Summary Report

Road Assessment and Erosion Prevention Planning Project for the Wing Canyon Assessment Area, Dry Creek Watershed, Napa County, California

PUBLIC COPY

prepared for

Napa County Resource Conservation District,
Pacific States Marine Fisheries Commission,
and California Department of Fish and Game

by

Pacific Watershed Associates
Arcata, California
(707) 839-5130

January, 2004

Summary Report
Road Assessment and
Erosion Prevention Planning Project
for the Wing Canyon Assessment Area,
Dry Creek Watershed, Napa County, California

Table of Contents ***Page***

List of Maps

Summary Report

Road Assessment and Erosion Prevention Planning Project for the Wing Canyon Assessment Area, Dry Creek Watershed, Napa County, California

prepared by
Pacific Watershed Associates

for
**Napa County Resource Conservation District,
Pacific States Marine Fisheries Commission
and California Department of Fish and Game**

History

In its heyday, the Wing Canyon watershed and the Mount Veeder area had many visitors and prospectors attracted to the canyon's wild beauty, year-round mineral springs, and several resorts. With the blessing of the Napa County Board of Supervisors in 1876, Captain Stalham Wing, an early pioneer of the area, initiated the construction of the Wing Canyon Road that began from the confluence with Dry Creek and wound up through Wing Canyon to the resorts at the top of Mount Veeder. This route became part of a stagecoach road network that took guests coming from the San Francisco area to the present Enchanted Hills Camp (then called Johannisburg Resort). They could then continue from the Ridge Road (currently Mount Veeder Road) to Mount Veeder Lodge (formally known as the "old Elkington Place") or along the present Lokoya Road to Mount Veeder's Lokoya Lodge (then called Solid Comfort, but since burned down). The visitors came by train that went as far as Calistoga, or by boat to Napa. For around 50¢, one could go from Oakville or Yountville in a stage pulled by four horses by Mr. Richard Brandlin up the old Oakville Grade, which was not more than a cow trail, to Dry Creek, and then up Wing Canyon past the Ridge Road, finally to the top of Mount Veeder. The horse drawn stage also delivered mail and supplies to the local farmers as well as the resorts (Hicks, 1975). The well-preserved remains of this stagecoach road network still lead up from Dry Creek to the present Lighthouse for the Blind Camp, though in some areas the trail is no wider than a foot.

In 1873, the Elkington family built a sawmill near Mount Veeder Resort. It is said this mill was operated by "abundant spring water" and cut most of the area's timber into lumber for the construction of local homes and fences (Hicks, 1975). Many of the old skid roads were developed at this time during the mid to late 1800's. By the late 1800's, a photo of Johannisburg Lake shows the surrounding areas bare of their redwood stands (Sinclair, 2000). Timber was heavily harvested in 1906 after the earthquake and again in 1956 when redwood and fir rights were sold in the area (NCRCD, 1998; Hicks, 1975). More recently, timber harvest plans and conversions to vineyards and residences have created more roads and changed the natural hydrological regime of the watershed. Over 100 acres of open development or vineyard has been created in the Wing Canyon watershed as seen from a 1993 aerial photo set (NCRCD, 1993).

In response to a devastating fire that burned hundreds of acres in 1945, the Dry Creek/Lokoya Fire District Association was formed. The first fire trails were bulldozed by Russell Parker in 1946 at $9/hour for a total of $113 and then again in 1959 when the Lokoya Lodge burned down. Other fires of historical significance occurred in 1923 when someone was smoking out bees in Rutherford, in 1937, 1964, and again in 1995 (NCRCD, 1998).

For centuries, the Enchanted Hills area was home to the Winton Indians whose word for “deer” was Lokoya (Sinclair, 2000). Around 1875, Captain Stalham Wing homesteaded the land and built the stream-fed “Lake Johannisberg” (also known as Lokoya Lake), a prominent reservoir noted on the Yountville USGS quadrangle map. After 1880, he sold all his property that bordered the present Mount Veeder Road across from the Resort all the way down to Dry Creek to Walter Metz (Hicks, 1978). Metz planted and maintained a small vineyard, roses, and an orchard developing his land into Johannisberg Resort. The resort was noted for its springs “of medicinal virtue,” gardens, hunting grounds, dairy, and swimming and one could stay for as little as $2 per day. Around 1900, the property was sold to Theo Blankenburg, Jr., who continued to manage the resort facilities for another 10 years. The property became private when a wealthy man purchased it in the early 1900’s with dreams of developing a chicken farm. In 1925, the property changed hands again, and was named “Hanford’s Rest” after Mr. Aven Hanford who is said to have financed the building of the Carquines Bridge near Benicia. Around 1928, Mrs. Hanford transferred the land to Philip Webster who incorporated the Lokoya Boys Camp with a swimming pool, cabins, and bathroom facilities. During the depression of 1931, Mr. Webster was unable to keep up the payments, and Mrs. Hanford resold the land in 1945 to Mr. Gibbons on the condition that it remain in use as a private boy’s camp (Sinclair, 2000). In 1950, Rose Resnick opened the Enchanted Hills for the Blind Camp – a coed camp that was geared toward the visually impaired. Fifty-four years later, this non-profit camp is still in operation today with many of the original structures from the Johannisberg Resort days in place.

Project Background

Wing Canyon is a 1.5 mi^2 second-order tributary to Dry Creek, approximately 1.8 miles long, located in Napa County (Figure 1). According to the USGS Sonoma and Rutherford 7.5' minute topographic quadrangle maps, the Wing Canyon watershed contains approximately 9.7 miles of blue-line streams. Elevations in the assessment area range between 620’ near the confluence with Dry Creek to 1,380’, just below Mount Veeder Road. The majority of the Wing Canyon sub-watershed is privately owned and is composed of rural subdivision residences, vineyards, the Lighthouse for the Blind camp, and undeveloped woodlands.

Vegetation in the Wing Canyon assessment area is dominated by annual grasses and oak woodlands in the headwaters and by Douglas Fir, redwoods and other hardwood species in the remaining portions of the watershed. The Wing Canyon assessment has experienced several cycles of timber harvesting since the turn of 20^{th} century, with some of the timberlands being presently converted to residential property and vineyards (NCRCD, 2001).

The assessment area contains a historic and existing network of unpaved and asphalted roads, as well as an old stagecoach road along the banks of Wing Canyon. Many of the maintained and

Figure 1. Location map of the Wing Canyon assessment area

abandoned roads are currently causing erosion and sedimentation to Wing Canyon.

Dry Creek has value as a historic coho salmon and steelhead trout stream, although only steelhead trout have recently been found. In 1997, the National Marine Fisheries Service listed steelhead as a threatened species. The California Department of Fish & Game (CDFG) conducted a stream inventory on Dry Creek during the summer of 1997 to document current habitat conditions and recommend options for the potential enhancement of habitat for steelhead trout. Based on the results of the habitat inventory, Bob Coey (CDFG) made the preliminary recommendation that all sources of sediment to the stream channels be mapped and rated according to their sediment yields, and adequate erosion control measures taken.

Pacific Watershed Associates (PWA) was contracted by the Napa County Resource Conservation District (NCRCD) to complete a sediment source assessment and prepare a prioritized erosion prevention plan for selected county roads and private subdivision roads in Dry Creek, as part of a comprehensive preliminary watershed assessment of the Dry Creek watershed (PWA, 2003). The Wing Canyon assessment is a small part of the Dry Creek watershed assessment and was funded by a California Adaptive Watershed Improvement grant administered by the Pacific States Marine Fisheries Commission (PSMFC) in conjunction with the California Department of Fish and Game (CDFG). The PWA sediment source assessment was specifically aimed at identifying future erosion sources that are impacting, or could impact, fish bearing streams and to develop prescriptions aimed at reducing sediment input to the watershed.

Perhaps the most important elements needed for long-term restoration of salmon habitat, and the eventual recovery of salmonid populations is the reduction of accelerated erosion and sediment delivery to the stream channel system. The latter is a very complex problem influenced by tectonic activity, geology, watershed erosion rates and land management activities in the watershed, among other factors.

The geology of the Wing Canyon watershed is composed primarily of Jurassic and Cretaceous sedimentary rocks of the Great Valley sequence, comprising mostly of sandstone, shale, with Tertiary volcanic outcrops near the headwaters on Mount Veeder and “the cove”. The underlying geology in combination with the numerous faults in Wing Canyon result in a tectonically unstable environment that is prone to erosion. The faults in Wing Canyon extend from Enchanted Hills to Dry Creek, and dip to the north-northeast at 30 to 80 degrees. There are several large Quaternary deep-seated landslides located in Wing Canyon.

Erosion and sediment delivery can have both natural and anthropogenic causes. In the absence of human activity, watersheds and streams have a natural background rate of erosion and sediment delivery. Dominant natural erosion processes include geologically and/or tectonically controlled mass wasting (landsliding), gully erosion and bank erosion. Anthropogenic erosion and sediment delivery is caused by a variety of land management activities including road construction, road maintenance, agriculture (vineyards), rural residential development, and grazing. As a result, land use activities can result in accelerated fine sediment inputs to the stream system.

In the Wing Canyon assessment area, as in many other watersheds, the disturbance caused by excess sediment input to stream channels during large rainfall events is perhaps one of the most significant factors affecting salmonid populations. Negative effects from excess sediment inputs include, 1) increased water temperatures, 2) lowered dissolved oxygen, and 3) the loss of adequate salmon spawning and rearing habitat.

This summary report describes the erosion assessment and inventory process that was employed in the Wing Canyon assessment area. It also serves as a prioritized plan- of-action for cost effective erosion control and erosion prevention treatments for the watershed. It also serves as a prioritized plan-of-action for cost-effective erosion control and erosion prevention treatments for selected roads within the watershed. When implemented and employed in combination with protective land use practices, the proposed projects are expected contribute to the long-term protection and improvement of salmonid habitat in the basin. The implementation of erosion control and erosion prevention work is an important step toward protecting and restoring watersheds and their anadromous fisheries, especially where sediment input is a limiting factor to fisheries production, as is the case for Wing Canyon.

Road systems are perhaps the most significant and most easily controlled sources of sediment production and delivery to stream channels. The Wing Canyon assessment area is underlain by erodible and potentially unstable geologic substrate, and field observations indicate that roads have been, and continue to be, a significant source of accelerated sediment production and delivery in the watershed. Chronic sediment inputs to the channel system, from roads, driveways and other bare soil areas, are also thought to be important contributors to impaired habitat and reduced salmonid populations.

Unlike many watershed improvement and restoration activities, erosion prevention and "storm-proofing" of road systems has an immediate benefit to the streams and aquatic habitat of the basin. It helps ensure that the biological productivity of the watershed's streams is not impacted by future human-caused erosion (or that such impacts are minimized), and that future storm runoff can cleanse the streams of accumulated coarse and fine sediment, rather than depositing additional sediment from managed areas. Sites targeted as high or moderate treatment immediacy in the Wing Canyon assessment area have been identified as priority sites for implementation so that fill failures, undersized stream crossing culverts, washouts, ditch relief gully erosion, stream diversions and chronic sediment delivery do not degrade the stream system.

The assessment, conducted in the first week of December, 2003, identified all recognizable current and future sediment sources on selected roads within the Enchanted Hills Camp-Lighthouse for The Blind property (Wing Canyon assessment area). The field inventory identified future sediment sources from approximately of 4 miles of private rural camp roads within the Wing Canyon sub-watershed. The primary objective of these road storm-proofing projects is to implement cost-effective erosion control and erosion prevention work on prioritized sites that were identified as a part of this watershed assessment and inventory. This assessment is also intended to be used as a tool for basin wide planning in which the ecological impacts of specific roads can be balanced against the needs for private and public use.

Project Description

Roads within the assessment area were identified and age dated from historic aerial photography as part of the Road Assessment and Erosion Prevention Planning project for the Dry Creek Watershed (PWA, 2003). Aerial photographs were analyzed to identify the location and approximate date of road construction. A composite map of the road systems in Dry Creek was developed from GIS layers provided by the NCRCD and updated through analysis of aerial photos. GIS base maps used in the field inventory were generated using the air photo identified roads, and depict the primary road network in the assessment area.

The project involved a complete inventory of 4 miles of rural camp roads within the Wing Canyon assessment area. The assessment process used in this project was developed by Pacific Watershed Associates and is one of the preferred methods outlined in the Stream Habitat Restoration Manual prepared by the California Department of Fish and Game (CDFG). Technically, this assessment was neither an erosion inventory nor a road maintenance inventory. Rather, it was an inventory of sites where there is a potential for future sediment delivery to the stream system that could impact fish bearing streams. All roads, including both maintained and abandoned routes, were walked and inspected by trained personnel from Pacific Watershed Associates with the assistance of NCRCD staff. All existing and potential erosion sites were identified and described. Sites, as defined in this assessment, include locations where there is direct evidence that future erosion or mass wasting could be expected to deliver sediment to a stream channel. Sites of past erosion were not inventoried unless there was a potential for additional future sediment delivery. Similarly, sites of future erosion that were not expected to deliver sediment to a stream channel were not included in the inventory. Non-delivery sites include small shallow cutbank failures, fillslope failures and gullies that are located far enough from a stream that they do not have the potential to deliver to a watercourse.

Inventoried sites generally consisted of stream crossings, potential and existing landslides related to the road system, and long sections of uncontrolled road and ditch surface runoff that currently discharge to the stream system. For each identified existing or potential erosion source, a database form was filled out and the site was mapped on a mylar overlay over a 1: 6,000 scale topographic map. The database form (Figure 2) contained questions regarding the site location, the nature and magnitude of existing and potential erosion problems, the likelihood of erosion or slope failure and recommended treatments to eliminate the site as a future source of sediment delivery.

Stream class was identified at each stream according to the California Forest Practice Rules outlined by the California Department of Forestry and Fire Protection. Generally, a Class I stream is defined as a fish-bearing stream or a domestic water source, a Class II stream is defined as non-fish bearing stream that supports other types of aquatic life, a Class III stream is defined as not supporting any aquatic life, and a Class IV stream is defined as a man-made watercourse. This classification system may differ from Napa County’s classification system.

The erosion potential (and potential for sediment delivery) was estimated for each major problem site or potential problem site. The expected volume of sediment to be eroded and the volume to be delivered to streams were estimated for each site. The data provides quantitative estimates of how much material could be eroded and delivered in the future, if no erosion control or erosion prevention work is performed. In a number of locations, especially at potential stream diversion sites, actual sediment loss could exceed field predictions. All sites were assigned a treatment priority, based on their potential to deliver deleterious quantities of sediment to stream channels in the watershed and the cost-effectiveness of the proposed treatment.

Figure 2. Road erosion inventory data form used in the Wing Canyon assessment area

*ASAP*_____	**P W A R O A D I N V E N T O R Y D A T A F O R M** (3/99 version)						*Check*____
GENERAL	**Site No:** ________	GPS:	Watershed:		CALWAA:		
Treat (Y,N):	Photo: ______	T/R/S:	Road #:		Mileage: ___________		
	Inspectors:_______	Date: ________	Year built:______	Sketch (Y):			
	Maintained	Abandoned	Driveable	Upgrade	Decommission	Maintenance	
PROBLEM	Stream xing	Landslide (fill, cut, hill)	Roadbed (bed, ditch, cut)	DR-CMP	Gully	Other	
	Location of problem (U, M, L, S)	Road related? (Y)	Harvest history: (1=<15 yrs old; 2=>15 yrs old) TC1, TC2, CC1, CC2, PT1, PT2, ASG, No		Geomorphic association*:* Streamside, I.G., Stream Channel, Swale, Headwall, B.I.S.		
LANDSLIDE	Road fill	Landing fill	Deep-seated	Cutbank	Already failed	Pot. failure	
	Slope shape: (convergent, divergent, planar, hummocky)			Slope (%) ______	Distance to stream (ft) __________		
STREAM	CMP	Bridge	Humboldt	Fill	Ford	Armored fill	
	Pulled xing: (Y)	% pulled ______	Left ditch length (ft) ___________		Right ditch length (ft) ___________		
	cmp dia (in) ______	inlet (O, C, P, R)	outlet (O, C, P, R)	bottom (O, C,P, R)	Separated?		
	Headwall (in) ____	CMP slope (%) _____	Stream class (1, 2, 3)	Rustline (in)			
	% washed out ____	D.P.? (Y)	Currently dvted? (Y)	Past dvted? (Y)	Rd grade (%) ________		
	Plug pot: (H, M, L)	Ch grade (%) _____	Ch width (ft) _____	Ch depth (ft) ____			
	Sed trans (H, M, L)	Drainage area (mi^2) _________					
EROSION	E.P. (H, M, L)	Potential for extreme erosion? (Y, N)		Volume of extreme erosion (yds^3): 100-500, 500-1000, 1K-2K, >2K			
Past erosion...	Rd&ditch vol (yds^3) (yds^3)___________	Gully fillslope/hillslope (yds^3)__________	Fill failure volume (yds^3) _________	Cutbank erosion (yds^3)__________	Hillslope slide vol. (yds^3) ___________	Stream bank erosion (yds^3) __________	xing failure vol (yds^3) _________
	Total past erosion (yds) __________	Past delivery (%) __________	Total past yield (yds) _________	Age of past erosion (decade)_______			
Future erosion...	Total future erosion (yds) __________	Future delivery (%) __________	Total future yield (yds) _________	Future width (ft) _________	Future depth (ft) ________	Future length (ft) _______	
COMMENT ON PROBLEM:							
TREATMENT	Immed (H,M,L)	Complex (H,M,L)	Mulch (ft^2)				
	Excavate soil	Critical dip	Wet crossing (ford or armored fill) (circle)		sill hgt (ft) ___	sill width (ft) _______	
	Trash Rack	Downspout	D.S. length (ft) ________	Repair CMP	Clean CMP		
	Install culvert	Replace culvert	CMP diameter (in) _____	CMP length (ft) _______			
	Reconstruct fill	Armor fill face (up, dn)	Armor area (ft^2) _______	*Clean or cut ditch*	*Ditch length (ft) _________*		
	Outslope road (Y)	*OS and Retain ditch (Y)*	*O.S. (ft) ____________*	*Inslope road*	*I.S. (ft) _____*	*Rolling dip*	*R.D. (#) __*
	Remove berm	*Remove berm (ft) _____*	*Remove ditch*	*Remove ditch (ft) __________*		*Rock road - ft^2 ________*	
	Install DR-CMP	*DR-CMP (#) ________*	Check CMP size? (Y)	Other tmt? (Y)	No tmt. (Y)		
EQUIPMENT HOURS	Excavator (hrs) ________	Dozer (hrs) ________	Dump truck (hrs) ______	Grader (hrs) ________			
	Loader (hrs) _____	Backhoe (hrs) ______	Labor (hrs) _______	Other (hrs) ______			
COMMENT ON TREATMENT:							

In addition to the database information, tape and clinometer surveys were completed on all stream crossings. These surveys included a longitudinal profile of the stream crossing through the road prism, as well as two or more cross sections. The survey data was entered into a computer program that calculates the volume of fill in the crossing. The survey allows for accurate and repeatable quantification of future erosion volumes (assuming the road was to washout during a future storm), decommissioning volumes (assuming the road was to be closed) and/or excavation volumes that would be required to complete a variety of road upgrading and erosion prevention treatments (culvert installation, culvert replacement, complete excavation, etc.).

Inventory Results

Portions of the existing road network date back as far as 1876 (Sinclair, 2000). Of the approximately 4 miles of road identified in the air photo analysis, all roads in the Wing Canyon assessment area were granted access for the sediment source assessment. Inventoried road-related erosion sites fit into one of two treatment categories: 1) upgrade sites - defined as sites on maintained roads and open roads that are to be retained for access and management and 2) decommission sites - defined as sites exhibiting the potential for future sediment delivery that have been recommended for either temporary or permanent closure. Virtually all future road-related erosion and sediment yield in the Wing Canyon assessment area is expected to come from three sources: 1) erosion at or associated with stream crossings (from several possible causes), 2) failure of road fills (landsliding), and 3) road surface and ditch erosion.

A total of 33 sites were identified with the potential to deliver sediment to streams. Of these, 32 were recommended for erosion control and erosion prevention treatment. Approximately 69% (n=22) of the sites recommended for treatment are classified as stream crossings, 6% (n=2) as existing or potential landslides, and 3% (n=1) as ditch relief culverts (Table 1 and Map 2). The remaining 22% (n=7) of the inventoried sites consist of other sites, which include road surface erosion, gullies, stream bank erosion and springs.

Stream crossings - Twenty-two (22) stream crossings were inventoried including 9 culverted crossings, 12 unculverted fill crossings and 1 bridge. An unculverted fill crossing refers to a stream crossing with no drainage structure to carry the flow through the road prism. Flow is either carried beneath or through the fill, or it flows over the road surface, or it is diverted down the road surface to the inboard ditch. The majority of the unculverted fill crossings in the assessment area are located at small Class III streams that exhibit flow only in larger runoff events.

Of the 22 stream crossings identified in the assessment, all have been recommended for erosion control and erosion prevention treatment. Approximately 2,093 yds^3 of future road-related sediment delivery in the Wing Canyon watershed assessment area could originate from stream crossings if they are not treated (Table 1). This amounts to about 39% of the total sediment yield from the road system. The most common problems that cause erosion at stream crossings include: 1) crossings with no culverts or undersized culverts, 2) crossings with culverts that are likely to plug, 3) stream crossings with a diversion potential and 4) crossings with gully erosion at the culvert outlet. The sediment delivery from stream crossing sites is always classified as 100% because any sediment eroded is delivered to the channel. Any sediment delivered to small ephemeral streams will eventually be transported to downstream fish-bearing stream channels.

Table 1. Site classification and sediment yield from all inventoried sites with future sediment delivery, Wing Canyon watershed assessment area, Napa County, California.

Site Type	Number of sites or road miles	Number of sites or road miles to treat	Sites recommended for treatment			
			Future yield (yds^3)	Stream crossings w/ a diversion potential (#)	Stream crossings currently diverted (#)	Stream culverts likely to plug (plug potential rating = high or moderate) (#)
Stream crossings	22	22	2,093	8	7	8
Landslides	3	2	220	--	--	--
Ditch relief culverts	1	1	34	--	--	--
Other	7	7	364	--	--	--
Total (all sites)	33	32	2,711	8	7	8
Persistent surface erosion[1]	2.27 miles	2.22 miles	2,599	--	--	--
Totals	**33**	**32**	**5,310**	**8**	**7**	**8**

[1] Assumes 15' wide road prism and cutbank contributing area, and 0.4' of road/cutbank surface lowering over two decades for unpaved roads. No lowering rate was applied to paved road in the assessment area.

At stream crossings, the largest volumes of future erosion can occur when culverts plug or when potential storm flow exceeds the culvert capacity (i.e., the culvert is undersized or prone to plugging) and flood runoff spills onto or across the road. When stream flow goes over the fill, part or the entire stream crossing fill may be eroded. Alternately, when flow is diverted down the road, either on the roadbed or in the ditch (instead of spilling over the fill and back into the same stream channel), the crossing is said to have a diversion potential and the roadbed, hillslope and/or stream channel that receives the diverted flow can become deeply gullied or destabilized. These hillslope gullies can be quite large and can deliver significant quantities of sediment to stream channels. Alternately, diverted stream flow that is discharged onto steep, potentially unstable slopes can also trigger large hillslope landslides.

Of 32 stream crossings recommended for erosion control and erosion prevention treatment in the Wing Canyon assessment area, 8 (36%) have the potential to divert in the future and 7 streams (32%) are currently diverted (Table 1). Eight (8) of the existing culverts have a moderate to high plugging potential (Table 1). Because the roads were constructed many years ago, many culverted stream crossings are under-designed for the 100-year storm flow. At stream crossings with no culverts or with undersized culverts, or where there is a diversion potential, corrective prescriptions have been outlined on the data sheets and in the following tables.

Preventative treatments include such measures as: constructing critical dips (rolling dips) at stream crossings to prevent stream diversions, installing larger culverts wherever current pipes are under-designed for the 100-year storm flow (or where they are prone to plugging), installing culverts at the natural channel gradient to maximize the sediment transport efficiency of the pipe and ensure that the culvert outlet will discharge on the natural channel bed below the base of the road fill, installing debris barriers, and armoring the fill face of the crossing to minimize or prevent future erosion and/or properly excavating the stream crossing of all fill material.

Landslides - Only road-related landslide sites with a potential for sediment delivery to a stream channel were inventoried. Three (3) potential landslides were identified and account for approximately 9% of the inventoried sites in the assessment area (Table 1). All three potential landslide sites were found along roads where material had been sidecast during earlier construction and now shows signs of instability.

Of the three potential landslides identified, two have been recommended for erosion control and erosion prevention treatment. Potential landslides recommended for treatment are expected to deliver up to 220 yds^3 of sediment to Wing Canyon in the future. Correcting or preventing potential landslides associated with the road is relatively straightforward, and involves the physical excavation of potentially unstable road fill and sidecast materials.

The one inventoried potential landslide site that was not recommended for treatment was identified as a hillslope debris slide. This landslide is part of a larger feature encompassing the entire road prism, as well as hillslope material above and below the road. Direct excavation of a portion of this feature is not recommended because it can result in further de-stabilization of the entire feature.

There are a few potential landslide sites located in the assessment area that will not deliver sediment to streams. These sites were not inventoried using data sheets due to the lack of expected sediment delivery to a stream channel. They are generally shallow and of small volume, or located far enough away from an active stream such that delivery is unlikely to occur.

Ditch relief culverts - One (1) ditch relief culvert site was identified to have future sediment yield to a stream channel, and it was recommended for erosion control and erosion prevention treatment. This site is attributed to excessive ditch length that generates concentrated runoff, causes a gully below the outlet, and delivers eroded sediment to a stream channel. Approximately 34 yds^3 of future sediment yield is expected to occur associated with this ditch relief culvert site. This site represents less than 1% of the total predicted sediment yield from road related erosion.

"Other" sites - A total of 7 other sites were also identified in the assessment area. Other sites include runoff and erosion from the road surface, ditch, and major springs, as well as stream bank erosion sites, that exhibit the potential to deliver sediment to streams. One of the main causes of existing or future erosion at these sites is surface runoff and uncontrolled flow from long sections of undrained road surface. Uncontrolled flow along the road or ditch may affect the roadbed integrity as well as cause gully erosion on the hillslope below the outlet of ditch relief culverts. All 7 of the other sites have been recommended for erosion control and erosion prevention treatment. We estimate 364 yds^3 of sediment will be delivered to streams if they are left untreated (Table 1). Sediment delivery from these sites represents approximately 7% of the total potential sediment yield from sites recommended for erosion control and erosion prevention treatment.

Chronic erosion **-** Road runoff is also a major source of fine sediment input to nearby stream channels. We measured approximately 2.27 miles of road surface and/or road ditch (representing 57% of the total inventoried road mileage) which currently drain directly to stream channels and deliver ditch flow, road runoff and fine sediment to stream channels in the Wing Canyon assessment area (Table 1). These roads are said to be hydrologically connected to the stream channel network. When these roads are being actively maintained and used for access, they represent a potentially important source of chronic fine sediment delivery to the stream system.

Of the 2.27 miles of road surface and/or road ditch contribution, 2.22 miles have been recommended for treatment. From the 2.22 miles, we calculated approximately 2,599 yds^3 (49%) of sediment could be delivered to stream channels within the assessment area over the next two decades, depending on road use, if no efforts are made to change road drainage patterns. This will occur through a combination of 1) cutbank erosion (ie., dry ravel, rainfall, freeze-thaw processes, cutbank failures and brushing/grading practices) delivering sediment to the ditch, 2) inboard ditch erosion and sediment transport, 3) mechanical pulverizing and wearing down of the road surface, and 4) erosion of the road surface during wet weather periods.

Relatively straightforward erosion prevention treatments can be applied to upgrade road systems to prevent fine sediment from entering stream channels. These treatments generally involve dispersing road runoff and disconnecting road surface and ditch drainage from the natural stream channel network. Road surface treatments include adding ditch relief culverts and/or adding rolling dips on paved and native roads prescribed for upgrade, or adding cross road drains on native roads prescribed for decommissioning.

Treatment Priority

An inventory of future or potential erosion and sediment delivery sites is intended to provide information that can guide long range transportation planning, as well as identify and prioritize erosion prevention, erosion control and road upgrading/decommissioning activities in the watershed. Not all of the sites that have been recommended for treatment have the same priority, and some can be treated more cost effectively than others. Treatment priorities are evaluated on the basis of several factors and conditions associated with each potential erosion site. These include:

1) the expected volume of sediment to be delivered to streams (future delivery - yds^3),
2) the potential or likelihood for future erosion (erosion potential - high, moderate, low),
3) the urgency of treating the site (treatment immediacy - high, moderate, low),
4) the ease and cost of accessing the site for treatments, and
5) recommended treatments, logistics and costs.

The ***erosion potential*** of a site is a professional evaluation of the likelihood that erosion will occur during a future storm event. Erosion potential is an estimate of the potential for additional erosion, based on field observations of a number of local site conditions. It was evaluated for each site, and expressed as High, Moderate or Low. The evaluation of erosion potential is a subjective estimate of the probability of erosion, and not an estimate of how much erosion is likely to occur. It is based on the age and nature of direct physical indicators and evidence of pending instability or erosion. The likelihood of erosion (erosion potential) and the volume of sediment expected to enter a stream channel from future erosion (sediment delivery) play significant roles in determining the treatment priority of each inventoried site (see treatment immediacy, below). Field indicators that are evaluated in determining the potential for sediment delivery include such factors as slope steepness, slope shape, distance to the stream channel, soil moisture and evaluation of erosion process. The larger the potential future contribution of sediment to a stream, the more important it becomes to closely evaluate its potential for cost-effective treatment.

Treatment immediacy (treatment priority) is a professional evaluation of how important it is to quickly perform erosion control or erosion prevention work. It is also defined as High, Moderate and Low and represents both the severity and urgency of addressing the threat of sediment delivery to downstream areas. An evaluation of treatment immediacy considers erosion potential, future erosion and delivery volumes, the value or sensitivity of downstream resources being protected, and treatability, as well as, in some cases, whether or not there is a potential for an extremely large erosion event occurring at the site. If mass movement, culvert failure or sediment delivery is imminent, even in an average winter, then treatment immediacy might be judged high. ***Treatment immediacy is a summary, professional assessment of a site's need for immediate treatment.*** Generally, sites that are likely to erode or fail in a normal winter, and that are expected to deliver significant quantities of sediment to a stream channel, are rated as having a high treatment immediacy or priority.

One other factor influencing a site's treatment priority is the difficulty (cost and environmental impact) of reaching the site with the necessary equipment to effectively treat potential erosion. Sites found on abandoned roads or un-maintained roads require brushing and tree removal to provide access to the work site(s). Other roads require minor or major road rebuilding of washed out stream crossings and/or existing landslides in order to reach potential work sites farther out the alignment. Road construction adds to the overall cost of erosion control work and reduces project cost-effectiveness. Potential work sites with lower cost-effectiveness, in turn may be of relatively lower priority. However, just because a road is abandoned and/or overgrown with vegetation is not sufficient reason to discount its need for assessment ant potential treatment. Treatments on heavily overgrown, abandoned roads may still be both beneficial and cost-effective.

Evaluating Treatment Cost-Effectiveness

Treatment priorities are developed from the above factors, as well as from the estimated cost-effectiveness of the proposed erosion control or erosion prevention treatment. Cost-effectiveness is determined by dividing the cost ($) of accessing and treating a site, by the volume of sediment prevented from being *delivered* to local stream channels. For example, if it would cost $2000 to develop access and treat an eroding stream crossing that would have delivered 250 yds^3 (had it been left to erode), the predicted cost-effectiveness would be $8/$yds^3$ ($2000/250 yds^3).

To be considered for priority treatment a site should typically exhibit: 1) potential for significant (>25-50 yds^3) sediment delivery to a stream channel (with the potential for transport to a fish-bearing stream), 2) high or moderate treatment immediacy and 3) a predicted cost-effectiveness value. Treatment cost-effectiveness analysis is often applied to a group of sites (rather than on a single site-by-site basis) so that only the most cost-effective groups of sites or projects are undertaken. During road decommissioning, groups of sites are usually considered together because there will only be one opportunity to treat potential sediment sources along the road. In this case, cost-effectiveness may be calculated for entire roads or road reaches that fall into logical treatment units.

Cost-effectiveness can be used as a tool to prioritize potential treatment sites throughout a sub-watershed (Weaver and Sonnevil, 1984; Weaver and others, 1987). It assures that the greatest benefit is received for the limited funding that is typically available for protection and restoration projects. Sites, or groups of sites, that have a predicted marginal cost-effectiveness value averaging in the general range of \$5-\$15/yd^3, or are judged to have a lower erosion potential or treatment immediacy, or low sediment delivery volumes, are less likely to be treated as part of the primary watershed protection and storm-proofing program. However, these sites should be addressed during future road reconstruction (when access is reopened into area for future management activities), or when heavy equipment is performing routine maintenance or restoration at nearby, higher priority sites.

Types of Prescribed Heavy Equipment Erosion Prevention Treatments
Forest, ranch, and rural roads can be storm-proofed by one of two methods: upgrading or decommissioning (PWA, 1994). Upgraded roads are kept open and are inspected and maintained. Their drainage facilities and fills are designed or treated to accommodate or withstand the 100-year storm. In contrast, properly decommissioned roads are closed and no longer require maintenance. The goal of storm-proofing is to make the road as "hydrologically invisible" as possible; that is to disconnect the road from the stream system and thereby reduce fine sediment delivery and protect downstream habitat. The characteristics of storm-proofed roads, including those, which are either upgraded or decommissioned, are depicted in Figure 3.

Road upgrading involves a variety of treatments used to make a road more resilient to large storms and flood flows. The most important of these include stream crossing upgrading (especially culvert up-sizing to accommodate the 100-year storm flow (including debris), and to eliminate stream diversion potential), removal of unstable sidecast and fill materials from steep slopes, and the application of drainage techniques to improve dispersion of road surface runoff. Road drainage techniques include rolling dips and/or the installation of ditch relief culverts. Twelve (12) sites located in the assessment area have been recommended for upgrade.

Heavy equipment conducting stream crossing culvert upgrades on these private roads will utilize two different methods to install new pipes. Methods are dependent on the road surface at the stream crossing site. For a stream crossing on a paved road surface, a trench will be excavated.

The new pipe will be installed and the crossing excavation will be back filled. The crossing then will be capped with road rock or new asphalt whose surface area is based on the width and length of the excavation. Cost for road rock was included in the analysis; additional cost will be necessary if asphalt is required.

Estimated excavator times are based on an excavation production rate that is determined by the complexity of the work site. Spoil will either be stored locally on site or dump trucks will endhaul spoil to another storage area.

FIGURE 3. CHARACTERISTICS OF STORM-PROOFED ROADS

The following abbreviated criteria identify common characteristics of storm-proofed roads. Roads are storm-proofed when sediment delivery to streams is strictly minimized. This is accomplished by dispersing road surface drainage, preventing road erosion from entering streams, protecting stream crossings from failure or diversion, and preventing failure of unstable fills which would otherwise deliver sediment to a stream. Minor exceptions to these guidelines can occur at specific sites within a forest, ranch or rural road system.

STREAM CROSSINGS

- Y all stream crossings have a drainage structure designed for the 100-year flow, including debris
- Y stream crossings have no diversion potential (functional critical dips are in place)
- Y stream crossing inlets have low plug potential (trash barriers & graded drainage)
- Y stream crossing outlets are protected from erosion (extended, transported or dissipated)
- Y culvert inlet, outlet and bottom are open and in sound condition
- Y undersized culverts in deep fills (> backhoe reach) have emergency overflow culvert
- Y bridges have stable, non-eroding abutments & do not significantly restrict design flood
- Y fills are stable (unstable fills are removed or stabilized)
- Y road surfaces and ditches are disconnected from streams and stream crossing culverts
- Y decommissioned roads have all stream crossings completely excavated to original grade
- Y Class 1 (fish) streams accommodate fish passage

ROAD AND LANDING FILLS

- Y unstable and potentially unstable road and landing fills are excavated (removed)
- Y excavated spoil is placed in locations where eroded material will not enter a stream
- Y excavated spoil is placed where it will not cause a slope failure or landslide

ROAD SURFACE DRAINAGE

- Y road surfaces and ditches are disconnected from streams and stream crossing culverts
- Y ditches are drained frequently by functional rolling dips or ditch relief culverts
- Y outflow from ditch relief culverts does not discharge to streams
- Y gullies (including those below ditch relief culverts) are dewatered to the extent possible
- Y ditches do not discharge (through culverts or rolling dips) onto active or potential landslides
- Y decommissioned roads have permanent road surface drainage and do not rely on ditches

For crossings on native roads, a non-trenched excavation will be applied. To install a new pipe at the natural channel gradient, a deep crossing will require the excavator to open up a crossing completely to allow room for laborers to safely replace or install the pipe at the base of the fill. The excavation will require sideslopes be excavated back at a 1:1 slope (at least), which differs significantly from a typical trenched excavation. Approximately 100 yds^3 of material will be stockpiled on-site and the remaining road fill will need to be endhauled to a temporary storage location. The new pipe will be installed using the locally stockpiled spoils for a compacted bed.

Road decommissioning basically involves reverse road construction, except that full topographic obliteration of the road bed is not normally required to accomplish sediment prevention goals. Generic treatments for decommissioning roads and landings range from outsloping or simple cross-road drain construction to full road decommissioning (closure), including the excavation of unstable and potentially unstable sidecast materials and road fills, and all stream crossing fills. Twenty (20) sites located in the assessment area have been recommended for temporary or permanent closure.

Recommended Treatments

Basic treatment priorities and prescriptions were formulated concurrently with the identification, description and mapping of potential sources of road-related sediment yield. Table 2 and Map 3 outline the treatment priorities for all 32 sites with future sediment delivery that have been recommended for treatment in the assessment area. Of the 32 sites with future sediment delivery that have been recommended for treatment, four (4) sites were identified as having a high or high-moderate treatment immediacy with a potential sediment delivery of approximately 1,499 yds^3. Twenty (20) sites were listed with a moderate or moderate-low treatment immediacy and account for nearly 2,796 yds^3 of future sediment delivery. Finally, eight (8) sites were listed as having low treatment immediacy with approximately 1,015 yds^3 of future sediment delivery.

Table 3 summarizes the proposed treatments for sites inventoried in the assessment area. These prescriptions include both upgrading and road closure measures. The database, as well as the field inventory sheets, provides details of the treatment prescriptions for each site. Most treatments require the use of heavy equipment, including an excavator, dozer, dump truck and or grader. Some hand labor is required at sites needing new culverts, downspouts, trash racks and/or for applying seed, plants and mulch following ground disturbance activities.

A total of 6 culverts are recommended for installation, either to upgrade an existing culvert or to install culverts at unculverted stream crossings (Table 3). Four (4) of the 6 upgraded stream crossings are on paved roads. It is estimated that erosion prevention work will require the excavation of approximately 4,029 yds^3 at 22 sites. Approximately 91% of the volume excavated is associated with upgrading or excavating stream crossings and about 7% is proposed for excavating potentially unstable road fills (landslides). We have recommended construction of 30 rolling dips on unpaved roads and installation of 1 ditch relief culvert at selected locations and at spacing dictated by the steepness of the road. A total of 15 yds^3 of mixed and clean rip-rap sized rock is to be used to armor three (3) armored inboard fill faces and a headcut. An additional 10 yds^3 of rip-rap is required to construct an armored fill crossing. Approximately 4,450 yds^3 of road rock is required to rock the road surface at 30 rolling dips, 6 stream crossing culvert installations and 1 ditch relief culvert. Re-rocking has been prescribed wherever treatments will disturb the existing road surface or where culverts are being replaced.

For one deep stream crossing where an excavator cannot reach the natural stream bottom for placement of the culvert at the natural channel gradient, a downspout has been prescribed to transport the stream flow beyond the road fill to the natural stream bottom. To prevent potential stream diversions, each site with a high diversion potential has been prescribed to have a critical dip.

All recommended treatments conform to guidelines described in “The Handbook for Forest and Ranch Roads” prepared by PWA (1994) for the California Department of Forestry, Natural Resources Conservation Service, and the Mendocino County Resource Conservation District.

Table 2. Treatment priorities for all sites recommended for treatment in the Wing Canyon assessment area, Napa County, California

Treatment Priority	Upgrade sites (# and site #)	Decommission sites (# and site #)	Problem	Future sediment delivery (yds^3)
High	**0**	**1** (site #: 30)	1 stream crossing	281
High Moderate	**1** (site #: 9)	**2** (site #: 11, 29)	3 stream crossings	1,218
Moderate	**6** (site #: 2, 4, 6, 21, 31, 33)	**7** (site #: 12, 13, 15, 17, 19, 23, 32)	10 stream crossings, 1 landslide, 2 other	2,356
Moderate Low	**1** (site #: 1)	**6** (site #: 7, 16, 18, 20, 25, 28)	3 stream crossings, 1 landslide, 3 other	440
Low	**4** (site #: 3, 8, 14, 22)	**4** (site #: 5, 24, 26, 27)	5 stream crossings, 1 ditch relief culvert, 2 other	1,015
Total	**12**	**20**	**22 stream crossings, 2 landslides, 1 ditch relief culvert, 7 other**	**5,310**

Table 3. Recommended treatments along inventoried roads in the Wing Canyon assessment area, Napa County, California.

Treatment	No.	Comment	Treatment	No.	Comment
Install CMP	1	Install a CMP at an unculverted fill	Rock road	37	Rock road surface using 37 yds^3 of rock (includes road rock for post installation for 30 rolling dips, 6 stream crossings, and 1 ditch relief culvert)
Replace CMP	5	Upgrade an undersized CMP	Install rolling dips	30	Install rolling dips to improve road drainage
Excavate soil	22	Typically consisting of fillslope & stream crossing excavations; permanent excavation of 4,029 yds^3	Install ditch relief CMP	1	Install ditch relief culvert to improve road surface drainage
Downspouts	1	Installed on stream crossing to protect fillslope erosion	Install cross road drains	77	Install cross road drains to improve road drainage
Install wet crossing	1	Install 1 armored fill using 10 yds^3 of rip rap	Clean/cut ditch	1	Clean/cut 350' of ditch to improve road surface drainage
Armor fill face or headcut	3	Rock armor to protect inboard fillslopes, and headcuts from erosion using 15 yds^3 of rock	Other	5	Miscellaneous treatments
Install trash rack	1	Installed to prevent culvert from plugging	No treatment recommended	1	

Equipment Needs and Costs

Treatments for the 32 sites identified with future sediment delivery in the Wing Canyon assessment area will require approximately 135 hours of excavator time and 197 hours of dozer time to complete all prescribed upgrading, decommissioning, and erosion control and erosion prevention work (Table 4). Excavator and dozer time is not needed at all sites that have been recommended for treatment and, likewise, not all the sites will require both a dozer and an excavator.

Approximately 69 hours of dump truck time has been listed for work in the basin for end-hauling excavated spoil from stream crossings and at unstable road and landing fills where local disposal sites are not available. Approximately 5 hours of grader time is needed to re-grade the road following upgrade treatments. In addition, 38 hours of labor time is needed for a variety of tasks such as installation or replacement of culverts, and installation of debris barriers and downspouts. An additional 43 hours of labor are needed for seeding, mulching and planting activities.

Table 4. Estimated heavy equipment and labor requirements for treatment of all inventoried sites with future sediment delivery, Wing Canyon watershed assessment area, Napa County, California. [1]

Treatment Immediacy	High, High/Moderate	Moderate, Low/Moderate	Low	**Total**
Site (#)	4	20	8	**32**
Total Excavated Volume (yds^3)[2]	1,890	2,274	396	**4,560**
Excavator (hrs)	41	68	26	**135**
Dozer (hrs)	65	93	39	**197**
Dump Trucks (hrs)	28	25	16	**69**
Labor (hrs)	6	21	11	**38**

[1] Estimated equipment times do not include daily lowboy or travel costs to treatment sites.
[2] Total excavated volume includes permanently excavated material and a percentage of temporarily excavated materials used in backfilling upgraded stream crossings at non-trench installations.

Overall site specific erosion prevention work: Equipment and labor needs for site specific erosion prevention work at sites with future sediment delivery are expressed in the database, and summarized in Table 4, as direct excavation times, in hours, to treat all sites having a high, moderate, or low treatment immediacy. These hourly estimates include only the time needed to treat each of the sites, and do not include travel time between work sites, times for basic road surface treatments that are not associated with a specific "site", or the time needed for work conferences at each site. These additional times are accumulated as "logistics" and must be added to the work times to determine total equipment costs shown in Table 5. Finally, the

Table 5. Estimated logistic requirements and costs for road-related erosion control and erosion prevention work in the Wing Canyon sub-watershed assessment area, Napa County, California

Cost Category[1]		Cost Rate[2] ($/hr)	Estimated Project Times: Treatment[3] (hours)	Logistics[4] (hours)	Total (hours)	Total Estimated Costs[5] ($)
Move-in; move-out[6] (Low Boy expenses)	Excavator	100	3	--	3	300
	Dozer	100	3	--	3	300
Road opening costs	Excavator	165	4	--	4	660
Heavy Equipment requirements for site specific treatments	Excavator	165	135	41	176	29,040
	Dozer	140	197	59	256	35,840
	Dump truck	75	69	21	90	6,750
Heavy Equipment requirements for road drainage treatments	Excavator	165	3	1	4	660
	Dozer	140	70	21	91	12,740
	Grader[7]	120	5	2	7	840
Laborers[8]		40	81	24	105	4,200
Water truck[9]		90	40	12	52	4,680
Rock Costs: (includes trucking for 25 yds^3 of rip-rap sized rock and 430 yds^3 of road rock)[10]						13,650
Culvert materials costs (20' of 18", 80' of 24", 130' of 36", and 210' of 72". Costs included for couplers and elbows.)						17,571
Mulch, seed and planting materials for approximately 2.7 acres of disturbed ground[11]						1,490
Layout, Coordination, Supervision, and Reporting[12]						25,751
Total Estimated Costs						**$154,472**
Potential sediment savings: 5,310 yds^3						
Overall project cost-effectiveness: $29.09 spent per cubic yard saved						

[1] Costs for tools and miscellaneous materials have not been included in this table. Costs for administration and contracting are variable and have not been included.

[2] Costs listed for heavy equipment include operator and fuel. Costs listed are estimates for favorable local private sector equipment rental and labor rates.

[3] Treatment times include all equipment hours expended on excavations and work directly associated with erosion prevention and erosion control at all the sites and road reaches.

[4] Logistic times for heavy equipment (30%) include all equipment hours expended for opening access to sites on un-maintained roads, travel time for equipment to move from site-to-site, and conference times with equipment operators at each site to convey treatment prescriptions and strategies. Logistic times for laborers (30%) include estimated daily travel time to project area.

[5] Total estimated project costs listed are averages based on private sector equipment rental and labor rates.

[6] Lowboy hauling for tractor and excavator, 3 hours round trip for one crew to areas within the Wing Canyon watershed. Costs assume 1 haul each for two pieces of equipment (one to move in and one to move out).

[7] An additional 5 hours of grader time is added to re-grade upgraded roads post treatment.

[8] Thirty-eight (38) hours of labor time is needed to assist with site work, and 43 hours of labor time are added for straw mulch and seeding on stream crossing culvert installations and stream crossing decommission excavations.

[9] Water truck hours include, 100% of the excavator hours during the backfill of stream crossing installation and 100 % of the dozer hours for rolling dip construction.

[10] Road rock volumes added to treat trench stream crossing culvert installations on paved roads instead of re-asphalt costs. Additional asphalt costs will need to be added if desired.

[11] Seed costs equal $6/pound for erosion control seed. Seed costs based on 50 lbs. of erosion control seed per acre. Straw costs include 50 bales required per acre at $5 per bale. Sixteen hours of labor are required per acre of straw mulching.

[12] Supervision time includes all direct and indirect costs associated with detailed layout (flagging, etc) prior to equipment arrival, training of equipment operators, supervision during equipment operations, supervision of labor work and post-project documentation and reporting).

estimated equipment time needed to reconstruct or open roads which have been abandoned are listed as a separate line item in Table 5.

The costs in Table 5 are based on a number of assumptions and estimates, and many of these are included as footnotes to the table. The costs provided are assumed reasonable if work is performed by outside contractors, with no added overhead for contract administration and pre- and post-project surveying. Movement of equipment to and from the site will require the use of low-boy trucks. The majority of treatments listed in this plan are not complex or difficult for equipment operators experienced in road upgrading and road decommissioning operations on forest lands. The use of inexperienced operators or the wrong combination of heavy equipment would require additional technical oversight and supervision in the field, as well as escalation of costs to implement the work.

Table 5 lists a total of costs for detailed pre-work layout, project planning (coordinating and securing equipment, materials and obtaining plant and mulch materials), on-site equipment operator instruction and supervision, implementation monitoring, establishing effectiveness monitoring measures, and post-project cost effectiveness analysis and reporting. It is expected that the project coordinator will be on-site full time at the beginning of the project and intermittently after equipment operations have begun.

Estimated costs for erosion prevention treatments - Prescribed treatments are divided into two components: a) site specific erosion prevention work identified during the watershed inventories and b) control of persistent sources of road surface, ditch and cutbank erosion and associated sediment delivery to streams. The site specific work is further divided into road upgrading activities and road closure (decommissioning) activities. The total costs for road-related erosion control at sites with future sediment delivery is estimated at approximately $154,508 for an average cost-effectiveness value of approximately $29.10 per cubic yard of sediment prevented from entering into streams (Table 5).

Conclusion

The expected benefit of completing the erosion control and prevention planning work lies in the reduction of long-term sediment delivery to Wing Canyon and ultimately to Dry Creek, an important salmonid stream. A critical first-step in the overall risk-reduction process is the development of a watershed transportation analysis and plan for erosion prevention and erosion control on roads. In developing this plan, selected roads in the watershed were considered for either decommissioning or upgrading, depending upon the risk of erosion and sediment delivery to streams and the owner’s needs. Not all roads are high risk and those that pose a low risk of degrading aquatic habitat in the watershed may not need immediate attention. It is therefore important to rank and prioritize roads in each sub-watershed, based on their potential to impact downstream resources, as well as their importance to the overall transportation system and to management needs. PWA can work with landowners to make recommendations that achieve both long-term sediment delivery reductions, access, and management requirements.

Good land stewardship requires that roads be either upgraded and maintained, or intentionally closed (put-to-bed). Most currently open and maintained roads within the assessment area were recommended for upgrade treatments. Un-maintained and/or abandoned roads were evaluated on a road by road basis to determine whether roads should be upgraded or decommissioned. With this prioritized plan of action, the landowners can seek funding to implement all or a portion of this project.

Road upgrading consists of a variety of techniques employed to storm-proof a road and prevent unnecessary future erosion and sedimentation. This requires a proactive investment in the basic infrastructure of the transportation network. Storm-proofing typically consists of stabilizing slopes and upgrading drainage structures so that the road is capable of withstanding both annual and winter rainfall and runoff, as well as a large storm event, without failing or delivering excessive sediment to the stream system. In fact, many of the drainage structures (culverts) at inventoried stream crossings are nearing the end of their useful life. They are rusted out and beginning to fail through erosion and collapse of the fill. These will need to be replaced, and this presents an opportunity to upgrade each aging drainage structure with one that better meets today's higher standards. The goal of road upgrading is to strictly minimize the contribution of fine sediment from roads and ditches to stream channels, as well as to minimize the risk of serious erosion and sediment yield when large magnitude, infrequent storms and floods occur.

The proper word for pro-active road closure is "decommissioning". Properly decommissioned roads no longer require maintenance and are no longer sources of accelerated erosion and sediment delivery to a watershed's streams. The impacts of reopening old, abandoned roads so that they can be correctly decommissioned has been evaluated on a case-by-case basis, but the benefits (large reductions in long term erosion) almost always far outweigh the negative effects of small, short term increases in erosion from bare soil areas.

Decommissioning does not necessarily suggest permanent closure. Most decommissioned roads, if they are needed, can be re-opened by simply reinstalling the stream crossings and regrading the former road bed. Some roads inventoried in the Wing Canyon assessment area have been recommended for permanent closure. Road surfaces along these roads will be ripped and re-planted.

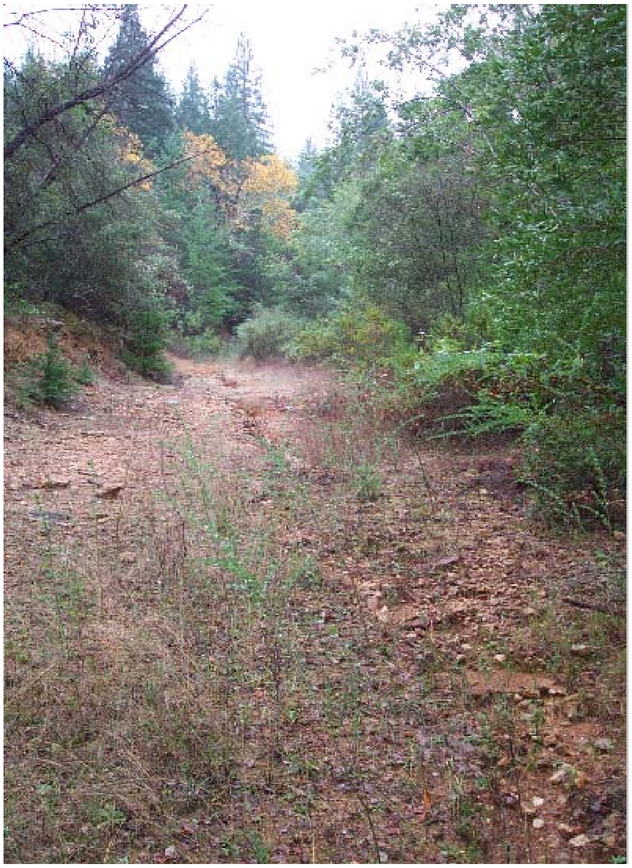

Figure 4. View of a gully down the roadbed at site #22.

Figure 5. Two concrete 36” culverts and 1 steel 36” culverts and sandbag crossing at site #11 on Wing Canyon. Decommission of crossing fill is proposed.

Figure 6. Gully down hillslope below the pond overflow culvert at site #6.

Figure 7. Gully from diverted stream at site #30. Proposed treatment is to excavate the fill at the stream crossing.

References

California Department of Fish and Game. 1998. California Salmonid Stream Habitat Restoration Manual, 3rd Edition. Inland Fisheries Division.

Harr, R.D. and R.A. Nichols. 1993. Stabilizing forest roads to help restore fish habitats: A Northwest Washington example. Fisheries. Vol.18, no. 4. pages 18-22.

Hicks, L. 1978. The History of Mount Veeder.

Napa County Resource Conservation District, 1997-2000. Minutes from the Dry Creek Stewardship Group History Tea Party Meetings.

Napa County Resource Conservation District. 2001. Dry Creek Watershed Planning Project: Year 1 Progress Report. Prepared for the California Department of Fish and Game.

Napa County. 1993. Digital Orthophoto Quadrangles.

Pacific Watershed Associates. 1994. Handbook for forest and ranch roads. Prepared for the Mendocino County Resource Conservation District in cooperation with the California Department of Forestry and the U.S. Soil Conservation Service. Mendocino Resource Conservation District, Ukiah, California. 163 pages.

Pacific Watershed Associates. 2003. Final Summary Report. 2001 S.B. 271 Road Assessment and erosion Prevention Planning Project for the Dry Creek Watershed, Napa, County, California. Prepared for the Napa County Resource Conservation District in cooperation with the California Department offish and Game. January, 2003. 41 pages.

Sinclair, H. 2000. Time Line for Enchanted Hills.

Weaver, W.E. and D.K. Hagans. 1999. Storm-proofing forest roads. In: Proceedings of the Skyline Forest Sedimentation Conference, Corvallis, Oregon. April, 1999, pages 230-245.

Weaver, W.E., D.K. Hagans and M.A. Made. 1987. Managing forest roads to control cumulative erosion and sedimentation effects. In: Proc. of the California watershed management conference, Report 11 (18-20 Nov. 1986, West Sacramento, Calif.), Wildland Resources Center, Univ. of California, Berkeley, California. 6 pages.