Study has been obtained through Proposition 40 Integrated Watershed Management Plan (IWMP) funds from the 2005 – 2006 Consolidated Grants Program provided by the State Water Resources Control Board (SWQCB). Funding for this project also includes the study and construction of a prototype vented low water crossing designed to replace the existing ford at the most southerly crossing (Crossing 1) to determine whether the prototype structure is a viable treatment for the remaining fords. Improvements at Crossing 1 have been addressed separately by DOT and are not included in this study.

1.1 Project Background

In 2001, the North Coast Regional Water Quality Control Board (RWQCB) began investigating water pollution resulting from the 2.5-mile section of Tomki Road which contains nine (9) wet ford crossings on Cave Creek. In June 2001, a meeting was held on-site to evaluate the condition of Cave Creek and Tomki Road. The meeting was attended by staff from RWQCB, DOT, the California Department of Fish & Game (CDFG), the Mendocino County Water Agency, and two local landowners. A variety of options to correct the pollution problem were discussed, including relocating the road away from Cave Creek, upgrading the ford crossings with bridges or other suitable structures, improved maintenance of crossings, restoring loss of riparian vegetation, and obtaining funding for the road work.

On August 31, 2001, DOT was notified that the RWQCB considered the pollution associated with Tomki Road to be significant, citing impacts to water quality, fish habitat and riparian vegetation. The County was required to submit a technical report to include short and long term solutions to correct the sediment pollution associated with Tomki Road. A preliminary study was prepared by Ross Taylor and Associates in 2003 to describe (a) the natural history and distribution of threatened salmonids in the local watershed, (b) impacts of the stream crossings on fish habitat and (c) management options to reduce these impacts. DOT was further required to submit bi-annual progress reports to the RWQCB in order to demonstrate that the County was moving towards resolution of the Cave Creek pollution problem.

In 2002, DOT held a meeting with Tomki Road landowners to discuss solutions to the problem and to understand landowner desires for Tomki Road. 18 people attended this meeting, including four County and State agency staff. From this meeting, the following solutions were offered:

1. Upgrade the south ford (Crossing 1) with a proto type design for a vented low water crossing. This structure would be designed to pass flow volumes up to and including the 10-year storm event, while higher flows would overtop the structure.
2. Upgrade the remaining 8 fords (Crossings 2-9) with alternative designs such as the prototype design in Option 1
3. Install conventional road crossing structures at the remaining 8 fords (Crossings 2-9), such as bridges or open bottom culverts typically designed to pass 100-year flows.
4. Total road relocation to a ridge or mid-slope position
5. Partial road relocation to avoid the use of some fords
6. Seasonal closure of the road
7. Road abandonment by the County

In order to meet the requirements of the RWQCB, DOT applied for and received funding through the Proposition 40 Integrated Watershed Management Plan (IWMP) 2005 – 2006 Consolidated Grants Program. Funds were granted to construct the prototype crossing at the south ford and to conduct a feasibility study to assess each of the above options.

1.2 Goals and Objectives

The primary objective of the Feasibility Study is to identify the most feasible solution, both in terms of effectiveness and cost, for improving water quality in Cave Creek which has been degraded by vehicle traffic across the wet fords on Tomki Road. The recommended solution will achieve this goal by significantly reducing sediment delivery and other pollutant inputs to the creek and will increase the protection of threatened Chinook salmon and steelhead within Cave Creek by eliminating direct fish mortality from crossing vehicles and by enhancing spawning and rearing habitat. The Study will also identify solutions for improving safety conditions for drivers on Tomki Road. The Feasibility Study will provide specific recommendations for achieving these goals, including practical recommendations for planning, designing, implementing, monitoring and funding the recommended solution.

1.3 Study Area Description

The project site (Study Area) is located approximately six miles east of Willits, in Mendocino County, California. The Study Area extends north along Tomki Road from the southernmost crossing of Cave Creek to near Tomki Creek, a distance of approximately 2.5 miles. Site latitude/longitude at the south end is approximately 39.3896N and 123.2291W, and at the north end is approximately 39.4166N and 123.2409W. For the purposes of the Feasibility Study, the Study Area encompasses approximately 861 acres within the Cave Creek watershed. The study corridor is approximately ½ mile wide, east to west, from ridge to ridge. The project area is located on the USGS 7.5” Foster Mountain Quadrangle, T18N, R12W, Sections 18, 19 and 20. A Location Map of the Study Area is provided in Figure 1.

Tomki Road is a County maintained roadway that connects Redwood Valley and Little Lake Valley in central Mendocino County. The road is functionally classified as a rural minor collector, with average daily traffic (ADT) less than 50 vehicles. The road surface is dirt and gravel, with an approximate width of 20 feet within a 60-foot wide fee-title right-of-way. The road crosses Cave Creek and its tributaries at 9 different locations within a 2.5-mile segment of the road. These ford crossings have existed since the creation of Tomki Road in the 1800’s. During extreme high flows, water in the fords reaches such depths and velocities that the road becomes impassable. In the event of road closure of U.S. Highway 101 between Ukiah and Willits, Tomki Road, if passable, provides the shortest public detour route in the area. It should be noted, however, that Tomki Road is *not* a Caltrans-designated detour route.

Three landowners have access to Tomki Road within the Study Area. Two of the three are able to access their property from alternate access routes, and one landowner relies entirely on Tomki Road to access her property. The area is frequented by recreational off-road vehicle (ORV) users, as evidenced by numerous areas adjacent to the road, both upslope and within the riparian zone, that are severely damaged and contributing sediment to Cave Creek. Trespassing and garbage dumping are common due to the area’s remote location.

The ford crossings are located within salmon and steelhead spawning, rearing and migrating habitat. Vehicle use and road maintenance practices are severely impacting the fish habitat with excessive amounts of sediment and vehicle pollutants. Riparian vegetation has been reduced due to the location of the road within the riparian zone of Cave Creek. Direct mortality to fish at Tomki Road crossings has been documented.

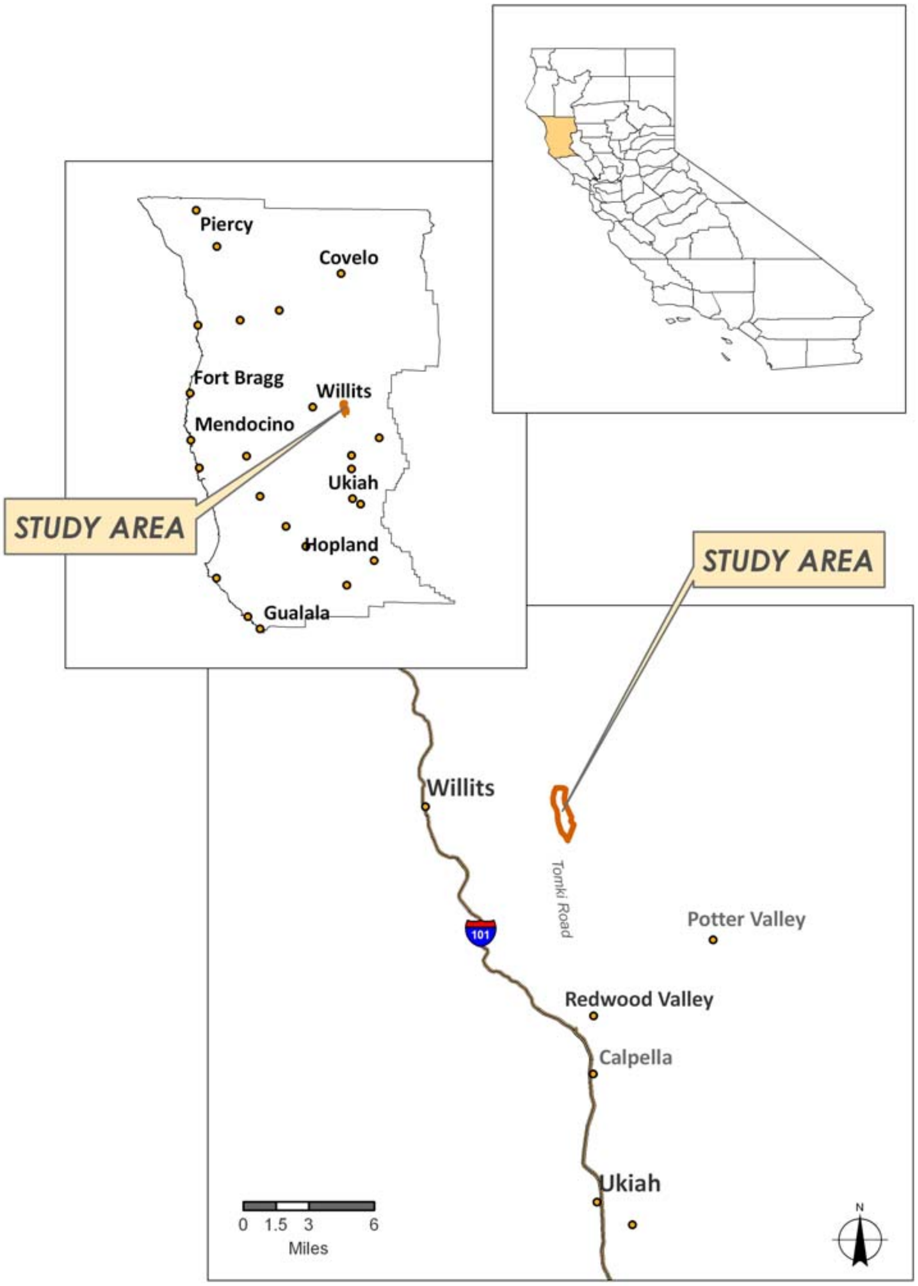

Figure 1. Location Map

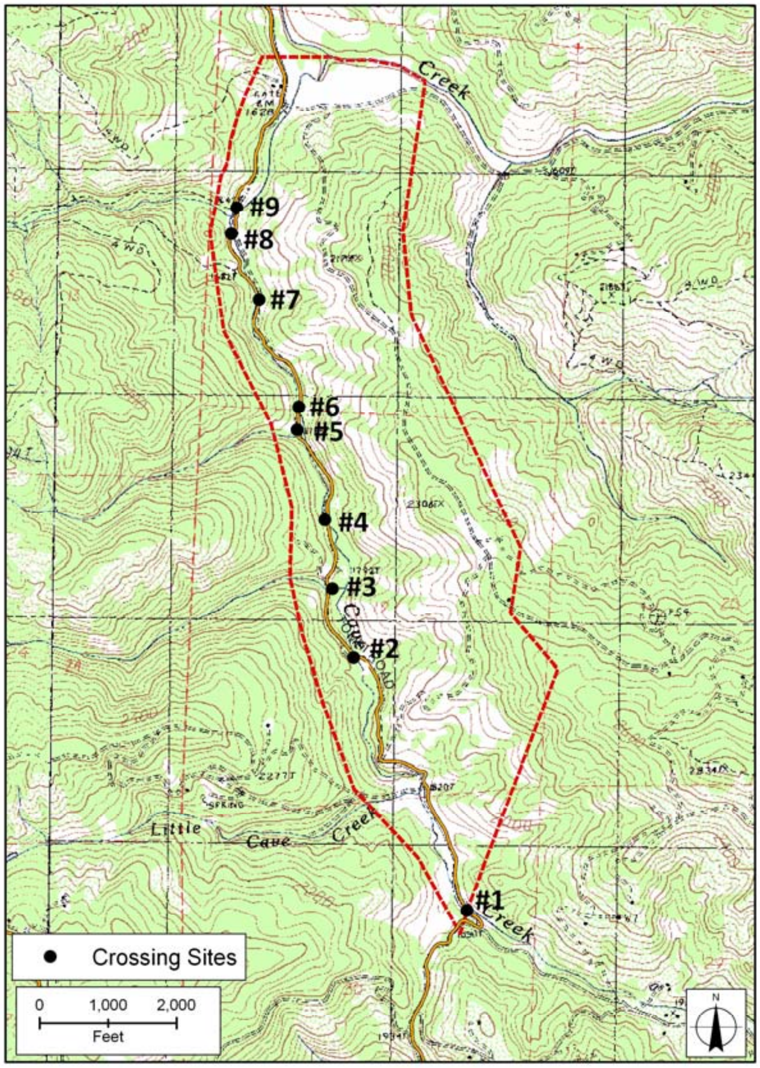

Figure 2. Study Area

2.0 Existing Conditions

A reconnaissance level environmental assessment was performed to describe the soils and geology, biological resources and cultural resources within the project area. The information collected from the assessment was used to identify potential impacts, constraints, and recommendations regarding each of the 7 alternatives. This section describes existing conditions within the Study Area and potential impacts to sensitive resources. Recommendations for avoiding or mitigating these impacts are discussed in Section 4.0.

2.1 Environmental Setting

The Study Area is located approximately six miles east of Willits in Mendocino County. Located within the interior North Coast Ranges along the eastern edge of the coastal fog belt, the climate is intermediate between the cool, moist maritime conditions of the coast and the extremes of the more continental climate of the inland valleys. These factors have produced a rich flora and a diverse mix of vegetation types and plant communities including mixed conifer forest, mixed conifer-hardwood forest, oak woodland, mixed hardwood forest, serpentine scrub, grasslands, and a variety of riparian and other wetland habitat. The diverse mix of habitats provide for a rich variety of wildlife.

Elevations within the Study Area range from 1,628 feet at the north end of Cave Creek near the Tomki Creek confluence to approximately 2,500 feet on the ridge to the east. The topography is complex with steep, mountainous uplands and intervening valleys, ridges, and drainages. Several tributaries feed into Cave creek from the west within the Study Area before entering Tomki Creek. The basic geology of the Study Area is a Late Cretaceous Franciscan Assemblage composed of graywacke-type sandstone and shale with minor greenstone, conglomerate, chert, limestone, and serpentine outcroppings.

2.2 Land Use

Nearly all of the property within the Study Area is classified as Rangeland (RL160) by the Mendocino County General Plan. Approximately 30 acres at the south end of the western ridge is classified as Forestland (FL160). Parcels range in size from 40 to 160+ acres. Property within the Study Area is held by six landowners, three of which hold lands within the 9 crossing sites. The primary use of the land is agriculture, timber and recreation. A few residences are located on the ridges, but the majority of residential development is found outside of the Study Area, to the north and south.

A number of gullied side hill trails and disturbed open fields indicate the intensive use of this area by off-road vehicles. Residents report frequent garbage dumping, abandoned vehicles, fish poaching, trespassing, camp fires, and other nuisance activities commonly associated with remote rural locations.

2.3 Geology and Soils

A Preliminary Soils and Geologic Assessment was performed by Blackburn Consulting, Inc. (BCI). The report addresses soils and geologic conditions associated with potential road improvements, and provides preliminary recommendations for the various improvement options. The report, including geologic and hazard mapping and soil pit data, can be found in Appendix C.

2.3.1 Geologic Setting

The topography and geology of the Study Area is characterized by steep terrain and active landslides, particularly along the slopes east of Cave Creek. Bedrock is exposed intermittently along the canyon slopes, mostly as isolated masses of fractured sandstone, and along portions of the Cave Creek channel and adjacent banks.

West of Tomki Road, the natural slopes are typically steep, heavily vegetated, and dissected by narrow drainages flowing easterly to Cave Creek. Tomki Road crosses these tributary drainages by means of large diameter corrugated metal pipe (CMPs), up to 72” in diameter, or low water crossings.

East of Tomki Road, the natural slopes are flatter and less vegetated, with areas of wide, grassy slopes and hummocky terrain. Drainage along these slopes is not well defined and generally follows irregular courses. These drainages are carried under Tomki Road by CMPs, typically 18-36” in diameter. At some culvert outlets, discharge onto the unconsolidated channel deposits has created deep scour holes up to 10 feet deep.

The project alignment is underlain by Jurassic-Cretaceous age sediments of the Franciscan Complex, comprised mostly of sandstone and shale with lesser chert and conglomerate. The Franciscan Complex in this area contains large, fragmented rock masses within a sheared, shaly matrix commonly referred to as mélange.

Several pre-Quaternary faults are mapped within 5 miles of the site, but no active faults are shown within the project alignment. Active faults are defined as showing evidence of surface displacement within the past 11,000 years. The nearest active fault is the Maacama Fault Zone, located approximately five miles to the west.

Fractured graywacke sandstone, consistent with the published mapping, was observed throughout the project vicinity. This rock is exposed along much of the creek bed and within some road cuts. Along the slopes east of Tomki Road, isolated rock outcrops of fractured rock masses occur, often surrounded by slide terrain. Few outcrops along the slopes west of Tomki Road were observed, although these slopes are steep and heavily forested; bedrock is expected at relatively shallow depth, likely less than 10 feet, along these slopes. The rock, where exposed, is variably weathered/fractured. No preferred fracture/bedding planes or rock structure were observed.

Quaternary stream and terrace deposits are present within the Cave Creek channel. These deposits vary from about 20 feet wide in the narrow reaches of the canyon, to over 200 ft wide where side drainages form broad, alluvial terraces. These deposits are generally unconsolidated granular soils subject to erosion and scour.

Numerous landslides were observed along the slopes above Tomki Road, primarily along the less steep, grassy slopes to the east. At 10-20 feet thick, these slides are relatively shallow with areas of surface slumps about 5-10 feet thick. Much of the active sliding appears to flow around isolated, large rock outcrops that are prominently exposed throughout the slopes.

2.3.2 Subsurface Conditions

To provide a feasibility-level assessment for possible structures at the low-water crossings, BCI observed and logged 18 test pits at Crossings 1 through 9. At Crossings 1 through 8, graywacke sandstone bedrock was encountered at depths of generally 5 feet or less. These levels are typically at or near the creek level, or in some cases, 1-2 feet below the thalweg of the creek. The rock quality varies from slightly weathered (hard digging to near refusal with the backhoe) to intensely weathered/decomposed (easy backhoe digging). Some of the intensely weathered rock was sheared to a waxy clay texture, with local serpentine. The surface materials overlying the rock are typically loose, silty sand with gravel and cobbles; these soils are unconsolidated channel deposits and subject to seasonal erosion and scour.

At Crossing 9, the northern-most crossing, channel deposits consisting of loose silt, sand and gravel were encountered to depths varying from 2 feet to greater than 9.5 feet. The Cave Creek channel widens to about 50-100 feet in this area, and the depth to bedrock varies with location.

2.4 Soil Erosion and Water Quality

Although the water quality in Cave Creek has not been tested, field observations demonstrate highly turbid waters year round at all crossing locations. Annual soil erosion volumes for the crossings on Tomki Road have been estimated by DOT and are contained in the County's DIRT Database. The following table identifies the estimated volume of erosion occurring annually on the road prism at each of the 8 crossings and what percent of this sediment is delivered to the stream system. In addition, DOT has assigned each of the crossings an "immediacy need" for treatment. Selected data forms for each of the 8 crossings are included in Appendix D.

Table 1. Sediment Delivery to Cave Creek

Crossing	Annual Road Prism Erosion (cubic yards)	% Delivery to Creek	Immediacy Need
2	17.9	100	High
3	6.2	75	High
4	7.1	100	High
5	9.2	100	High
6	6.3	100	High
7	10	100	High
8	5.9	100	High
9	9.6	100	High
TOTAL	72.2 cubic yards		

Based on data from the DIRT Database, the road approaches at the wet fords are contributing approximately 70 cubic yards of sediment into Cave Creek annually. DOT considers every crossing to be a high priority for treatment. Additional erosion is occurring on private lands where off-road vehicle use has denuded numerous areas adjacent to Cave Creek, compacting soils, destroying stabilizing vegetation, creating trails, and causing concentrated runoff to carry sediment and other pollutants directly to the creek.

Other pollutants, such as petroleum products from oil and gasoline leaks and asbestos-containing brake dust, enter the creek when the undercarriage of a vehicle makes contact with the creek water when crossing one of the fords. The creek waters are generally high enough for this to occur at least 8 months of the year (November-June). Many of the ford approaches are steep and contain deep holes and large boulders, conditions that frequently result in damage to oil pans. Vehicles are regularly abandoned in this remote area, along the roadside or within the creek channel itself. Sometimes the vehicles are burned and left to leak oil, gasoline, antifreeze/coolant, brake and steering fluids, and other harmful products into the ground, and directly or eventually entering the creek. While the amount of vehicle-related pollutants being delivered to Cave Creek is impossible to quantify, it can be safely stated that eliminating the opportunity for road users to drive across the stream channel will considerably reduce the direct impacts of this pollutant source.

It is recommended that baseline water quality data be collected, including sediment, turbidity and hydrocarbons, in accordance with SWQCB protocol before the County initiates any improvements within the Study Area.

2.5 Hydrology

Cave Creek watershed is located within the Tomki Creek hydrologic sub area, in the Upper Main Eel River hydrologic area, in the Eel River hydrologic unit and the North Coast hydrologic region. The Cave Creek watershed drains approximately 11,627 acres, or over 18 square miles. The average annual rainfall is estimated to be 43 inches.

The regression analysis, as developed in USGS Publication 77-21, was used to determine the flood flows during 2-year, 10-year and 100-year storm events. The North Coast region equation was applied and data from the Department of Water Resources Bulletin 195 was used for rainfall data. The Study Area is located on the lee side of the mountain range due east of Willits. Review of the NOAA Atlas 2 rainfall data indicates that the depth of rainfall received during a 100-year rainfall event is approximately equivalent to the average of the rainfall occurring at CDF Willits Howard Forest gauging station and the Redwood Valley gauging station. Mean annual project precipitation was therefore calculated to be 43 inches. The rainfall data and hydrology calculations are included in Appendix E. A detailed hydrologic analysis was conducted for Crossings 2, 4, 5, 8 and 9 only. A summary of the flows at each of these crossings is provided in Table 2 below.

Table 2. Hydrology Summary for Selected Crossings

Crossing	A (sq. miles)	P (inches)	H (feet X 1000)	Q2 (cfs) 50% probability	Q10 (cfs) 10% probability	Q100 (cfs) 1% probability
2	3.19	43	1.92	209	478	973
4	4.62	43	1.9	293	663	1342
5	5.08	43	1.9	320	722	1459
8	5.48	43	1.86	345	774	1556
9	7.5	43	1.86	458	1022	2046
A = drainage area P = mean annual precipitation H = altitude index						

The DOT Road and Development Standards defines waterways with drainage areas between one and 4 square miles as a secondary waterway and waterways draining greater than 4 square miles as major waterways. All crossings within the Study Area except for Crossings 2 and 3 drain areas greater than 4 square miles and are considered to be major waterways.

2.6 Vegetation

A comprehensive CCDFG-protocol level floristic survey was conducted by Kerry Heise Botanical Consulting in summer/fall 2007 and spring/summer 2008 to determine whether any special-status plant species or sensitive communities exist within the Study Area. The complete report can be found in Appendix F.

2.6.1 Vegetation Characteristics

Cave Creek is a rich and diverse riparian area due in part to its location between two floristically different vegetation types, Douglas-fir dominated coniferous forest and Shreve Oak dominated oak woodland/grassland. There is good habitat with the potential to support many of the rare vascular plant species that have been found within the nine quad area surrounding the Foster Mountain USGS quad. Some potential rare plants are montane species found at higher elevations to the east in the Mendocino National Forest such as *Anisocarpus scabridus* (*Raillardiopsis scabrida* in Jepson Manual), and *Sidalcea oregano* ssp. *hydrophila*. Both species are plants of vernal pools and seasonal meadows, habitat not present in the Study Area.

Cave Creek is bounded on the west by dense mixed conifer/hardwood forest comprised largely of Douglas fir, Garry Oak, Black Oak, Pacific Madrone, Ponderosa Pine and California Bay. To the east on dryer slopes, a mosaic of oak woodland comprised largely of Shreve oak, Garry oak, annual-dominated grassland, and patches of Douglas fir dominated conifer forest. The creek effectively divides two major ecotones and thus integrates floristic elements of several vegetation types including the Mixed Oak Series, Mixed Willow Series, Douglas Fir – Ponderosa Pine Series, and White Alder Series, as described in Sawyer and Keeler-Wolf (1995).

The riparian vegetation along Cave Creek near the channel consists largely of Oregon Ash, Garry Oak, and several species of Willow. In the northern half of the Study Area White Alder becomes more prevalent and dominates some reaches. Other trees include Douglas-fir, California Bay or Pepperwood, Black Cottonwood, Valley Oak, Pacific Madrone, Big-leaf Maple and Black Oak. Common understory species include Red Willow, Arroyo Willow, Narrow-leaf Willow, Western Raspberry, Snowberry, Poison Oak, Durango Root, Mugwort, Torrent Sedge, and Tall Fescue. Impacts from vehicle traffic at the crossings has resulted in a loss of riparian vegetation.

The main stem of Cave Creek is structurally complex and species rich with high quality aquatic habitat for salmonid, resident fishes, and amphibians. The creek has reaches that are dense with well-developed tree, shrub, and herbaceous canopies, in some places knitted together with vines such as Honeysuckle and Poison Oak to form thick mats of vegetation. Tree canopy cover along the riparian zone ranges from very low to very high (0 to > 95%). The most mesic reach is between crossings 4 and 5 and is characterized by a dense hardwood canopy comprised largely of mature White Alder, a diverse assortment of shrubs and herbaceous species, and shade tolerant ferns and bryophytes.

Other general observations include an abundance of down large woody debris (LWD) along relatively undisturbed reaches and a lack of LWD along disturbed sections. Downed large woody debris is important to the structural and functional integrity of the riparian system. These consist of large trees that have fallen either parallel or perpendicular to the stream and lodging to become permanent features of the creek channel, which slow the current down and helps develop structure for fish and wildlife habitat.

The smaller tributary streams where they intersected the main stem of Cave Creek have very small catchment basins and are characterized by narrow channels (< 2 meter wide) with little or no late-season surface water. They lack development of more typical herbaceous species that occupy higher flow channel bottoms such as Torrent Sedge and Horsetail.

Tree cover in the tributary streams is dense but composed of upland species favoring more mesic conditions including California Bay or Pepperwood, Douglas-fir, and Garry Oak. Poison Oak is abundant in these dryer systems. The herbaceous plants of these drainages are more typical of shady slopes and ravines than larger creek channels and included species such as Maidenhair, Goldenback fern, Curly Dock, California Polypody Fern, Slender Hairgrass, and Geyer's Melic.

2.6.2 Special Status Plant Species

No rare vascular plants were found (including CNPS List 3 and 4 plants), however one (1) moss and one (1) lichen considered rare were seen in the Study Area. In addition, considered too common to rank as rare with CNPS, one Pacific Yew tree (*Taxus brevifolia*) was found along Cave Creek approximately 100 meters south of Crossing 5. This species, a component of the Douglas-fir – Tanoak series, is locally rare in Mendocino County, however, no protection is currently afforded to it.

Sulcaria badia

The rare lichen, *Sulcaria badia* (Grooved Beard Lichen), was found at Crossing 2, approximately 25 meters south of the Cave Creek and 3 meters east of road, and at Crossing 4, between the creek and the old roadbed to the west. Both lichens were found on Oregon Ash trees. This species has a Recommended Global Rarity Rank of G2G3, a Recommended Global Threat Rank of .2, and a Recommended Local Rank (CA) of S2S3.2.

Sulcaria badia is narrowly distributed in the Northern Hemisphere, restricted to the Pacific Northwest. Localities adjacent to agricultural lands face loss of vitality through declining air quality. Seven of eleven localities consist of fewer than five occupied trees. This lichen is possibly sensitive to air pollution, making them vulnerable to human activities. Found at a small number of sites (7 localities and 21 occurrences, including Cave Creek), only two localities have a large number of sites and/or occupied trees, and only one of these localities is on Federal lands and afforded some legal protection.

In California the *Suclcaria badia* is found in well-lighted Garry Oak and *Oregon Ash* grassland and riparian communities, and in mature Douglas-fir forests containing a black oak component. Recent discoveries have greatly increased the number of localities and occurrences in California, raising the possibility that this lichen is under-collected or overlooked. It is a sensitive plant in four National Forests in Northern California, however no protections are afforded at present on private property. Most sites are in danger due to pollution and tree removal from human settlement. *Sulcaria badia* has been accepted to the world red-list of lichens with the status "critically endangered."

Didymodon norrisii Zander

The rare moss, *Didymodon norrisii* Zander (Pottiaceae), was found at Crossing 1, on the east-facing sandstone/serpentinite boulder, just below the ford on the west side of the creek. Sheet drainage of water from above is a characteristic habitat feature for this species. It is included by the California Native Plant Society on List 2.2 (List 2 = rare, threatened, or endangered in CA; common elsewhere; a Threat Rank of 0.2 = Fairly Threatened in California).

Didymodon norrisii is restricted to rock substrate with some sheet drainage of water in low to moderate elevations (200-1500 m). Serpentine, calcareous, and volcanic boulders and outcrops in fields, cliffs, and runoff areas are typical habitat for this densely matted moss.

Based on the conservation status of *Didymodon norrisii* and *Sulcaria badia*, any impact to these species should be avoided. Specific recommendations for the protection of sensitive botanical resources are provided in Section 4.2.1.

Based on the results of the botanical study, the installation of crossing structures and improvements will have no impact on rare and endangered vascular plant species and communities in the Cave Creek/Tomki Road study area. These improvements should serve to enhance the integrity of the crossing areas by restoring fluvial processes which in turn will improve native plant establishment.

2.7 Wetlands

A wetlands assessment was conducted separately for the prototype structure at Crossing 1, and was included in the Initial Study and Mitigated Negative Declaration prepared by DOT. It is considered premature at this stage in the planning process to conduct wetland delineations for the remaining options; however, a description of the riparian vegetation within the Study Area is provided in Section 2.5.1. If the County selects a design alternative that requires disturbance of riparian vegetation or other wet areas, appropriate wetland delineation studies should be conducted prior to the project design phase. Wetland studies should be performed in consultation with the U.S. Army Corps of Engineers and the RWQCB's Division responsible for 401 permitting, and should describe the extent and characteristics of the wetlands and provide recommendations for mitigation, and avoidance where possible.

2.8 Aquatic Life and Wildlife

A preliminary wildlife survey was conducted by BioConsultant LLC in August and September 2007. The complete report can be found in Appendix G. A fishery study was not conducted for the Feasibility Study, however a report prepared by Ross Taylor & Associates for DOT in 2003 provides some background on Tomki Road's impacts on fish habitat in Cave Creek along with possible management solutions. This draft report can be found in Appendix H.

2.8.1 Biological Setting

As discussed in Section 2.5.1, Cave Creek contains generally high quality in-stream structure with deep pools, large boulders, and undercut banks with overhanging trees and riparian vegetation. A variable riparian canopy creates open sunny basking sites and cool shady areas under a lacy alder canopy. Well-developed riparian vegetation provides stream bank stability, shade and shadows, food input in the form of leaf and insect fall, and large woody debris that enhance in-stream shelter for aquatic species. The stream substrate is primarily bedrock with large and small cobble, and areas of gravel and pebble. These characteristics and habitat elements coupled with the presence of perennial tributaries produce suitable aquatic habitat for the special-status foothill yellow-legged frog, salmon and steelhead, and common amphibians and reptiles.

Adjacent to the riparian corridor, the upland plant communities contain a diverse mix of mature oaks and conifers that provide a varied source of nesting opportunities for raptors and a rich avifauna. Several tall standing snags support acorn woodpecker granaries and cavities large enough for many different secondary cavity nesters, such as the western screech owl, the marten, and the special-status oak titmouse. Various bats have the potential to utilize these standing snags, as well as trees with exfoliation bark and deformities.

Based upon the habitat assessment and literature review, the following special-status species have the potential to occur within the Study Area: Pacific fisher, Humboldt marten, American badger, Sonoma tree vole, northwestern pond turtle, foothill yellow-legged frog, steelhead, Chinook salmon, northern goshawk, yellow-breasted chat, the yellow warbler, and the northern spotted owl.

Common species observed within the Study Area include rough skinned newts, bluegill fish, many invertebrates, and a rich avian and terrestrial wildlife community. Special status species found include steelhead and foothill yellow-legged frog.

2.8.2 Foothill Yellow-Legged Frog

Preliminary surveys found a population of foothill yellow-legged frog (FYLFs), a California species of special concern. The FYLFs were located in hydrated areas between Crossings 3 and 7 in the main channel of Cave Creek, and along the perennial tributary and its confluence at Crossing 5. A large number of adult FYLFs were concentrated at and around Crossing 5, where the small tributary flows through a culvert under Tomki Road just downstream from the crossing. FYLFs were found at this location above the culvert intake in shaded shallow flows and pools, and at the outlet where flows created a fairly large, deep pool with clear, cool water. At least 4 adults were observed in this pool, which, during high flows, would be part of the main channel of Cave Creek. Several other adults were found in small, shallow (1-3 inches deep), muddy pools adjacent to the crossing. These pools were light chocolate in color due to the continual fine sediment churned up from vehicle passage through the fairly deep water at the crossing.

One adult and at least 3 juvenile FYLFs were found in a very small and shallow stagnant puddle at Crossing 7. This small pool was the only hydrated area for 1.05 miles, from the north end of the Study Area to just downstream of Crossing 6. Details of the foothill yellow-legged frog occurrences are provided in Table 3 below.

Table 3. Occurrence of Foothill Yellow-legged Frogs in the Study Area

Location	Water Source	No. of FYLFs Observed	Description
300’ ± east of #3	Residual water from Cave Creek	1 Juvenile	Isolated pool in Cave Creek. Small juvenile- red-back form, occurring with 4-5 rough skinned newts and trout-like fingerling fish.
300’ ± upstream of #5	Perennial tributary from west	4-5 Adults	Large (10x10ft), deep boulder-lined perennial pool in the main channel of Cave Creek.
≤100’ downstream of #5	Perennial tributary from west	4-5 Adults	Various sized small pools cloudy with sediment occurring within 100 ft downstream of #5.
Tributary at #5	Perennial tributary from west	7 Adults	Shallow, slow flows and pools upstream of culvert and larger (9’ x 5’) clear cool (50˚ F) pool at outlet.
100’ downstream of #6	Perennial tributary from west	1 Individual (age unknown)	Shallow flows and semi-connected pools in main channel of Cave Creek: observed a single splash, but no voice.
At #7	Residual water from Cave Creek	1 Adult 3 Juveniles	Small (4’ x 1.5’) shallow (1-3”) warm and green with algae puddle. Fresh raccoon scat at edge of pool.

Breeding areas are often associated with confluences of tributary streams that are predominantly perennial. The detection of FYLFs in isolated drying pools at the limits of the frog distribution area within the Study Area correlates with the natural history of this species, which requires a persistent water source, and illustrates the importance of seasonal wetted pools. Impacts to FYLFs outside of hydrated areas are unlikely, because unlike most other ranid frogs in California, this species is rarely encountered far from permanent water, even on rainy nights.

The presence of small juveniles indicates that the population successfully bred this year, despite low annual rainfall. Mating and egg-laying occurs in water from mid-March until early June when stream flows have slowed from winter runoff. Clusters of eggs are attached to the downstream side of submerged rocks. Tadpoles require water for at least three or four months while completing their aquatic development and transform in about 15 weeks, from July to September. The current survey did not find any tadpoles; the population had completely metamorphosed into small sized juveniles by late September.

Due to variation in annual rainfall and resultant changes to instream flows and conditions, FYLFs may be found in additional or completely different areas in the future; however, due to the perennial tributaries at Crossings 3 and 5, the continued presence of FYLFs at these crossings is expected.

Options which involve the disturbance of hydrated crossings have the potential to cause direct mortality to foothill yellow-legged frogs and other aquatic wildlife located inside the construction footprint. Project activities also have potential to alter important habitat elements, possibly impacting the foothill yellow-legged frog population following construction. Recommendations for avoiding and mitigating impacts to the foothill yellow-legged frog are provided in Section 4.2.3.

2.8.3 Salmon and Steelhead

Cave Creek, a tributary to the Eel River system, provides critical habitat for North Coast steelhead trout (*Onchorhynchus mykiss*) and Chinook salmon (*Onchorhynchus tshawytschaw*). Both species are currently listed as threatened, pursuant to the federal Endangered Species Act (ESA). The California Department of Fish & Game (CCDFG) stream survey reports document juvenile steelhead and Chinook in Cave Creek.

A preliminary report was prepared by Ross Taylor and Associates in 2003, titled "Tomki Road in Mendocino County – Impacts to Salmonid Habitat and Management Options to Reduce Impacts." The report describes the life history requirements of the two Salmonid species present in Cave Creek; the road's impacts to spawning and rearing habitat; and suggested short- and long-term options for reducing or eliminating these impacts. The report can be found in Appendix H. Since further study of fishery resources was not conducted as part of the Feasibility Study, this section provides information from the Ross Taylor report. It should be noted, however, that during the wildlife survey, BioConsultant observed trout-like fingerling fish that were probably juvenile steelhead in an isolated pool approximately 300 feet east of Crossing 3.

Both Chinook salmon and steelhead are known to utilize Cave Creek for spawning and rearing. Spawning surveys conducted by CCDFG suggest that the numbers of Chinook salmon using Cave Creek in any given year are highly variable and may range from less than 20 fish to several hundred In drought or low-water years, it is possible that no Chinook spawning occurs in Cave Creek. The numbers of adult steelhead spawning in Cave Creek are unknown, yet juveniles are often observed in large numbers in late-spring and early-summer after emergence from the gravel.

Fall run Chinook salmon would most likely be present in Cave Creek between November and January. Redds (nests) are typically constructed in riffles and pool-tails where suitable-sized substrate is located, generally a mix of gravels to small cobbles. These areas also have adequate stream flow for providing oxygen for the developing eggs and a means of flushing metabolic waste products. In Cave Creek, most of the wet fords are located at pool-tails with characteristics conducive to Chinook salmon spawning.

Steelhead, or anadromous coastal rainbow trout, could be present in Cave Creek between January and April, and possibly even as late as May if late-spring storms occurred. Spawning usually occurs in pool tails with cool, clear, well oxygenated water with suitable current velocity, depth and substrate particle-size. Generally summer run steelhead spawn in the upper sections of watersheds, utilizing habitat inaccessible to fall/winter run fish. Steelhead often utilize intermittent stream reaches for spawning purposes. In these streams, the young migrate downstream to reaches that have year-round surface flow.

Both spawning and rearing habitat has been impacted by the ford crossings. Fine sediment fills the spaces between cleaned gravels within completed redds, potentially suffocating the eggs. Sediment-filled pools also decrease the amount of rearing habitat. Most of the fords cross at pool-tails with good spawning habitat and good rearing habitat for newly emerged fry. Redds and fish residing in these locations have a high likelihood of being crushed by vehicles.   Chronic turbidity caused by vehicles crossing the fords may affect the growth and survival of Chinook and steelhead fry through irritation of the gills and reducing feeding efficiency. Adult Chinook salmon are quite conspicuous in Cave Creek and their presence often leads to poachers who have excellent access to spawning fish along Tomki Road.

For a better understanding of the Cave Creek fishery, and for baseline data needed for monitoring purposes, salmon habitat within the Study Area should be assessed and fish counts should be conducted at the seasonally-appropriate time before beginning any alteration of existing stream conditions.

2.8.4 Terrestrial and Avian Wildlife

Although habitat exists for nesting raptors and roosting bats, no evidence of these animals was detected adjacent to the creek crossings or flanking the roadway and creek corridor. No evidence of the characteristic sign of the Sonoma tree vole was detected at any of the Douglas-fir trees associated with the creek crossings.

A search of the California Natural Diversity Database (CNNB) identified a northern spotted owl (owl) occurrence in the upland Douglas fir – Ponderosa Pine community located in the forested upland approximately 100 feet west of Crossing 7. The northern spotted owl is listed as threatened by the U.S. Fish & Wildlife Service (USFWS) and as a species of special concern by CCDFG.   The occurrence was documented in 1995, and it is unknown whether the owl still occupies habitat within the Study Area.

Due to the location of the proposed project alternatives, either within the stream corridor or to the east, direct impacts to potential owl habitat can be avoided by following the recommendations provided in Section 4.2.3. Indirect impacts to owl habitat can also be avoided if construction activities avoid the breeding season (February 15 through July 15) of this species.

Activities with the potential to impact the avifauna community, roosting bats, common terrestrial residents, or any special-status terrestrial species having the potential to occur within the Study Area will require additional study if avoidance is not possible.

2.9 Cultural Resources

An archaeological survey of the Cave Creek corridor was conducted by North Coast Resource Management (NCRM) in October 2007 to identify and record cultural resources in the Study Area and to recommend procedures for avoidance or mitigation of adverse effects to potentially significant resources. The report can be found in Appendix I.

Ethnographic literature indicates that at the time of historic contact, the Study Area was within the territory of both the Northern Pomo and the Huchnom people. According to Barrett (1908) the closest village site was Ha'tupokai. The Huchnom village of "Ha'tupokai, or tadam (Northern Pomo dialect name), was located on the south bank of Tomki Creek.

A records search and literature review for this study were done (1) to determine whether known cultural resources had been recorded within or adjacent to the Study Area and (2) to assess the likelihood of unrecorded cultural resources based on archaeological, ethnographic, and historical documents and literature, and on the environmental setting of nearby sites. The review found no cultural resources within the Study Area listed in these inventories. The records search indicated that the property has never been surveyed for cultural resources. No cultural resources are recorded within or immediately surrounding the project area.

The State of California Native American Heritage Commission (NAHC) indicated there were no known cultural sites in the project area and provided a list of individuals and organizations that may have knowledge of cultural resources within the area. Of the 9 individuals/groups identified by the NAHC, one response was received from the Potter Valley Tribe of Pomo Indians stating they had no specific knowledge of archaeological sites in the project area but that they recognize all of Mendocino County as culturally sensitive and request to be notified if cultural resources are identified in the project area.

In October, 2007, concentrated areas within the Study Area were surveyed for cultural resources. The survey included a field inspection of approximately 50-meter radius around each of the nine stream crossings. No cultural, historical, or archaeological resources were observed within the identified survey areas.

3.0 Alternatives Analysis

The alternatives chosen for inclusion in the Feasibility Study were selected based on recommendations provided by DOT, RWQCB, CDFG, Ross Taylor, and the landowners and residents of Tomki Road who participated in a community meeting held in 2002. The list of alternatives considered in this report includes:

1. Upgrade the south ford (Crossing 1) with a proto type design for a vented low water crossing. This structure would be designed to pass flow volumes up to and including the 10-year storm event, while higher flows would overtop the structure. (This structure has already been analyzed by DOT and is currently awaiting permits for construction at Crossing 1. Option 1 is included in the Feasibility Study as a reference structure for Option 2.)
2. Upgrade Crossings 2-9 with alternative designs such as the prototype vented, low water structure designed by DOT for Crossing 1.
3. Install conventional road crossing structures at the remaining 8 fords, such as bridges or arch culverts typically designed to pass 100-year flows.
4. Completely relocate the road to a ridge or mid-slope position
5. Partially relocate the road to avoid the use of some fords
6. Seasonal closure of the road
7. Road abandonment by the County

3.1 Methods

Evaluation of the alternatives was based on a number of considerations, including:

- Ability to meet the goals and objectives of the Study;
- The findings of the preliminary geotechnical, botanical, wildlife, and cultural resources reports;
- Document review, including DOT files, agency correspondence, and environmental documents and permits for Crossing 1;
- Recommendations provided in CDFG's California Salmonid Stream Habitat Restoration Manual;
- Discussions and site visits with staff from RWQCB, CDFG and DOT; and
- Landowner surveys and discussions

Surveys were distributed to the landowners within the Study Area and the Cave Creek subdivision south of the Study Area, in which residents were asked about their use of the road and their preferences for improving the road. Background information was included with the survey form to provide a basic understanding of the history of the problem, as well as the proposed options being considered in the

Feasibility Study. Completed surveys were received from 4 of the 6 landowners within the Study Area and from 14 landowners in the surrounding area. Information provided by the surveys is included in the alternatives analysis.

Each of the alternatives are analyzed based on geologic constraints, issues identified by RWQCB and CDFG, concerns raised by local residents, road user issues, effectiveness in reducing pollutant delivery, ability to secure necessary permits and funding, ability to meet fish passage goals, minimizing right-of-way acquisition, maintaining emergency access, and minimizing implementation costs. A summary table comparing the alternatives is provided at the end of this section.

Three culvert design options are presented in the California Salmonid Stream Habitat Restoration Manual to meet fish passage goals in accordance with CDFG. The three design options include (1) Stream Simulation Design, (2) Active Channel Design, and (3) Hydraulic Design.

A summary of the criteria for the CDFG design options are as follows:

- The Stream Simulation Design requires that the culvert width be equal to the channel width from top of bank to top of bank, but not less than 6 feet. The culvert slope should approximate the slope of the stream and the culvert must be buried.

- The Active Channel Design requires that the culvert width be 1.5 times the active channel (typical low-flow channel) width. A closed bottom culvert must have no slope and be buried. Open bottom culverts may maintain a slope consistent with the slope of the channel, on a case by case basis. The maximum length of the culvert is 100 feet and the channel slope should be less than 3%.

- The Hydraulic Design is based on the hydraulics of the culvert and requires detailed flow velocity and depth calculations to meet fish passage requirements, based on the target fish species within the stream. The Hydraulic Design is not the preferred CDFG method as it does not account for the habitat requirements of non-target species.

- The Stream Simulation and Active Channel Designs are considered to meet fish passage requirements if the specified design criteria are met, and therefore do not require the detailed fish passage (flow/depth) analysis as required with the Hydraulic Design.

- All three designs require that the headwater depths do not exceed the top of the culvert inlet for the 10-year peak storm event and shall not be greater than 50 percent of the culvert height or diameter above the top of the culvert inlet for the 100-year storm event.

A detailed summary of the design option criteria are included in the reference manual as noted in the reference section of this report.

Based on the widths of the streams it was determined that the Stream Simulation Design was not appropriate, as the top of bank widths are wide at the crossing sites. The Hydraulic Design option was not selected as it would not account for non-target species habitats, and is the least preferred option by CDFG. The Active Channel design was selected for the purposes of this study. The active channel width (typical low flow width) was determined from field observations for each crossing and was confirmed with CDFG personnel in the field.

Closed bottom culverts were not included in this study as a potential structure type due to habitat concerns, CDFG recommendations, site conditions, and the general movement away from closed bottom culverts in streams containing anadromous fish.

3.2 Detailed Assessment of Alternatives

The following sections provide a detailed assessment of each of the alternatives considered for the Feasibility Study.

3.2.1 Option 1. Upgrade Crossing 1 with a Prototype Crossing Structure

MDOT has designed a low water crossing to replace the southerly ford at MP 6.17 with a 20’ wide x 4’ high x 60’ long pre-manufactured bottomless concrete arch structure to accommodate the 10-year, or 10% probability storm event without overtopping, and pass the 100-year storm event, 1% probability of occurrence, without structural damage. Flow volumes greater than those encountered in a 10-year event would overtop the structure, requiring closure of the road only during extreme high flow events. The structure has been designed to allow anadromous fish passage at all life stages and to pass stream bed material using natural streambed geomorphology.

Construction of the prototype structure at Crossing 1 will involve excavation for two strip footings located at the approximate limits of the bankfull channel and set below the anticipated scour depth. The location of the structure is at the existing ford which is seriously impacted due to vehicle traffic. When the footings have cured, the structure components will be lowered into place with a crane. The structure will be water proofed and grouted, then backfilled with material from the footing excavation, supplemented with import material to achieve the desired finished road grade. The roadway will be protected with concrete to prevent erosion during high flow events. Structure embankments will be protected with grouted rip-rap. The stream channel within the immediate area will also be reconfigured to conform with the anticipated stable channel grade and bank full dimensions. Upstream and down stream segments will further be protected against erosion pursuant to Regional General Conditions for NWP 13 - Bank Stabilization and NWP 14 - Linear Transportation Projects. The existing road above the crossing will need to be realigned for approximately 200 feet in order to reduce skew for hydraulic considerations, to create a higher road elevation for structural and hydraulic considerations, and to meet minimum road width and turning radii requirements. All disturbed areas will have erosion control Best Management Practices (BMPs) applied prior to the winter period.

An initial study and mitigated negative declaration was approved by the County on March 11, 2008 for the prototype structure at Crossing 1. Funding for this project has been obtained through the Proposition 40 Integrated Watershed Management Plan (IWMP) from the 2005 – 2006 Consolidated Grants Program, under the same contract as the Feasibility Study. Due to permitting delays, construction is scheduled for summer 2009. Implementation of the prototype design at the remaining 8 fords is considered under Option 2. Drawings of the prototype structure are provided in Appendix J.

3.2.2 **Option 2.** Upgrade Crossings 2-9 with Low Water Structures

The design developed by MDOT for Crossing 1 (vented low water crossing), or similar low flow, open-bottom culverts, were found to be viable options for most of the creek crossings. At Crossings 1 through 8, bedrock was encountered in each test pit near, or slightly below, channel bottom. The bedrock is suitable for support of typical strip footing for structure foundations. In general, it is expected that a 20-28 foot span width will meet hydraulic and fish passage requirements. Some minor approach realignment may be necessary at some crossings to reduce high skew and reduce overall structure dimensions.

Two different culverts were considered for use: (1) a concrete long-span culvert that requires only 0.8' of cover if necessary and (2) a corrugated metal pipe (CMP) that requires a minimum of 2' of cover. The concrete culvert is roughly 10% more expensive than the corrugated culvert, but will allow for the dip in the roadway to constrain the overflow during large storm events, provide for increased protection should the fill wash away on the surface during high storm events and will have a longer life span. For these reasons the concrete culverts were considered the preferred option for all culverts analyzed in this study, including the low flow culverts analyzed under Option 2. A cost savings of 10% did not justify the use of corrugated metal culverts when weighing the benefits of the concrete culverts. A typical vented low water crossing is shown in Appendix J, and in Appendix K, Sheet 3, at Crossing 2.

In order for the low flow structures to be considered a viable option, the following engineering and fish passage criteria must be met:

- Structures must meet the CDFG "active channel" design criteria discussed in Section 3.1;
- Structures must pass 100-year storm flows without significant overtopping during a 100-year flow. Overtopping of 1.0 feet or less is acceptable for the purposes of this study;
- Flows over the road must be constrained to limit overtopping to a confined area so that damage to the roadway and channel are minimized during high flow events. An acceptable confined width was considered to be 80' for the purposes of this study;
- Minimum 0.8 feet over the structure shall be maintained;
- Drainage structures should meet the MDOT drainage criteria as outlined in the Road and Development Standards, to the extent feasible;
- To the extent feasible, roadway improvements should be constructed within the existing right-of-way.

A detailed hydraulic analysis was conducted on Crossings 2, 5, 8 and 9 using the HEC-RAS hydraulic modeling program. The analysis was based on the County prototype designed for Crossing 1, using mid- and long-span culverts that are commercially available. The sizes of the structures for Crossings 3, 4 and 7 were extrapolated based on the results of the HEC-RAS analysis.

The results of the HEC-RAS modeling for the crossings confirmed that the low-flow vented crossings can meet the above criteria. The HEC-RAS computations and cross-sections are included in Appendix E. Recommended structure sizes and estimated costs are provided in Table 4 of the following section.

With the exception of Crossing 5, the resulting stream flow velocities upstream of the structures were reduced and the stream flow velocities downstream of the structures remained relatively the same following installation of the prototype structure. The HEC-RAS results showed that a low water structure installed at Crossing 5 would increase stream flow velocities downstream of the structure. If this option is chosen for Crossing 5, it is recommended that a detailed stability analysis be performed to ensure that the higher stream flow velocity is acceptable and will not cause scour or otherwise destabilize the channel.

The HEC-RAS analysis indicate that there may be hydraulic jumps which occur under existing high stream flow conditions near the crossing sites. At Crossing 8, the hydraulic jump moved to the culvert outlet when the structure was installed. This result occurred for both the low-flow and the conventionally designed culvert options. Increasing the culvert size did not change this condition. It is possible that the hydraulic jumps may be a result of discrepancies in the survey data obtained and entered into the HEC-RAS program, as the data used was a combination of ground (at the culvert site) and aerial (outside the culvert site) surveys. Given the reconnaissance level of the feasibility study, a detailed, pre-design level ground survey along the channel was not conducted. When a design option is selected, a detailed ground survey will be performed upstream and downstream of the crossing sites to prepare the final design plans. At that time it is recommended that an expanded survey and hydraulic analysis be performed to confirm whether this condition actually exists. A hydraulic jump occurring at the culvert inlet or outlet may require design modifications to the channel and/or the structure to ensure channel stability.

A cost comparison of the different structural options can be found in Table 3 in the following section (3.2.3). In general, the costs for Option 2 are 4-21% less than for a conventional culvert (Option 3A), depending on the crossing. Option 2 costs less than a modular bridge (Option 3B) at Crossings 2, 3, 4, 6 and 8; however a bridge is less expensive than a low water culvert at Crossings 5, 7 and 9. For Crossings 2 and 3, the low flow vented option is the least expensive and meets the CDFG criteria.

The prototype low water structures are expected to significantly reduce sediment and vehicle-related pollutant input into Cave Creek by removing the road bed from the stream channel. The exception would be during > 10-year storm events when flows would overtop the structures and spread across the crossing approaches and adjacent roadway. Option 2 will eliminate direct fish mortality from crossing vehicles.

The only geological constraints for the low water structures would be at Crossing 9, where, due to the width of the channel and depth to bedrock, a bridge is recommended. A bridge is also recommended for Crossing 5, where Foothill Yellow-legged frogs were found in pools at the crossing. There are no known botanical or archaeological constraints to implementing this option at any of the crossings.

CDFG approved the prototype structure at Crossing 1, however CDFG staff have informally commented that they are more likely to scrutinize a low water structure than a structure designed to pass 100-year flows. This is primarily due to concerns regarding downstream scour which could impact fish habitat. If this option is chosen, CDFG may require evidence that the structures would not create scour downstream of the structure.

4 of the 16 landowner surveyed indicated that Option 2 would be their first choice. This option received the highest number of votes (7) as a second choice.

3.2.3 **Option 3.** Upgrade Crossings 2-9 with Conventional Structures

Option 3 involves the installation of conventional road crossing structures at all fords, such as bridges or open bottom culverts typically designed to pass 100-year flows. Two options were considered: (1) a mid- or long-span open bottom (arch) culvert and (2) a modular bridge.

Both structure types were designed to meet all criteria listed under Option 2 except that the structures in Option 3 will not allow overtopping during the 100-year storm event. The DOT drainage criteria recommends that the design flow for a crossing have a minimum 1' clearance to the soffit of the pipe or bridge. Given the constraining topography in the area (narrow canyon), the widening or raising of culvert structures to meet these criteria was considered to be extremely difficult. Instead a minimum 1' freeboard criterion was used between the top of the road surface and the water surface. In considering the bridge option, the 1.5' clearance to the soffit could be met to prevent blockage that could potentially undermine the bridge.

The HEC-RAS study first modeled the low-flow vented culvert, Option 2, and then raised or increased the size of the structure for Option 3 using the 1.0 freeboard criteria from the top of the road. Due to budgetary constraints the bridges were not modeled in HEC-RAS; however, it is reasonable to assume that flows would mimic existing channel flows and would be less likely to have any detrimental affects on velocity or channel stability than the other structural options. The water surface elevations obtained from modeling of culvert structures were used in the presentation drawings but are expected to be 1-2' less than shown. Although flows are not calculated for the bridges, it is reasonable to assume that these structures would have less of an impact on the depth, and velocity of the channel flows and the flow regime than either of the two culvert options. A typical modular bridge crossing is shown in Appendix K, Sheet 5, at Crossing 9.

<u>Arch Culvert Option (Option 3A).</u> As discussed under Option 2, a concrete long-span culvert was found to be preferable to a corrugated culvert due to the longer life span and a minimal (10%) increase in cost compared to the benefits. Table 3 shows the culvert sizes that would need to be used for each of the crossings. The culvert heights shown in Table 4 do not include footing depths. Heights shown are based on the bottom of the manufactured culvert extending 1' below existing grade. Refer to the project plans and geotechnical report for details regarding potential footing depths. A typical conventionally-sized long-span culvert crossing, used in Option 3A, is shown Appendix K, Sheet 4, at Crossing 8.

<u>Bridge Option (Option 3B)</u>. Modular bridges were considered as an alternative to the concrete long-span culverts. Modular bridges are typically constructed of steel and have steel upright abutments with railings attached to the outside edges of the structure. Typical strip footings can also be used. These structures will require wing walls and railings at the ends of the structures. A modular bridge with a

span no longer than approximately 70' will not require center piers or significantly increase the cost due to an exponential increase in steel beam weight required for longer spans.

For these reasons, the bridge analysis uses 70-foot spans and 26' wide decks. The entire 70-foot span was used on all but one crossing to minimize fill volumes and reduce environmental impacts. Crossing 3 is a smaller tributary channel which requires only a 40-foot span. In order to reduce impacts to Foothill Yellow Legged Frogs at Crossing 5, a bridge is recommended. Bridges at Crossings 4 and 7 may require road realignment or a reduction in span length to accommodate the 26-foot width. Minor roadway re-alignment will be necessary at all crossing approaches to reduce the length of the wingwalls, reduce the amount of fill placed in the channel, and to balance the earthwork cut and fill to the extent possible due to the raising of the roadway elevation.

The estimated costs for the different structure types, including the low water prototype (Option 2), the conventionally-sized arch culvert (Option 3A), and the modular bridge (Option 3B), are provided in Table 4. Option 3A is less expensive than Option 3B at Crossings 2, 3 and 8; Option 3B is less expensive than Option 3A at Crossings 4, 5, 6, 7 and 9. At Crossing 9, the footing would be constructed on pilings which would be utilized to construct steel end abutments, which are less expensive than standard concrete abutments. Additional costs for fill and guardrail will be necessary with the bridges, but would not be expected to increase the costs to the extent that it would exceed the cost of a culvert. The maximum feasible bridge length for a modular bridge was used in order to minimize channel impacts and promote fish passage. The longer bridge length will also reduce the height of the structure due to the additional stream channel capacity provided.

Both Options 3A and 3B will significantly reduce sediment and vehicle-related pollutant loads into Cave Creek by removing the roadway from the stream channel. Both structure types in Option 3 will pass 100-year flows without overtopping of the structure, further reducing sediment delivery during large storm events. Option 3 will eliminate direct fish mortality from crossing vehicles.

A bridge (Option 3B) is more feasible at Crossing 9 than a culvert (Option 3A) due to channel width and geometry. A bridge is also recommended instead of a culvert for Crossing 5, where Foothill Yellow-legged frogs were found in pools at the crossing. There are no known botanical or archaeological constraints to implementing this option at any of the crossings.

CDFG generally prefers bridges to culverts for many reasons. Bridges typically cause less disturbance in the active channel, are less likely to cause damage to existing habitat, reduce the potential for changing stream hydraulics, require less maintenance, and have less potential for plugging and scouring. CDFG and RWQCB staff have both commented that they would like to see bridges, even where they are not feasible, seriously considered in this study.

9 out of the 16 landowner surveys selected Option 3 as their first choice. The survey did not differentiate between culverts and bridges, so there is no data regarding road user preferences between Options 3A and 3B.

Table 4. Comparison of Crossing Structures

Crossing	Options					
	#2 Low-Flow Vented Prototype		#3A Conventional Arch Culvert		#3B Modular Bridge	
	Structure Size	Estimated Cost	Structure Size	Estimated Cost	Structure Size	Estimated Cost
Crossing 2	24' x 7' x 64'	$442,200	24' x 8' x 64'	$465,400	26' x 70'	$548,000
Crossing 3	16' x 5' x 48'	$234,100	16' x 6' x 48'	$243,700	26' x 40'	$333,000
Crossing 4	24' x 8' x 72'	$506,500	24' x 9' x 72'	$561,600	26' x 70'	$548,000
Crossing 5	24' x 9' x 92'	$621,600	28' x 10' x 92'	$825,000	26' x 70'	$548,000
Crossing 6	24' x 10' x 56'	$463,700	28' x 9' x 56'	$589,600	26' x 70'	$548,000
Crossing 7	28' x 7' x 64'	$560,900	28' x 10' x 64'	$668,500	26' x 70'	$548,000
Crossing 8	28' x 8' x 40'	$402,100	28' x 10' x 40'	$446,900	26' x 70'	$548,000
Crossing 9	32' x 9' x 56'	$690,000	32' x 10' x 56'	$725,800	26' x 70'	$468,000
TOTAL COST		**$3,921,100**		**$4,526,500**		**$4,089,000**

3.2.4 **Option 4.** Total Road Relocation to a Ridge or Mid-Slope Position

Two possibilities were considered for alternate alignments that would bypass the fords. The first was to utilize an existing private road located east of the existing alignment, following the easterly ridge (ridgetop option). The second was to develop a new road, also to the east, along the slope between the existing alignment and the private ridgetop road (mid-slope option).

A private dirt road currently exists along the easterly ridge, effectively connecting the north and south ends of the Study Area. The road is accessed from Tomki Road at the south end of the Study Area between Crossings 1 and 2, heads due east to the top of the ridge where it follows the ridge in a northwesterly direction. The road terminates at a private road, accessed from Tomki Road north of Crossing 9. A shared access easement allows the use of this road by the private landowners whose properties encompass the easterly ridge. Given that a road currently exists on a conceivably stable ridgetop, this option was considered as potential alignment option to bypass Crossings 2-9.

The viability of these options is primarily dependent on slope stability in the area of the proposed road alignments. Because the realignment options cross private property, new rights-of-way would need to be acquired from at least four landowners. The ridgetop road option was suggested in 2002 by previous landowners who owned property along the ridge, and it was therefore assumed that there would be cooperation from landowners to relocate the road to the ridgetop alignment and acquire the necessary rights-of-way.

Based on the findings of the preliminary geotechnical assessment, it was determined that the options to realign Tomki Road within the original ½-mile wide corridor between Cave Creek and the ridge to the east would require considerable slope stabilization effort to support a permanent road. This would include extensive measures in areas of deeper, active landslides. These efforts would likely include combinations of slope buttressing, grading, deep subdrainage (e.g., horizontal drains and toe drains/trenches), flexible gravity and/or anchored wall systems, surface drainage systems and erosion control measures. Due to the difficult construction through slide terrain, realignment options were determined to be less desirable than upgrading the existing road, which has performed generally well.

It was also discovered that many of the parcels within the Study Area had transferred ownership since the 2002 community meeting in which alternate alignments were positively received by local landowners. Current landowners responded strongly against the proposed road realignments, as did the vast majority of residents within the Cave Creek subdivision. New and proposed residential and agricultural development along the ridge could also prove to be problematic with the ridgetop alignment option.

Following discussions with DOT regarding the geotechnical constraints and construction difficulties of the alternative alignments, coupled with a lack of landowner cooperation and support, it was decided that this option lacked feasibility and no further study of this option would be conducted.

3.2.5 **Option 5.** Partial Road Relocation to Avoid the Use of Some Fords

With the knowledge that the easterly slope is constrained by unstable terrain, we considered options that could potentially bypass one or more fords closer to the existing alignment. Initially, the most feasible options included (1) an old, abandoned road segment located on the west side of the existing alignment between Crossings 4 and 6 that had been washed out by landslide activity and (2) construction of a road segment on the east side of the existing alignment that would potentially bypass Crossings 8 and 9.

For the same reasons described under Option 4, for the mid-slope road alignment, the partial road relocation options were similarly constrained. Upon field investigation of the old roadbed to the west it was discovered that the road was washed out entirely in several locations, and slopes were too steep and unstable to feasibly rebuild the road. We were unable to identify a stable area on the east side of the existing alignment that would allow for development of bypass around any of the crossings, including Crossings 8 and 9. Based on the lack of stable terrain for constructing an alternate road segment, this option was deemed infeasible and no further study was conducted.

3.2.6 **Option 6.** Seasonal Road Closure

The seasonal road closure option consists of closing Tomki Road between Crossings 1 and 9 to vehicular traffic when fish are present in Cave Creek. Determining when to close the road would be decided by DOT on an annual basis depending on when the rainy season begins in the fall. The road would be opened either when fry are absent in the spring or when the creek goes sub-surface. Locked gates would be installed at either ends of the closed road segment, and gate keys or combination would be provided to emergency service providers, such as CalFire and the County Sheriff, as well as landowners who must access their property through the closed section of Tomki Road.

The benefits of seasonal road closure include a reduction in impacts to fish from crossing vehicles; a reduction in sediment, oil, brake dust, and other pollutants into Cave Creek during the closed period; a reduction in off-road vehicle damage to adjacent lands which contributes sediment to the creek; and a reduction in illegal dumping and poaching resulting from trespassing. The reduction in pollutant delivery from this option would not be as great as the removal of the roadway from the stream channel, as provided in Options 2 and 3.

Responses to this option were mixed from local landowners, with strong feelings on either side. Some landowners favored this option, commenting that it would increase privacy and reduce nuisance activities associated with more frequent road usage. Landowners within the Study Area are routinely burdened with having to clean up abuses to their land - including damage to private roads and driveways, burn piles, garbage dumping, destruction of fences and gates and other forms of vandalism, removal of boulders, abandoned vehicles - which are pervasive despite landowners' considerable efforts to prevent them from occurring.

Landowners at the north and south gateways to the Study Area were particularly supportive of options that would limit access; however, at least one landowner relies entirely on Tomki Road to access her property, and she has expressed stringent concerns with all options that would limit this access.

Of primary concern with the seasonal road closure option is emergency access, both into and out of, this remote region of the County. Locked gates can be inconvenient for emergency service providers and may cause delays. One landowner commented that he had been land-locked on two occasions due to landslides, and that Tomki Road must remain open year round for emergency access. The majority of survey respondents held the same opinion.

Highway 101 between Redwood Valley and Willits is almost continually under construction due to unstable terrain, and landslides are common occurrences during intense winter storms. If Highway 101 is closed, Tomki Road is the nearest alternate route. If Tomki Road is closed, the nearest detour route would be Highway 20 to the coast and back to Highway 101 via Highway 128 and Highway 253, adding over 2 hours to the detour delay.

It is probable that the gates at Tomki Road would be vandalized during the closed period so that vehicles could pass. Off-road vehicles might also attempt to get around the gates, resulting in damage to road shoulders, slopes or embankments. Proper site selection of the gates and strict enforcement would need to occur in order for this option to be successful in keeping vehicles out of the area during the wet period.

DOT estimates that the cost to install and maintain gates at the north and south ends of the Study Area for seasonal closure would be approximately $3,000 to purchase and install two gates and $2,000 per year for maintenance.

3.2.7 **Option 7.** Road Abandonment

Road abandonment would require the County to officially vacate the road, releasing all responsibility and maintenance duties associated with the road, including responsibilities to the RWQCB and other resource agencies to address the existing water quality issues. Upon road vacation by the County, Tomki Road would become a private road and these responsibilities would be transferred to private landowners. Public access to property currently provided by Tomki Road would be eliminated, requiring that access easements across private property be developed to avoid some properties from becoming land locked. Road abandonment must be initiated by the public by submitting a completed road vacation petition.

Road abandonment was considered unacceptable by all but two of the survey respondents, citing the need for emergency access and public funds for road maintenance and habitat improvement. One long-time landowner commented that regardless of the studies and intentions of the County and other public agencies, the land degradation in this area is worse than ever. Having witnessed the “thick chocolate milk shake” of Cave Creek high water flows, rampant trashing and illegal off-road vehicle activity, he feels the only way to repair the damage is to close the road. The few landowners who make their permanent residence within the Study Area are the most directly impacted by the illegal and damaging activities occurring within the area, and understandably prefer to reduce vehicle traffic to the extent possible. Those living outside of the Study Area are not directly burdened with these illegal activities, and fear closure of the road for public use would create a hazardous condition by eliminating this emergency access.

The estimated cost to officially vacate the road is approximately $9,400, which covers County staff costs for the processing of a road vacation petition.

3.3 Comparison of Alternatives

Following a preliminary analysis of each alternative, Options 2, 3A, 3B, 6 and 7 were selected as the only viable alternatives with the potential to meet the needs and goals of DOT, resource agencies, and users of Tomki Road. Option 1 was not included in the assessment since it is has already been analyzed by DOT. Options 4 and 5 were eliminated from further assessment due to geologic constraints which would create significant construction challenges and possibly create new sources of sediment that could be delivered to Cave Creek.

Table 5 below identifies a list of 9 considerations used for determining the recommended option. The five options have been ranked from 1 to 5, with 1 being the highest, or best, score. Some options received tying scores for certain goals. Each option has been scored based on these 9 items, and the scores totaled. The option with the lowest score is considered to best meet the identified goals of the Feasibility Study. This grossly simplified rating system should be used as a cursory review tool only. The sections of this report that analyze each of the options in detail should be consulted to understand how well each option meets the goals of the Study.

Table 5. Ranking Matrix of Alternatives

PRIMARY GOALS	OPTIONS				
	2	3A	3B	6	7
	Prototype Structure	Conventional Arch Culvert	Modular Bridge	Seasonal Road Closure	Road Abandonment
Reduces sediment delivery to creek	3	2	1	4	?
Reduces vehicle-related pollutant input to creek	2	1	1	3	?
Allows for or improves fish passage	3	2	1	4	?
Improves road safety conditions	2	1	1	3	?
Implementation costs	3	5	4	2	1
Need for right-of-way acquisition/negotiation	1	1	1	1	5
Road open to year-round access	2	1	1	3	?
Complexity of permitting	4	3	2	1	5
Funding ability	3	2	1	4	5
SCORE	23	18	13	25	?

Option 3B, installation of modular bridges, has the lowest, or best score of the 5 options, and is able to meet all of the goals of the Feasibility Study with the exception of cost. When comparing the costs for this option with the other structural options, however, the cost differential is not significant. This simplified scoring system does not take into account the possibility of installing different types of structures at different crossings, so when considering the costs of the structural options, Table 4 should be consulted for a better understanding of the costs associated with improvements at each crossing.

Option 3A, conventional arch culverts designed to pass 100-year flows, rated 2nd of the 5 options. This option scored second to the bridge option with regard to sediment delivery due to an increased disturbance footprint resulting from earthwork associated with culvert installation. Even when treated with erosion and sediment control measures, the disturbed areas will be more prone to erosion until the site stabilizes. Fish passage will likely not be impacted by Option 3A due to culvert sizing, however , in general, installation of a confined pipe within a stream has greater potential for impacts to the channel than a bridge.

Option 2, the installation of vented, low water prototype crossings designed to pass the 10-year event, scored 3rd, due primarily to the impacts of infrequent >10-year events when the structures would be overtopped by stream flows. The cost savings for Option 2 over Options 3A and 3B were not considered significant enough to justify construction of these smaller structures.

Options 2, 3A and 3B have the added benefit of disconnecting the road from the creek so that vehicles cannot cross the stream bed.

Option 6 scored 4th, and should be considered a temporary solution if the installation of crossing structures is delayed. Because this option does not disconnect Tomki Road from the creek, it is not recommended as a permanent, long-term solution.

Option 7 is difficult to compare with the other options due to many unknown variables that are dependent on how landowners would choose to treat the road if it were to be vacated by the County. If the road became private, landowners may choose to close the road and install gates at property boundaries. This would require diligent maintenance by landowners and possibly frequent repair due to vandalism. Landowners that use Tomki Road to access their properties within the Study Area may have differing ideas on how to address the road and water quality issues. Without County control over the road, the responsibility for addressing agency concerns and the existing water quality violations will be transferred to landowners. The costs for improving the crossings is high, and the potential for securing funding for a private project is more difficult than for a public project. For these reasons, road abandonment is considered to have the least ability to improve existing water quality and stream habitat conditions and to meet the goals of the Feasibility Study.

4.0 Recommendations

4.1 Recommended Option

Based on the findings of the Feasibility Study, a combination of Options 3A and 3B will best meet the goals identified by DOT, resource agencies and the users of Tomki Road. Conventional arch culverts designed to pass 100-year flows are recommended for Crossings 2 and 3. Modular bridges are recommended for Crossings 4 through 9.

Bridges are generally the preferred solution at stream crossings for a variety of reasons. The construction of a bridge allows for the avoidance or minimization of disturbance to the stream bed and bank, which in turn reduces impacts to instream aquatic habitat, riparian vegetation and habitat, bank stability, stream hydraulics, and fish passage. However, due to the typically higher cost of bridges, culverts are often selected as the structure of choice. Cost estimates for the installation of culverts vs. bridges at the 8 remaining fords found modular bridges to actually be less costly due to existing road and channel conditions, such as steep approaches often coupled with wide channels, which would require a significant amount of fill for culvert installation. Bridge installation will require considerably less earthwork, reducing installation costs such that the bridge option at most crossings is less expensive than culvert installation. An estimate of probable cost for the recommended option is provided in Table 6 below.

In comparing costs at each of the 8 crossings (see Table 4), a modular bridge is less expensive than a conventional arch culvert at Crossings 4, 5, 6, 7 and 9. Although the cost of bridge installation at Crossing 8 is more expensive than a culvert, a bridge is recommended due to the close proximity of the bridge structure at Crossing 9 downstream. Bridges at both Crossings 8 and 9 are expected to reduce flow velocities on this reach and minimize potential impacts to the channel.

The site conditions at Crossings 2 and 3 are less challenging, requiring less earthwork and site disturbance to install crossing structures. The ford at Crossing 3 crosses a small tributary to Cave Creek and will require a much smaller structure than the other seven fords. The lower cost for culverts at these crossings reflects these less challenging conditions. Culverts are therefore the recommended option for Crossings 2 and 3. Using the low water prototype structure at these two crossings does not save enough money to justify their use, and are therefore not recommended.

If the construction of crossing structures is significantly delayed, we recommend installing locking articulated concrete blocks as described in Section 4.4 in order to reduce erosion at the ford approaches until the culverts and bridges can be constructed. Another temporary measure would be to seasonally close the road to reduce the number of vehicles crossing the creek during the wet period when the most damage can be done.

Table 6. Opinion of Probable Cost for Recommended Option

Site	Structure Dimensions	Recommended Option	Estimated Structure Cost	Estimated Non-Structure Cost	Total Estimated Cost
Crossing 2	24’x8’x64’	3A	$450,100	$132,000	$582,100
Crossing 3	16’x6’x48’	3A	$243,700	$113,000	$356,700
Crossing 4	26’ x 70’	3B	$535,000	$132,000	$667,000
Crossing 5	26’ x 70’	3B	$535,000	$132,000	$667,000
Crossing 6	26’ x 70’	3B	$535,000	$132,000	$667,000
Crossing 7	26’ x 70’	3B	$535,000	$154,000	$689,000
Crossing 8	26’ x 70’	3B	$535,000	$154,000	$689,000
Crossing 9	26’ x 70’	3B	$468,000	$189,000	$657,000
			$3,836,800	**$1,138,000**	**$4,974,800**

4.2 Soils and Geological Considerations

At Crossing 9, the creek channel widens considerably and the depth of channel deposits exceeds 9.5 ft in places. Construction of typical strip footings in rock will be difficult, depending on the location, and may encounter course-grained, saturated sediments subject to caving. Pile support may be required for structure foundations at this crossing. This location will require further study to address channel configuration, hydraulic requirements, fish passage and other issues. Realigning the road about 150 feet downstream may be feasible, although new cut into the existing right (east) bank will require further study, as this slope appears to be near the base of an old slide.

Alternatives to an open bottom culvert can include a prefabricated, steel plate girder bridge or a single-span, flat-slab concrete bridge. Support for shallow, spread footing foundations appears available for structure abutments at Crossings 1 through 8; Crossing 9 may require pile foundations depending on the structure location.

Between the creek crossings, the existing road alignment appears generally stable and suitable for continued use. Some culvert crossings, on the small tributaries entering Cave Creek, have created deep scour holes at the outlets, and will require backfilling (e.g., with large rock) to protect the road. About 2000 feet north of Crossing 1, the road grade rises abruptly and is separated from the creek by a very steep (about ½H:1V), 30 ft high bank; this area may require protection from future bank erosion.

The following recommendations should be considered when selecting and designing structures for each of the crossings.

Crossings 2 through 8

At these sites, it is estimated that footings at least 3 feet wide and established at least 2 feet into the rock unit can be assigned preliminary allowable bearing capacity of about 3 tsf (tons per square foot), net at groundline. Based on preliminary exploration, rock excavation is locally difficult but appears generally achievable with air tools without blasting. The rock surfaces likely vary along footing lines.

For preliminary design, use a coefficient of friction to resist sliding of 0.40 between the footing and weathered rock, and passive pressures in the rock unit of 500 pcf (equivalent fluid weight). Dowels may be suitable to establish a positive connection between the footing and rock (e.g., staggered row of 8 bars grouted in drilled holes extending 5±feet into rock), for additional security against sliding if necessary or if hard rock precludes reasonable rock excavation.

Assuming dry season (low flow) construction, it is anticipated that de-watering will be achievable by means of diking/diversion of surface water and sump pumping.

Crossing 9

At Crossing 9, bedrock may be as deep as 15-20 feet in some places. Foundation support may require driven piles, such as steel H-pile sections. Cast-in-drilled-hole piles may be feasible, but would likely require rock coring and casing through the surficial unconsolidated soils. Large-diameter cassions (e.g., 30-36 inch diameter designed as end-bearing piers on rock) might be feasible, but are likely more costly than H-piles.

Further Study

Additional geotechnical study is necessary for final structure design at the individual creek crossings. The final support locations will depend on factors such as channel hydraulics, fish passage requirements, alignment/skew, and profile grades. At Crossings 1 through 8, additional test pits can establish base of footing elevations and depth for scour security. At Crossing 9, test borings may be necessary to establish the soil/rock profile and foundation criteria for driven piles, if needed. Specific road realignment segments must be evaluated, especially where new cuts may impact slopes with old or active landslides. Naturally occurring asbestos (NOA) may be present at locations where serpentine is exposed, and should be further evaluated during project design.

4.3 Structural Recommendations

Crossings 2 and 3

The low-flow vented crossings (Option 2) are feasible at all crossings, will meet the CDFG standard and will reduce the sediment delivery. However, from discussions with CDFG personnel, it was apparent that the comfort level with crossings that would overtop the roadway was low. Based on these discussions and also in considering the increased liability for both safety and potential contamination due to direct contact with creek flows during high flood events, it recommended that crossings 2 and 3 be able to pass the 100-year flood event using a long-span culvert (Option 3A). The increase in the costs between culverts for Option 2 and 3A are not significant enough to warrant these risks. The increase in the cost of installing modular bridges, Option 3B, at these locations are significant enough that bridge structures are not being recommended.

Crossings 4 through 9

For all other crossings, the low flow vented crossing is not considered feasible as it would not meet County criteria for drainage structures as outlined in the Road and Development Standards. For these crossings it is recommended that modular bridges (Option 3B) be constructed. Although a culvert structure at Crossing 8 is less expensive, due to the close proximity of the bridge structure at Crossing 9 downstream, a bridge is recommended at Crossing 8 also. Bridges at both Crossings 8 and 9 are expected to reduce flow velocities on this reach and minimize potential impacts to the channel. The bridges will further reduce impacts to the stream bed and habitat during construction and will provide for a capacity that will allow vehicles to cross the creek during high flows without contact with the channel flows, resulting in a reduction of petroleum products in the stream. Bridge spans are estimated to be 70’ in length, but may need to be reduced to allow for road realignment and to minimize grading.

Although a detailed HEC-RAS analysis was not performed for the bridges, it is reasonable to assume that flows would mimic the existing channel flows and be less likely to have any detrimental affects on velocity or channel stability than the other structure options. Certainly the water surface elevation will be lower than that calculated for Option 3A. It is recommended that the bridge at Crossing 9 incorporate road realignment as shown in Appendix K, Sheet 5, so that the structure is installed downstream of the tributary that joins Cave Creek just upstream of the crossing, and to reduce impacts to the creek channel and adjacent habitat. As mentioned in the preceding section, further geotechnical study will be required to assure that the road cut will not undercut an old landslide.

Further Study

Detailed design and analysis of the roadway and structures will need to be performed at each of the crossings. To support this design, detailed topography and channel stability studies will need to be performed along the channel and along the roadway upstream and downstream of the crossing structures to complete the final design and verify channel stability and footing depths. Detailed HEC-RAS analysis should be performed for each of the selected structures based on the additional topographic information to verify the size of the structures, flow regimes and potential locations of hydraulic jumps and armor sizing for channel stability.

4.4 Erosion and Sedimentation Control

It is recommended that a minimum length of 200 feet on either side of all crossing structures be paved to minimize the erosion of the road surface occurring at the bridge abutments and its resultant sediment delivery. In some locations, vegetated filter strips could be installed along road margins to filter sediment before entering the creek.

A combination of wingwalls and rock slope protection or alternative armoring will need to be placed at the abutments to prevent erosion. Alternative armoring is available in a variety of aftermarket products that have 100 year + longevity and will allow for vegetative restoration. Bioengineered, or “soft” armoring techniques that will stabilize slopes, enhance the riparian corridor and improve habitat should be seriously considered instead of, or in addition to, “hard” armoring products. Companies such as Bioengineering Associates, Inc. and Salix Applied Earthcare are experienced in biotechnical slope and streambank stabilization and may be consulted for “soft” solutions to rock armoring. These techniques are generally preferred by resource agencies and may save time in the permitting process if they are incorporated into the project.

It is likely that funding for the structures may not be available for a number of years. To address erosion at the crossings in the interim, it is recommended that the County consider a temporary solution to reduce erosion generated by vehicle passage at the crossing approaches. One option is to install locking articulated concrete blocks across the channels and for a short distance on either side of the channel (at the approaches) to reduce further erosion, sediment delivery and degradation of the channel. This interim solution will not address direct fish mortality from vehicle traffic or residual petroleum products from entering the stream but could help reduce sediment loading and channel degradation.

Before any modifications to the creek or roadway are made, water quality samples should be collected and analyzed in accordance with SWRCB protocol as a baseline reference tool. Continued water quality monitoring is recommended until the stream and disturbed areas associated with construction activities have stabilized. The Mendocino County Water Agency may be able to assist with water quality monitoring.

4.5 Biological Considerations

4.5.1 Vegetation

Based on the conservation status of *Didymodon norrisii* and *Sulcaria badia*, any impact to these species should be avoided. For *S. badia* this can be easily accomplished by keeping Garry Oak and Oregon Ash removal to a minimum, which are likely the two most common host trees in the area. The only location for *Didymodon norrisii* as noted was on an east-facing boulder in a weakly serpentine area just downstream from Crossing 1 on the west side of the creek. Crossing structures or construction activity should avoid the large boulders in this area.

Areas of Garry oak/California Fescue (*Festuca californica*) are intermittent on shady slopes adjacent to the main creek channel. The old road bed between Crossings 4 and 5 on the west side of the creek passes though patches of this community type. Garry Oak/California Fescue woodland is considered unique in California by CNPS and although there is no formal protection for the community type it is recommended that impact be avoided as it provides good habitat for native as well as some rare species.

The Torrent Sedge (*Carex nudata*) is abundant throughout the Cave Creek riparian corridor, except for the actual crossing sites, and adds significantly to stream function and integrity. Studies show it provides critical stable substrate for other wetland plants and aquatic invertebrates during winter floods. Together with willows (*Salix*), Rushes (*Juncus*), and other taxa in the Sedge Family (*Cyperaceae*), these wetland plants slow fast-moving materials from cobbles to fine sediment, effectively limiting water turbidity. *Carex nudata* is one of the few herbaceous perennial species that can persist mid-channel and its use for channel stabilization should be considered along with the other native species mentioned above.

At a minimum, disconnecting the roadway from the channel by removing the fords will allow for the natural recruitment of riparian vegetation. In some areas, revegetation may be required, other than that required for erosion control and slope stabilization. The area around Crossing 9 is severely degraded due to off-road vehicle use and would be a potential opportunity for stream enhancement. In open, disturbed areas within the riparian corridor, willow planting would be a simple solution to vegetating and stabilizing stream banks. As stated above, there are many plant species growing within the project area that could be used for revegetation.

4.5.2 Wetlands

If the County selects a design alternative that requires disturbance of wetlands or riparian areas, appropriate wetland delineation studies should be conducted prior to the project design phase. Wetland studies should be performed in consultation with the U.S. Army Corps of Engineers and the RWQCB's 401 Division, and should describe the extent and characteristics of the wetlands and provide recommendations for mitigation.

The SWRCB is currently in the process of developing a policy to protect wetlands and riparian areas in order to restore and maintain the water quality and beneficial uses of the waters of the State. The proposed policy will likely be significantly more restrictive than current policies found in Sections 401 and 404 of the Clean Water Act. It is strongly recommended that DOT remain abreast of developments relating to this and other future policies regarding the protection of wetlands and riparian areas.

4.5.3 Aquatic Life and Wildlife

General Construction Schedule

Based upon the biological constraints identified in the wildlife study, a construction window of August 1 to October 15, which generally falls outside of the breeding season for birds and sensitive aquatic species, is recommended. An earlier construction date is possible with the additional surveys as discussed further in this section; however, these studies can be involved and costly, and thus may not be practical.

Steelhead and Salmon

Construction of stream crossings may impact Chinook and steelhead by disturbing vital spawning and rearing habitat. Construction activities may impact wet pools that are a source of refugia during the dry summer months. A habitat assessment is recommended prior to the commencement of construction activities in order to document baseline (existing) habitat conditions for monitoring purposes. The Department of Fish & Game and/or NOAA Fisheries should be consulted for recommendations regarding potential Chinook and steelhead studies and mitigation measures that may need to be provided prior to determining a construction date.

Foothill Yellow-legged Frogs

The proposed crossing upgrade activities have the potential to cause direct mortality to FYLF and other aquatic wildlife located inside the construction footprint at hydrated crossings during the construction phase. The project activities also have potential to alter important habitat elements, possibly impacting the FYLF population post-construction.

The current survey effort found a population of FYLF within the middle section of the Study Area; multiple FYLFs were found at or adjacent to Crossings 5 and 7, and scattered isolated pools with individuals were discovered in the main channel of Cave Creek. Due to variation in annual rainfall and resultant changes to the creek channel, FYLFs may be found in additional or completely different areas in the future; however, due to the perennial tributaries at Crossings 3 and 5, the continued presence of FYLFs at these crossings is expected.

Prior to the onset of construction, the creek crossings and adjacent portions of Cave Creek should be re-surveyed for the presence of FYLFs and other sensitive species, and a detailed plan outlining protective measures for FYLF and other aquatic species should be completed. The plan should be developed by a qualified biologist and all handling of FYLFs and other sensitive species should be conducted under the supervision of a qualified biologist.

Construction at crossings identified as supporting FYLFs should begin later in the season/construction window to insure the metamorphosis process is completed prior to relocation. Late stage tadpoles are cryptic, and difficult to see and capture and may have less chance of surviving relocation.

Due to the confluence of the perennial tributary at crossing 5 and the occurrence of the special-status FYLF, a bridge as the crossing structure may have the least environmental impact during and post-construction.

Nesting Raptors and Native Birds

Impacts to nesting birds would be unlikely if a late season construction window of August 1 to October 15 is implemented. This window falls outside of the breeding bird season for the avian community in general. However, some birds do have second clutches that may extend past August 1, although the fledglings would be in the late stages of development, and most likely not be reliant upon the nest. Sections 3503, 3503.5 and 3513 of the California Fish and Game Code prohibit take of all birds and their active nests, and avoidance measures are necessary under CEQA. If project activities cannot feasibly avoid the breeding bird season, CDFG recommends that a qualified biologist survey all potential nesting habitat within the project site for nesting birds. Surveys should begin no later than June 1. Surveys should be conducted every 7 days for 8 consecutive weeks until at least July 1. If no nesting birds are observed, site preparation and construction activities may begin. If an active bird nest is located, the nest site should be fenced a minimum of 200 feet (500 feet for raptors) in all directions. Construction can begin after juveniles have fledged and when there is no evidence of a second attempt at nesting.

Prior to construction and following the delineation of each crossing's footprint, all trees slated for removal and those adjacent to them should be surveyed for sign of active nesting. Focus should be on those special-status and/or raptor species with potential to occur in riparian habitats, such as the yellow warbler, the yellow-breasted chat, and the red-shouldered hawk. The latest confirmed breeding activity dates for each of these species as documented in the Sonoma County Breeding Bird Atlas are as follows:

Yellow warbler:	June 28-adults attending young
Yellow-breasted chat:	June 15-adults attending young
Red-shouldered hawk:	July 8-recently fledged young

Northern spotted owl

The northern spotted owl is listed as threatened by the USFWS and as a species of special concern by the CCDFG. An occurrence of northern spotted owl was documented within the Study Area in 1995, in the forested upland habitat near crossing 7. However, the potential to impact the owl directly or indirectly should be low with the avoidance of its breeding season (February 15 through July 15) and because no owl habitat will be removed during the creek improvement activities.

An August 1 construction start date is recommended, although if surveys find that FYLF or breeding birds are not present at the construction site, construction can begin July 15. If the County desires to begin construction earlier than July 15, a northern spotted owl USFWS protocol-level survey should be conducted to see if the nesting owl pair observed in 1995 or other owls are present. This would involve either a 2-year study or six separate surveys conducted in one year, and consultation with USFWS.

Due to the location of the proposed project alternatives, either within the stream corridor or to the east, direct impacts to potential owl habitat can be easily avoided. Indirect impacts to owl habitat can also be avoided if construction activities avoid the breeding season (February 15 through July 15) of this species. Guidelines for the protection of the northern spotted owl have become increasingly stringent in the past year, and it would be prudent to consult with the USFWS to ensure that the appropriate measures are taken to avoid disturbance of this species if found to be present near construction activity sites.

4.6 Recommendations for Cultural Resources

If previously unidentified cultural resources are encountered during project implementation, work in the area should stop immediately. The area should be protected to avoid altering the materials and their context until a qualified professional archaeologist has evaluated the situation and determined an appropriate course of action. Prehistoric resources include, but are not limited to, chert or obsidian flakes, projectile points, mortars, pestles, and dark friable soil containing shell and bone dietary debris, heat-affected rock, or human burials. Historic resources include stone or abode foundations or walls; structures and remains with square nails; and refuse deposits or bottle dumps, often located in old wells or privies.

Should cultural resources be discovered at the site, the following people should be contacted by phone immediately:

Howard Dashiell
Director, Mendocino County Dept. of Transportation
(707) 463-4363

Alex DeGeorgey
Project Archaeologist, NCRM
(707) 542-6591

4.7 Permits and Studies

Implementation of the recommendations discussed in this report will require permits from the following agencies:

- 401 Certification, issued by State Water Quality Control Board
- 1600 Streambed Alteration Agreement, issued by Department of Fish & Game
- 404 Nationwide Permit, issued by Army Corps of Engineers
- Consultation with NOAA Fisheries in association with the 404 permit

If the total area to be disturbed exceeds one (1) acre, a construction stormwater permit, issued by the Regional Water Quality Control Board, and a Storm Water Pollution Prevention Plan (SWPPP) will also be required.

A wetland delineation study will be required by the Army Corps and the RWQCB for each of the crossing sites, and for any other wet areas to be disturbed (i.e.; staging areas) as part of the 401 and 404 permitting process. The wetland delineation will provide information needed for preparation of the environmental (CEQA) document and will be used to determine appropriate mitigation measures to reduce impacts to biological resources and water quality that could potentially result from the project.

Prior to the onset of construction, the creek crossings and adjacent portions of Cave Creek should be re-surveyed for the presence of FYLFs and other sensitive species, and a detailed plan outlining protective measures for FYLF and other aquatic species should be completed. The plan should be developed by a qualified biologist and all handling of FYLFs and other sensitive species should be conducted under the supervision of a qualified biologist. Important elements of the plan should include:

- Surveys to identify the current distribution of FYLFs;
- Site-specific methodology for capturing and handling FYLFs and other species at wetted crossings;
- Pre-determined relocation sites for FYLFs within the Cave Creek drainage;
- Site-specific evaluation of habitat elements for retention at crossings with FYLF presence.
- Site-specific methods for excluding FYLFs and other aquatic species from each dewatered construction footprint.

CDFG and/or NOAA Fisheries may require fish surveys or more detailed fish habitat studies to determine baseline population counts and habitat conditions for monitoring purposes. Additional biological studies may be required by resource agencies if 5 years pass before construction begins.

4.8 Monitoring and Maintenance

Any project which will impact wetlands and/or other jurisdictional waters of the U.S. will require Section 401 and 404 permits, which will require compensatory mitigation and the preparation of a mitigation and monitoring plan (MMP). The industry standard for the preparation of MMPs is the U.S. Army Corp of Engineers *Mitigation and Monitoring Proposal Guidelines*. If compensatory mitigation is required for project impacts in riparian habitats, a plan consistent with the Army Corp's *Guidelines for Monitoring Riparian Mitigation Projects* will have to be prepared. Both documents can be accessed from the San Francisco District's Army Corp website at: http://www.spn.usace.army.mil/regulatory/mitigation.htm. Since the project is intended to enhance and restore natural areas and habitats, it is possible that compensatory mitigation will not be required, and that the project itself will be considered mitigation for existing degraded conditions.

During consultation with permitting agencies, including the Army Corps, CDFG and RWQCB, every effort should be made to visit the site with agency staff to discuss possible recommendations for additional studies, mitigation measures, and design features prior to designing the project.

4.9 Funding Sources

A number of potential funding sources exist for projects that restore, enhance or otherwise improve degraded habitat for special status species. The Department of Fish & Game, NOAA Fisheries, State Water Resources Control Board, and many other agencies and organizations offer funding for public improvement projects. For example, the Coastal Counties Restoration Initiative (CCRI) provides financial assistance on a competitive basis to innovative, high quality county-led or supported projects, with an emphasis on fish passage projects. The 5 Counties Effort provides support to Mendocino County for the improvement of salmonid habitat associated with county roads.

A list of potential funding sources is provided in Appendix J. Funding sources and availability are constantly changing; many organizations have email lists that provide notification of new or upcoming funding opportunities. The SWQCB has regular funding fairs in Sacramento to inform the public about the different funding programs provided by SWQCB. FishNet 4C notifies those on the email list of grant opportunities as they become available.

Another way to reduce the cost of project implementation is to partner with local community groups and organizations for volunteer or low cost labor. Partners to consider would include watershed groups, road or home owner associations, river protection groups, and not-for-profit restoration organizations such as the E-Center or California Conservation Corps. Involving local residents is also a good way of educating community members about the values of creeks and their associated habitats and species, and the consequences of human activities on these systems.

Funding is also available to landowners for exclusionary fencing to prevent recreational trespassing. Under the Farm and Ranch Solid Waste Cleanup and Abatement Grant, the Mendocino Solid Waste Management Authority (MSWA) granted one landowner within the Study Area the funds to install 1.3 miles of fencing and gates along Tomki Road to prevent illegal dumping of solid waste on his property. The Natural Resources Conservation Service (NRCS) has matching funds for landowners for land improvements associated with agricultural activities such as streambank stabilization, exclusionary fencing for livestock, and reclamation of degraded land for agricultural uses. Landowners can contact the Ukiah NRCS office at (707) 468-9223 for more information.

4.10 Additional Recommendations

A significant source of sediment delivery within the Study Area is from off road vehicle (ORV) use on privately-owned lands adjacent to Cave Creek. Although the County has no authority over these areas, for the purposes of this Study it is important to identify these additional pollutant sources. The County may offer to partner with landowners who wish to rehabilitate these degraded sites in order for rehabilitation projects to be eligible for grant funds.

The dumping of solid and hazardous waste, vehicle abandonment, poaching and other illicit activities also contribute to the pollutant load entering Cave Creek. The Mendocino Solid Waste Management Authority (MSWA) will pick up dumped waste if they are notified of the activity and the County's Abandoned Vehicle program will arrange for pick up of abandoned vehicles. Remote locations such as Tomki Road are not routinely traveled by law enforcement, so vehicles and waste often persist in the landscape for weeks or months unless private landowners perform the clean up themselves or diligently persist with County agencies to remove the waste. The County's resources are limited, and enforcement by the County is not likely to increase unless illicit dumping and vehicle abandonment is assigned a heightened priority by the Board of Supervisors. At a minimum, signs can be posted that include the phone numbers for MCWA, the Vehicle Abatement program, and the CDFG hotline so that road users who witness illicit activities know where to report these activities.

In an effort to address the problem of unauthorized dumping, one landowner within the Study Area has already been successful in obtaining funding from the California Integrated Waste Management Board's Farm and Ranch Solid Waste Cleanup and Abatement Grant to construct 1.3 miles of fencing and gates along the west side of Tomki Road. Once installed, the fencing will have the added benefit of restricting access to some of the largest areas damaged by OHV users. This is one mechanism that is already in place to assist local landowners in protecting their property while also protecting the creek and surrounding area. When considering whether to install exclusionary fencing, consideration should also be given to wildlife migration to ensure that the solution to one problem does not create a new problem.

It is unknown what contribution the Cave Creek Subdivision roads may have to delivering sediment into Cave Creek upstream of the Study Area. The Cave Creek Road Association is encouraged to partner with any number of nonprofit or public agencies to conduct water quality monitoring, with possible funding sources listed in Appendix J.

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6.0 Appendices

Appendix A	Project Maps and Exhibits
Appendix B	Project Photographs
Appendix C	Preliminary Soil and Geological Assessment
Appendix D	DIRT Inventory Forms for Crossings 2-9
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