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Steelhead Habitat Assessment and Restoration in Upper Williams Canyon Creek: Mitteldorf Redwood Preserve, Monterey County, California

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Summary

The following report presents the results of a study performed under subcontract between the Big Sur Land Trust (BSLT) and the Watershed Institute through The Foundation of California State University Monterey Bay (CSUMB). Faculty, staff, and students at the Watershed Institute at CSUMB conducted the research and writing between August 2001 and Winter 2003. The report was presented to the BSLT in paper and electronic PDF formats, with a GIS Arcmap project addendum. A copy of the report and GIS project are archived with the Central Coast Watershed Studies (CCoWS) group at the Watershed Institute of CSUMB.

Upper Williams Canyon is a small, but critically-important, headwater subwatershed of the San Jose Creek watershed system located south of the Carmel Valley in Monterey County, California (Fig. 1). San Jose Creek has historically supported steelhead trout. The primary goal of this management plan is to develop a guideline for restoring the anadromous fisheries of this tributary of San Jose Creek. Because of ongoing San Jose Creek watershed development, this subwatershed is now the keystone of any fishery restoration because it alone has perennial flow and good restoration potential.

Although damaged by past logging and road construction, the Mitteldorf lands in Upper Williams Canyon are the key to sustained perennial flow from fractured granitic bedrock and associated food sources to sustain spawning steelhead in both the lower part of the Mitteldorf lands and along Williams Canyon below the Mitteldorf Reserve. The single most serious threat that must be rectified to support salmonids in Williams Canyon is that of episodic sediment release associated with logging and access roads. If cost and continued access were not concerns, the best management strategy would be to fully restore the road network in the watershed. This is the approach used to preserve the riparian habitat of Redwood National Park. It involves "pulling" all road prisms to refill the road cuts with the material originally removed from them, regrading and restoring all gullies and slides caused by past land abuses, reintegrating all drainages on hillslopes, and fully revegetating all modified land surfaces with native plant communities. But at Mittledorf not all the roads can be "put to bed" in this fashion because some access routes are to be maintained, and because costs cannot be borne by the entire nation. Here a modified "road rehabilitation and restoration" effort must be used that prioritizes restoration efforts based on potential sediment yield and that does not try to reduce all sediment yield to conditions that would exist prior to any modification. If maintenance of those road segments that must remain is not effected, roads will wash out and future repairs will be costly in terms of both increased sediment yield and increased monetary costs.

The stream gradients in Williams Canyon are steep enough to allow transport of most sediment delivered to the stream during any bankfull (1.5 to 2-year return period) winter flood flow. This sediment will fill pools or small undercut protected habitats that are vital for growth of young-of-the-year until it is flushed downstream. Restoration should minimize this episodic filling of

small step-pool habitats. If coupled with removal of migration barriers in the main San Jose Creek channel below its junction with Williams Canyon, spawning habitat might be restored downstream to Highway One. Williams Canyon restoration will contribute to improve overall steelhead habitat in the entire San Jose Creek watershed because it serves to maintain both summer low flow and winter flushing flows in the main lower canyon. By reducing sediment delivery to upper Williams Canyon, we permit natural stormflow to be effective to flush sediment from the lower San Jose Creek. If downstream barriers to fish migration could all be removed and road-related sediment delivery were minimized on the Mitteldorf parcel, then the historic steelhead runs may be restored to the entire watershed below and including Williams Canyon.

Our management plan sets the following priorities.

1. Preserve and foster local and regional groundwater resources in order to ensure a sustainable perennial surface water flow. Advocate groundwater conservation among upper watershed partners on adjoining parcels.
2. Reduce the sediment load by decommissioning and reducing future sediment delivery from a series of old logging roads and landings. Advocate sediment control among other San Jose Creek watershed partners.
3. Remove unnatural fish migration barriers located below the Mitteldorf lodge. Advocate migration barrier removal with downstream watershed partners as a highest priority.

Future work should include an analysis of surface and groundwater budgets (volumes over time) to better understand the local links between groundwater and surface water as a means of preserving sources of perennial flow. Additional work includes a monitoring program to assess how both restored sites and un-restored sites evolve toward recovery or further degradation. With monitoring information, a responsive iterative management program can evolve to optimize sediment control in the watershed.

Although many restoration projects we recommend could begin immediately, some of the more challenging restoration projects, including decommissioning several miles of old roads will require the work of specialist consultants.

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A: Purpose and Scope of Report

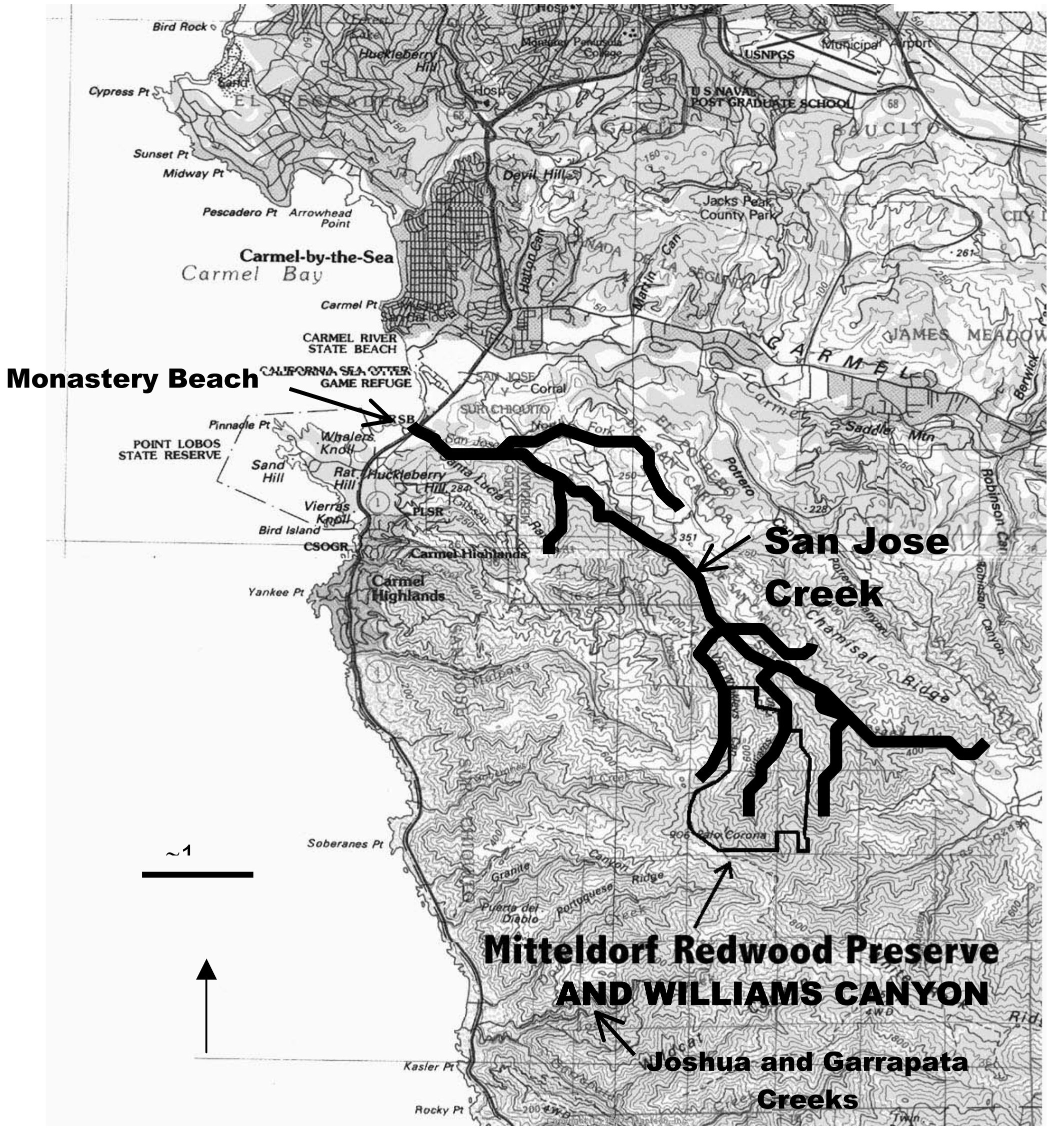
Williams Canyon Creek (Monterey County, CA) is a tributary to San Jose Creek, which enters the sea at Monastery Beach just south of Carmel Valley (Fig. 1). San Jose Creek is within a U.S. Fish & Wildlife-identified Evolutionary Significant Unit for the Federally-listed Southern Steelhead Trout. The upper watershed was selectively logged in the early 1980s, just prior to property transfer to the Big Sur Land Trust (BSLT), which now owns and manages the land. Logging roads, river crossings, and various other logging infrastructure were not properly decommissioned at the end of the logging activities, leaving the watershed impaired as anadromous fish habitat. This report presents a watershed management plan for the upper watershed of Williams Canyon Creek. The management activities we recommend have a principal goal of restoring the landscape to pre-disturbance conditions for the benefit of anadromous fisheries. The scope of the report includes:

- inventory of near-channel sediment sources impacting the creek,
- inventory of potential and current sediment sources associated with a road and trail network,
- inventory of fish migration barriers in reaches of the creek with the potential to sustain salmonid spawning,
- analysis of a 12 month discharge record
- prioritization of management activities, leading to improved fisheries through reduction of chronic fine sediment sources and migration barriers.

B: Introduction

The present physical and ecological conditions of the coastal watersheds of California are the net result of the integration of a wide range of variables, including events that occurred in the ancient past. Although we concentrate in this report on the negative impacts of recent anthropogenic disturbance, there is much to be learned about how the watershed will respond to these recent impacts by putting the recent events within the context of what has come before. Thus the report begins with a brief geologic and land-use history.

Figure 1: Location of Mitteldorf Redwood Preserve



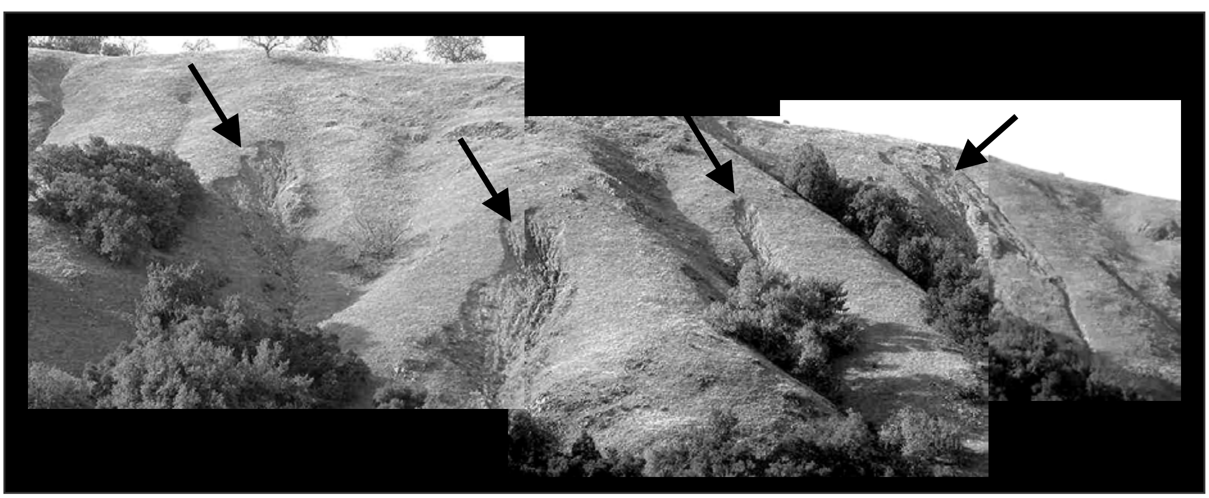
1. Geologic History: Two Million Years of Landslides

Williams Canyon dissects the northern part of the Santa Lucia Range, within the Coast Ranges geomorphic province. This part of the Santa Lucia Range is underlain by approximately 100 million year old, locally-faulted Santa Lucia Granodiorite (Mattinson and James, 1985; Kistler and Champion, 2001). These "granitic" rocks are part of the Salinian Terrane that has moved northward over the past several million years from an origin just south of the Sierra Nevada Mountains (Mattinson and James, 1985). As a side note, the closest genetic neighbors to the coastal redwoods are the Sequoias of the Sierra Nevada Mountains, so the genetic ancestors of the coastal redwoods in Williams Canyon may well be Sierran redwoods that long ago rafted northward atop the Salinian Terrane.

Recent studies suggest that the Santa Lucia Range stood considerably taller 2 million years ago. Thereafter, the western side of the range, including Williams Canyon, has had a very high erosion rate (>1mm/yr) during the last 2 million years, thereby rapidly lowering the mean elevation of the range (Ducea et al., 2002). Because the rate of sediment export exceeds the rate of river incision, it is likely that slope failure, including landslides, is the natural, dominant mode of rock exhumation in this region (Ducea et al., 2002). Willis et al. (2001) mapped over 1500 landslides along Highway 1 between San Capoforo Creek and Point Lobos, just northwest of Williams Canyon, suggesting that the inferred dominance of slope-failure processes, initiated 2 million years ago, continues today.

The Santa Lucia Granodiorite underlying the watershed weathers to a reddish brown grus and sandy soil with good drainage. According to our observations, it is prone to shallow slope failure by colluvial creep and by both debris flow and landslides comprising colluvium and weathered rock. There is evidence for historic and active slope failure in both the grassy slopes and forested regions of the upper watershed. Large landslides present in the Williams Canyon watershed have been typical of the region for 2 million years, and clearly represent one of the natural pathways of sediment into Williams Canyon Creek (Fig. 2). The landslides shown in Figure 2 are not visible on a 1-m resolution aerial photograph from 1994, indicating that these are new features, likely generated during the 1995 or 1998 El Nino events. Considering that landslide processes can periodically deliver very high volumes of sediment to a valley bottom, it is likely that Williams Canyon Creek has witnessed countless episodes of catastrophic sediment input in the geologic, and more recent prehistoric, past. We note that the creek bottom is locally now resting on granitic bedrock, indicating that the combined hydrology and geomorphology of the canyon has been able to process and transport all of that sediment out of the upper watershed. On the other hand, most of the pools are currently filled with sand and fine sediment, indicating the presence of chronic fine sediment sources. In addition to sporadic high flow events, a strong perennial base flow of water can be effective in moving fine sediment through the system, keeping the pools flushed of silt and clay.

Figure 2: Soil-slip landslides in grassland vegetation on west canyon slope



Based upon the evidence, it is our opinion that upper Williams Canyon has sporadically experienced very high sediment loads from various kinds of naturally occurring landslides.

These landslide events likely delivered high volumes of sediment and large woody debris to the creek. It is very likely that, at times, the creek experienced periods of sediment infilling behind natural debris dams, and may have experienced periods of more widespread valley filling as well. These periods with sediment surplus were interwoven with periods of sufficient hydrologic work to gradually transport these slugs of sediment out of the upper watershed, and to gradually rot and dismantle the debris jams. Since periods of sediment and debris accumulation are likely associated with impaired fisheries, and periods with few migration barriers and clean gravel are related to excellent fisheries, it would follow that there have been innumerable times in the ancient and recent past when fisheries were naturally impacted and naturally restored. We view this canyon as a very dynamic place, where, over time, the watershed has been able to naturally process the sediment naturally delivered to it, while accommodating native fisheries.

2. Land-use History and Impacts

The first owner of record in Monterey County was the Sergents family who owned the parcels now called the Mitteldorf Preserve and Little Horse Ranch. Steven Fields bought the land in 1931 and built the lodge and bunkhouse. The Fields sold the property to the Bishop family in 1949. The Bishops sold the property to the Carter brothers in 1955. The Carter brothers built the first road network in the watershed between 1955 and 1965. The Morain family purchased the land in 1965. In 1978, the Morains sold the property to the Westbrook Land and Timber Company who contracted to liquidate the timber reserves in order to pay off the land in two parcels. Westbrook eventually paid for the Mitteldorf Preserve section, but allowed the bank to foreclose on the parcel now known as Little Horse Ranch (Price, 1994).

In 1983 the Westbrook Company improved the roads to allow logging trucks to remove approximately 3 million board feet of selectively cut redwood. After a 1988 proposed timber sale was met with strong public resistance, the BSLT purchased the property to create the Mitteldorf Preserve (Price, 1994).

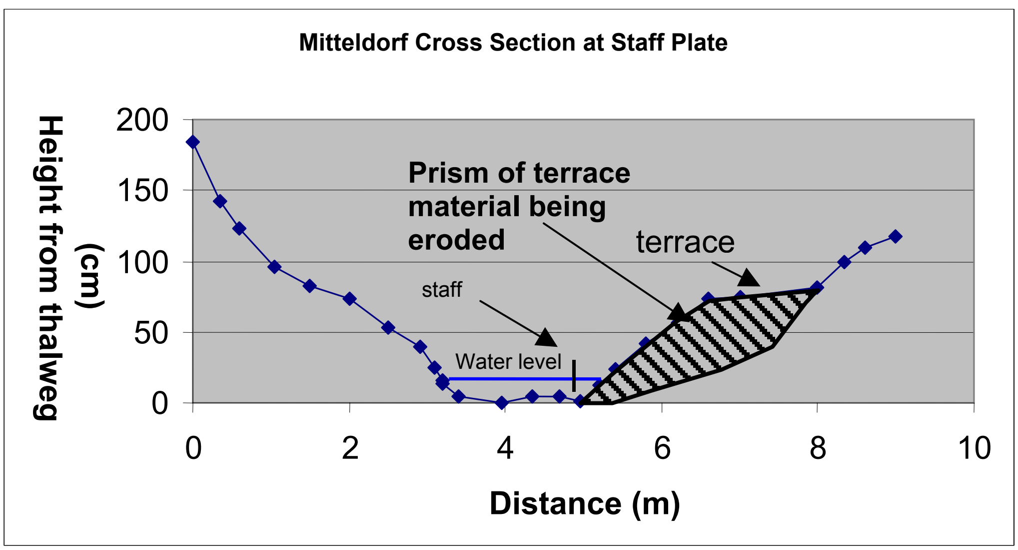
Given that the region has inherently unstable slopes and soils with “very high” erosion hazard indices (Table 1; USDA, 1978), human impacts, such as road construction and logging have the potential to greatly accelerate the delivery of sediment to local creeks. Willis et al. (2001) noted that highly erodible soils are characteristic along much of the western flank of the Santa Lucia Range. Vincent (2002) used a paired watershed study to demonstrate a very great increase in sediment load associated with road construction in Joshua Creek watershed adjacent to Williams Canyon. Vincent (2002) notes that the pool habitat of Joshua Creek (Fig. 1) is filling with fine-grained sediment, impairing trout habitat, as a result of the high sediment loads. We observe the same relationship in upper Williams Canyon where there is abnormally high sediment delivery to the creek because of failing road systems and stream crossings. The storm flows of 1995 and 1998, transported very high sediment and debris loads as indicated by high water deposits and failed culverts.

There are three basic impacts resulting from human activities in the watershed. First, there is high sediment and debris delivery rate from chronic upland and near-channel sediment sources as indicated by partially, or completely, filled pool volume. Second, the debris and sediment have locally formed debris jams that act as fish migration barriers. Third, excess sediment, deposited some time ago in channel-side terraces, is now eroding.

A typical cross section of Williams Canyon Creek shows a considerable volume of sediment stored in channel-side terraces (Fig. 3). At some time in the past several decades, sediment was delivered to the Creek far in excess of the Creek's ability to transport it. Sediment that could not be transported filled the canyon bottom with a long, "v"-shaped prism of sediment that is incrementally being transported out of the canyon today. The Creek has cut down through the prism(Fig. 3), locally reaching bedrock, and each year it moves a little more of the stored sediment by eroding laterally through the terrace. The terrace was likely the result of poor land-use and heavy winter rains that destabilized the landscape. Thus, there is presently a background of fine sediment mobilization and transport associated with that terrace system. There is also background fine sediment delivered to the stream from numerous landslides, gullies, and failed culverts and road crossings.

The logging activities in the 1980s generated an abnormally high supply of cut timber and slash on the side slopes of the canyon. This logging debris has locally washed into the creek forming debris jams that act as barriers to fish migration. It is typical of streams such as Williams Canyon to sporadically form migration barriers as landslides contribute material to the canyon bottom, but based upon the amount of cut wood we see in the debris jams, it is likely that the creek now has debris jams in excess of what we would expect naturally.

Figure 3: Sediment Stored in small terrace.



3. Physical and Hydrological Metrics of the Watershed

The various geomorphic metrics of Williams Canyon Creek and watershed are summarized in Table 1. Williams Canyon Creek is a Strahler third-order, step-pool stream that has a substrate ranging from bedrock to small gravel, with rare deposits of sand. The Rosgen (1994) channel classification is typically A and B, with minor reaches of C, G and F. The channel drains a 5 km^2, steep, high relief watershed. The upper watershed is well vegetated, comprising a mixture of redwood, oak, chaparral, and grassland vegetation. The roughly 5 km^2 (1.9 mi^2) watershed has approximately 16 km (10 mi) of dirt roads in varying states of repair and decay.

The soils on the property include the Gamboa-Sur complex and Junipero-Sur complex soils, which have a "very high" erosion hazard (USDA, 1978).

Table 1: Physical Characteristics of Upper Williams Canyon Watershed and Creek

Drainage area	5.0 km^2 (1.9 mi^2)
Dominant aspect	010°, but all aspects present
Length	4.4 km (2.8 mi)
Divide elevation	960 m (3150 ft)
Confluence elevation	260 m (850 ft)
Relief	700 m (2300 ft)
Average slope	0.15 or 15%
Strahler stream order	3^{rd}
Network geometry	Dendritic
Dominant stream types (Rosgen, 1994)	B1, B2, B3
Road Length	16 km (10 mi)
Vegetation types	Redwood, oak, chaparral, grassland
Soil Series	Gamboa-Sur complex and Junipero-Sur complex; stony loamy sands

Sporadic measurements of surface flow were initiated on February 11, 2000. A continuously recording stage gage was installed on March 10, 2000 and removed on August 20, 2001. Other flow measurements were taken in July and August of 2000 and March and April of 2002. The gage record, in combination with our sporadic observations during even the driest months of the year indicate that Williams Canyon Creek yields a low, but significant perennial base flow (Fig. 4). It is the incremental addition of base flow from numerous subwatersheds of the upper San Jose Creek system that is vital for supporting a healthy perennial flow for fisheries in the lower reaches of San Jose Creek.

Figure 4: Annual Hydrograph of Williams Canyon Creek Near the Lodge. Time axis is abbreviated Month_year

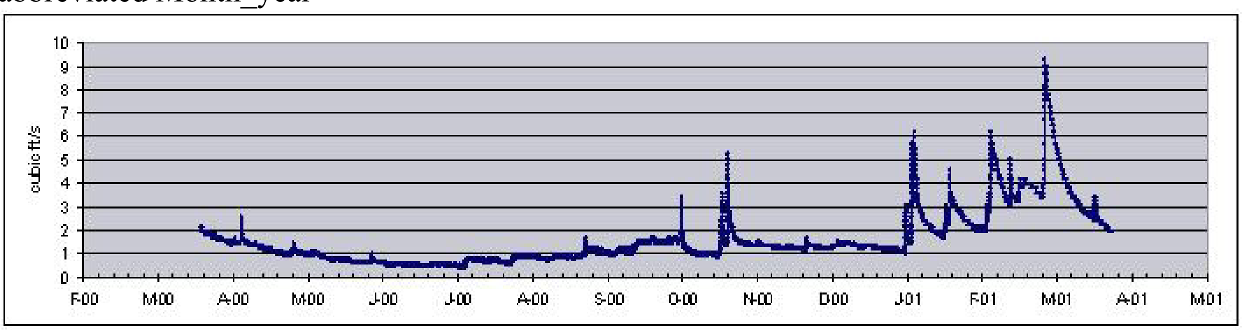


Figure 5 is a histogram of the monthly water volumes gaged near the lodge on Williams Canyon Creek. The gage record indicates that the 5 km^2 (1.9 mi^2) upper Williams Creek watershed produced 40,850 m^3 during even the driest month of our record, July, 2000 (Table 2; Fig. 5). Garrapata Creek (Fig. 1), a neighboring watershed with comparably little development and roughly five times the drainage area, produced 81,350 m^3 of flow in July of 2002, a relatively dry year. This suggests that local undeveloped watersheds typically provide somewhere between 8100 and 8200 m^3 of water per square km of watershed during the driest months of the year. According to that formula, San Jose Creek upstream from Williams Canyon (7.7 km^2) should provide an additional 63,000 m^3 of base flow during dry summer months. Sporadic observations suggest that the branch of San Jose Creek upstream from the confluence of Williams Canyon Creek falls far short of this rough index. If action is not taken to improve the sustainable surface water yield of upper San Jose Creek, then the vital role of upper Williams Canyon Creek in supporting the fisheries of this region cannot be overstated.

Figure 5: Monthly Surface Water Flow from Williams Canyon (4/2000-3/2001)

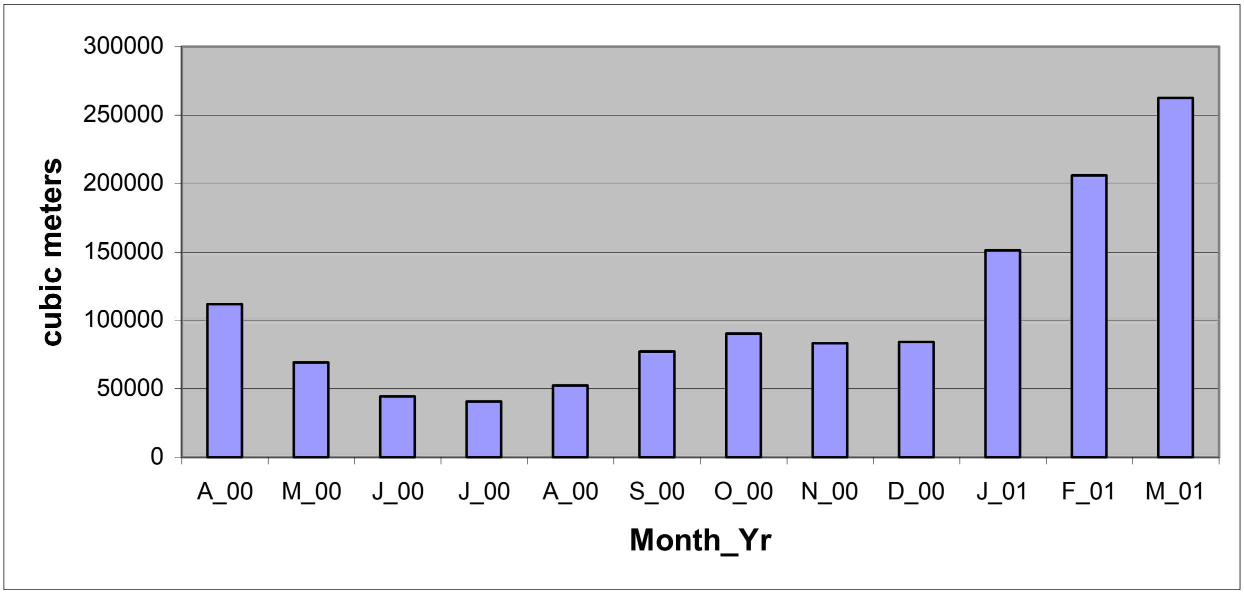
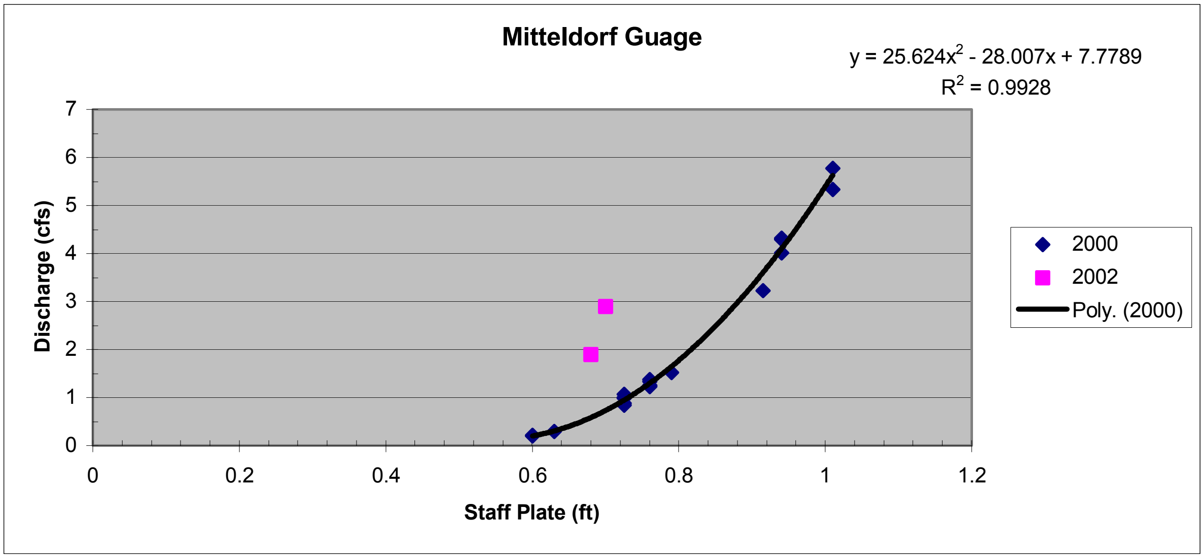


Table 2: Annual Volume of Surface Water Flow

Month	m^3	ft^3	acre-feet
A_00	111700	3942000	90.50
M_00	69250	2444000	56.10
J_00	44450	1569000	36.01
J_00	40850	1441000	33.08
A_00	52450	1851000	42.49
S_00	77350	2729000	62.66
O_00	90550	3196000	73.36
N_00	83300	2939000	67.47
D_00	84450	2980000	68.41
J_01	151350	5340000	122.60
F_01	206100	7272000	166.96
M_01	262650	9269000	212.78
	--------------	--------------	--------------
Total	**1274450**	**44972000**	**1032.42**

A stage-discharge relationship was developed to convert stage (ft) recorded by the gage to discharge (ft^3/s). An index of stream stability is the stability of the stage-discharge relationship through time. An analysis of the change in stage-discharge relationship (Fig. 6) shows between 0.12 ft and 0.20 ft of stage decrease for a constant discharge between Spring 2000 and Spring 2002. This change is due to a change in channel shape during that interval or a change in the gage pool control. The channel could have become slightly wider and/or deeper. The change in stage-discharge relationship is statistically significant ($p<0.01$), indicating that net erosion may have occurred at the gage site, approximately 20 m downstream from the lodge stairs between 2000 and 2002. Therefore, during those two years, the water passing by the lodge had more energy than was required to move the sediment supplied from upstream; the excess water energy caused slight enlargement of the local channel. Although the amount of scour was not large, it is significant to note that any "excess" sediment supplied to the channel during that same time, was insufficient to aggrade (partially fill) the channel.

Figure 6: Stage-Discharge Relationship in 2000 and 2002



4. Regional Fisheries Issues: Steelhead Trout and the Evolutionary Significant Unit. Like Carmel River to the north and Garrapata Creek to the south, San Jose Creek is part of the south central steelhead trout evolutionary significant unit (ESU), and has historically supported a run of federally listed steelhead trout. The number of watersheds in California that support anadromous fisheries is greatly diminished because of watershed alteration (McEwan and Jackson, 1996); therefore, identifying and preserving high-quality watersheds is now the key to the fostering the survival of these fish. The Carmel River may be impacted by high sediment load during the impending decommissioning of San Clemente Dam. Considering that the Carmel River may have an impaired steelhead run during that time, it is yet more important to foster the steelhead runs in neighboring rivers such as San Jose Creek. Of critical importance in maintaining anadromous fisheries in San Jose Creek is the

- preservation/restoration of surface water quantity and quality,
- preservation/restoration of fish passage to headwater streams, and
- preservation/restoration of appropriate stream habitat for fish survival and reproduction.

Much of the key fish habitat for a successful run must be maintained in the subwatersheds composing the upper reaches of San Jose Creek and its tributaries. It is there that much of the perennial flow originates from springs and seeps. It is also there that the trout typically spawn, so it is the key habitat for vulnerable juvenile fish populations.

C: Methods and Data

Field data were collected for three classes of landscape disturbance on the BSLT owned portion of Williams Canyon Creek: near-stream sediment sources, road-related sediment sources, and migration barriers. A total of approximately 175 sites were described. Forty-nine sites have been prioritized for restorative measures. Locations were estimated using a hip-chain (calibrated string dispenser) anchored to several well-established benchmarks. Dense forest canopy generally prevented the use of GPS devices for site locations. The accuracy and precision of the hip-chain surveys are less than that of a surveyor's wheel, but adequate enough to assure reproducible results. Documentary photographs were taken at many sites. "Tape and Brunton" surveys were made at two high-priority restoration sites to better illustrate those problem areas.

A GIS project was developed to display the site locations and to help with prioritizing the restoration sites. UTM site coordinates (Tables 3, 4, and 5) were determined from the GIS project after plotting the data using the hip-chain data and visual alignment. The drainage network (Fig. 7) was drawn using a 1-m resolution digital aerial photograph (USGS, 1994) and the USGS 1:24,000 scale topographic map. Roads were drawn with reference to the aerial photograph and hip-chain data (Fig. 7). The road map we provide does not exactly match the maps found published elsewhere. We believe that our mapping effort more accurately shows the roads, but electronic surveying will be required to create a truly accurate road map.

Table 3: Near-Channel Sediment Sources
UTM, NAD 83 Coordinates

[1]Site #	Easting	Northing
1	602449	4035730
2	602167	4035504
3	602182	4035231
4	602311	4035596
5	602713	4036055
6	603009	4035704
7	603068	4035343
8	602625	4036256
9	602653	4036281
10	602691	4036304
11	602732	4036332
12	602756	4036350
14	602873	4036470
15	602562	4036153

Notes for Table 3:

1. Site # shown on Figure 8

Figure 7: Overview Map of Mitteldorf Redwood Preserve

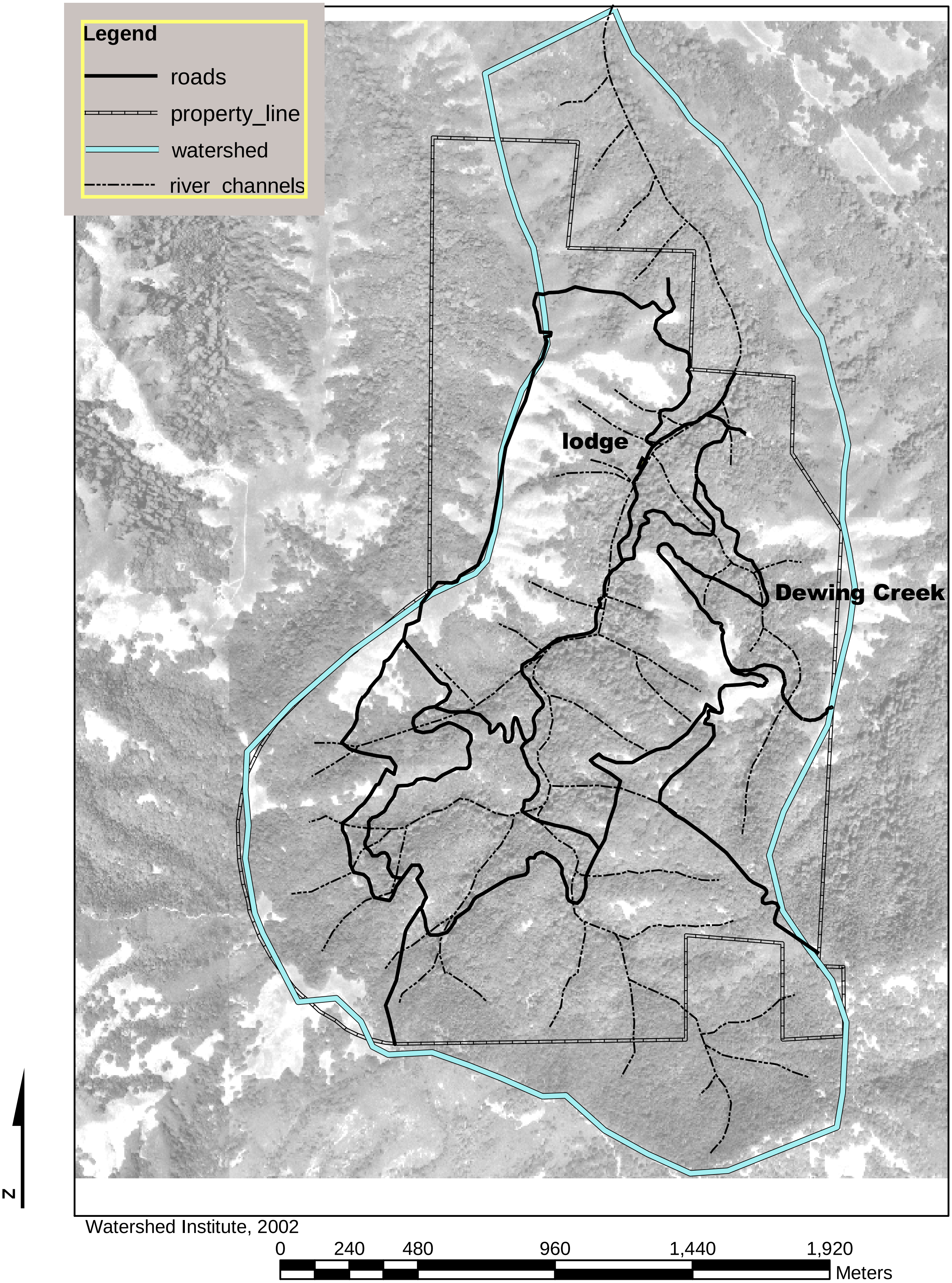


Table 4: Road-related Sediment Sources
UTM, NAD 83 Coordinates

[1]Site #	Easting	Northing		Site #	Easting	Northing
1	602671	4036306		18	602763	4035299
2	602722	4036338		19	602829	4035961
3	602706	4036330		20	601961	4035341
4	602975	4035848		21	602366	4034683
5	602999	4035712		22	602318	4034725
6	602644	4036360		23	601855	4034559
7	602643	4036390		24	601641	4034837
8	602685	4036747		25	601610	4034886
9	602633	4035902		26	601628	4034932
10	602865	4035561		27	601644	4034971
11	603075	4035429		28	601979	4035258
12	603010	4035450		29	601722	4035558
13	602474	4035836		30	601621	4035413
14	602190	4035519		31	601545	4035220
15	602164	4035474		32	601592	4035197
16	602498	4035066		33	601718	4035154
17	602606	4035195		34	601535	4034956
18	602763	4035299		35	601560	4034796

Notes for Table 4:

1. Site # shown on Figure 9

Table 5:Migration Barriers UTM NAD 83 Coordinates

[1]Site #	Easting	Northing
1	602225	4035224
2	602260	4035377
3	602247	4035429
4	602318	4035584
5	602476	4035878
6	602544	4036117
7	602669	4036284
8	602681	4036295
9	602764	4036341
10	602828	4036396

Notes for Table 5:

1. Site # shown on Figure 12

1. Near-channel sediment sources

Fifteen significant near-channel sediment sources were located and described while walking along the channels in Williams and Dewing Canyons (Fig. 8; Table 6).

Table 6: Prioritized Near-channel Sediment Sources

Site#	Priority	Location	Comments
1	2	Williams Creek	Failed culvert
2	3	Williams Trail	Large gully with 2m relief
3	11	Williams Trail	Road slumping, side cast failure-30m long
4	14	Williams Trail	Road slumping, side cast failure-10m long
5	8	Dewing Road	Road slumping, side cast failure-60m long
6	12	Dewing Creek	Road culvert with back pool deposits-20m long
7	1	Dewing Creek	Landing restoration- loose sediment
8	7	Williams Creek	Bank failure
9	9	Williams Creek	Gully deposits, loose sediment
10	4	Williams Creek	Large gully up to road
11	6	Williams Creek	Debris accumulation, small migration barrier
12	13	Williams Creek	Deflected flow undercuts bank/bridge foundation
13	NA	NA	NA
14	5	Williams Creek	Large gully
15	10	Williams Creek	Gully left bank

The highest priority site (Site 7; Table 6) was restored by BSLT during the period of this study. Subsequent visits to the site show a very high survival rate for transplanted redwoods and other species.

We do not list restorative measures for these sites individually, but most will require excavation to create a more stable slope followed by native plantings. The gullies will benefit from headcut slope reduction where feasible, and energy dissipaters within the gully bottom and at the mouth. In rare cases, heavy equipment will be able to reduce the gully side slopes. On the more technical sites, we recommend consulting with an erosion control specialist who has experience with habitat restoration.

2. Road-related sediment sources

All maintained and non-maintained roads on the property were walked and measured in an effort to locate and document all significant present and future sediment sources for Williams Canyon Creek (Fig. 9). Locations (Table 4) were estimated using a topographic map, high-resolution aerial photograph, hip chain, and GPS receiver where the forest canopy did not impede reception. At each point where a road crossed a stream channel, a detailed description of the condition of the culvert system, or other crossing, was made. Other sediment sources, such as failed landings and landslides were also assessed. The assessment was based upon a modified "PWA Road Erosion Inventory Data Form" (PWA, 1998) provided by the California Department of Fish and Game.

Site locations, descriptions, a three-part prioritization, and general comments on restoration activities are provided in Tables 4, 7, 8 and 9. Below is a discussion of some general themes associated with the roads followed by a description of a few of the highest priority sites.

Figure 8: Near-channel Sediment Sources

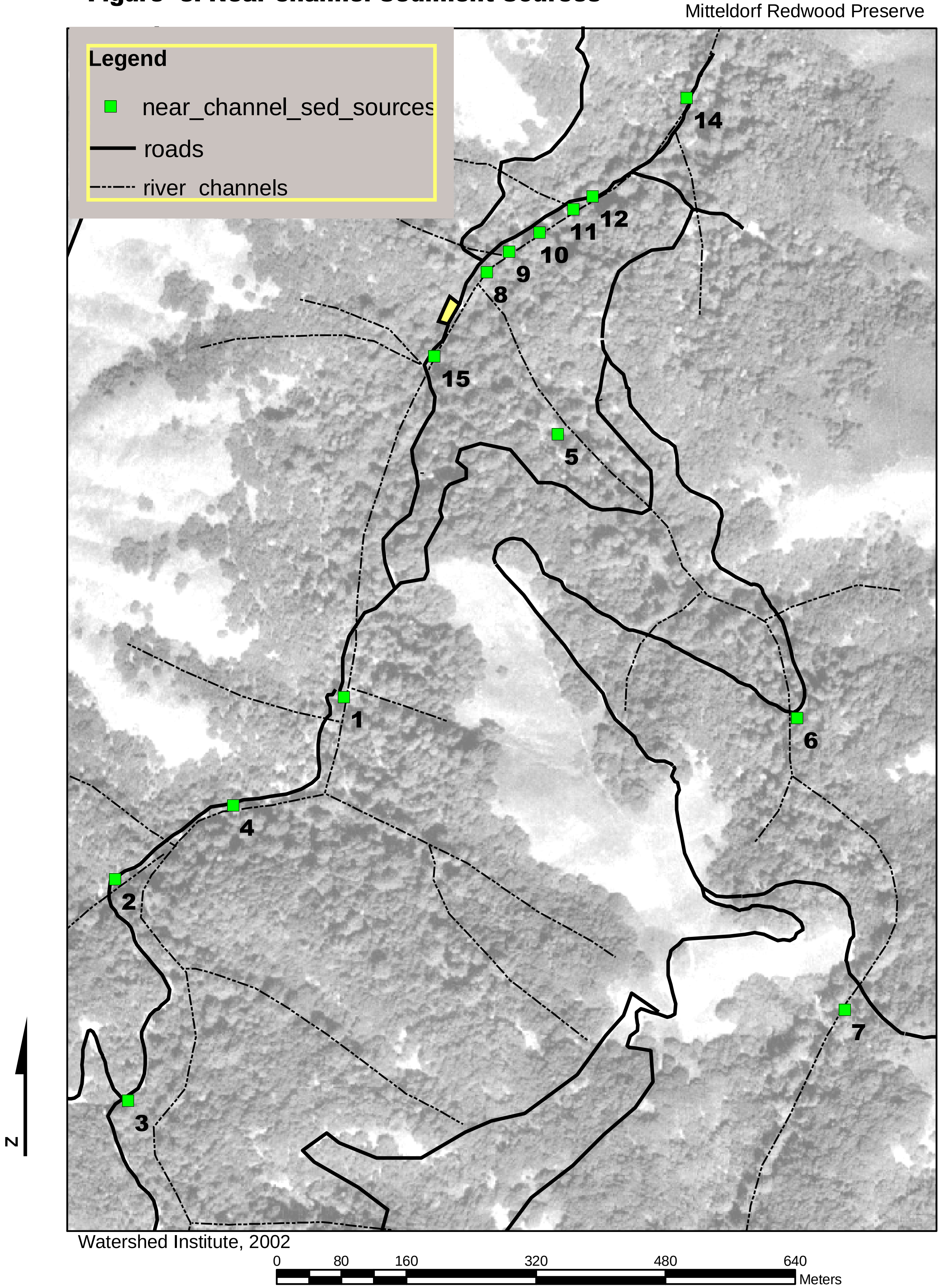


Figure 9a: Road-related Sediment Sources (Part 1)

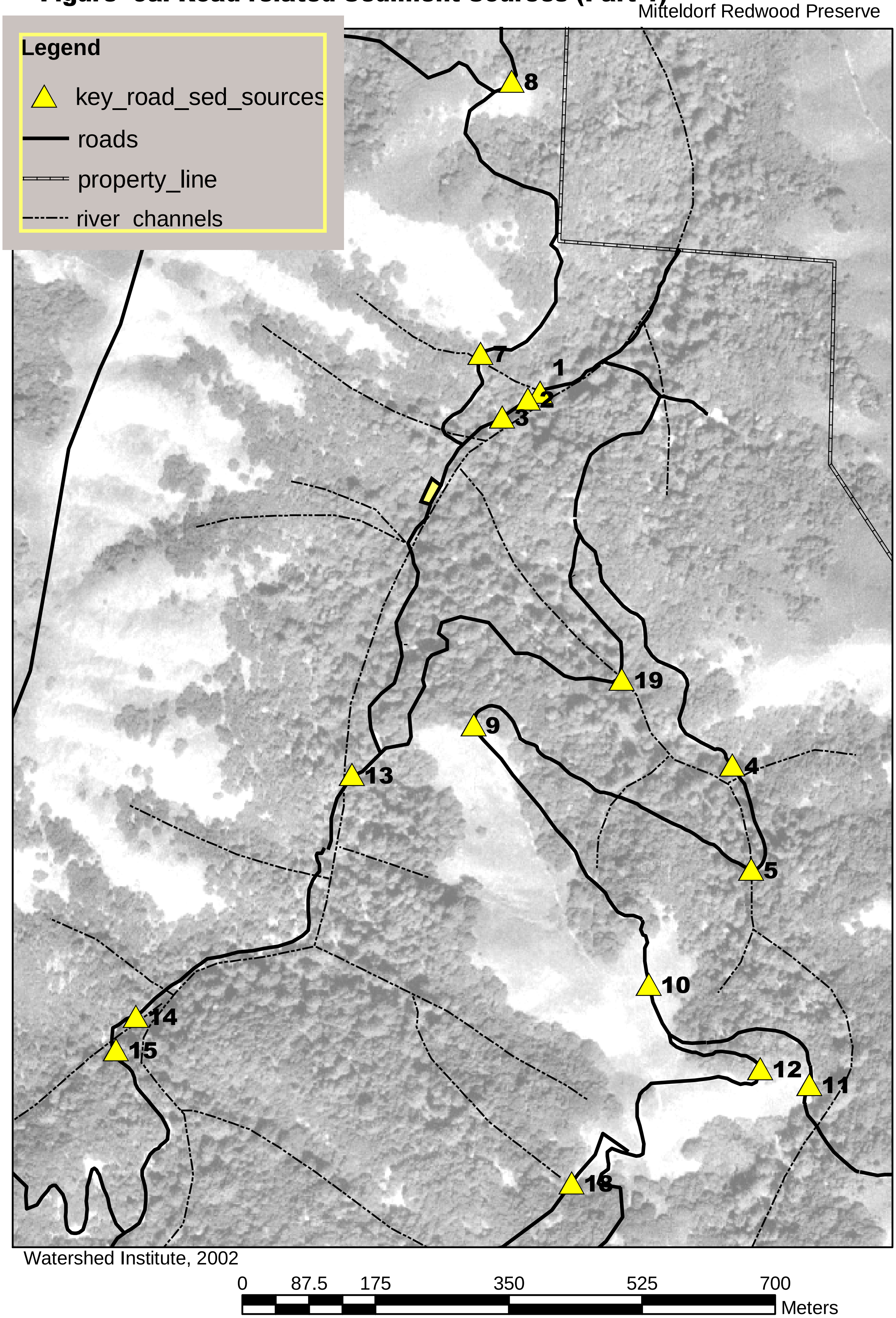


Figure 9b: Road-related Sediment Sources (Part 2)

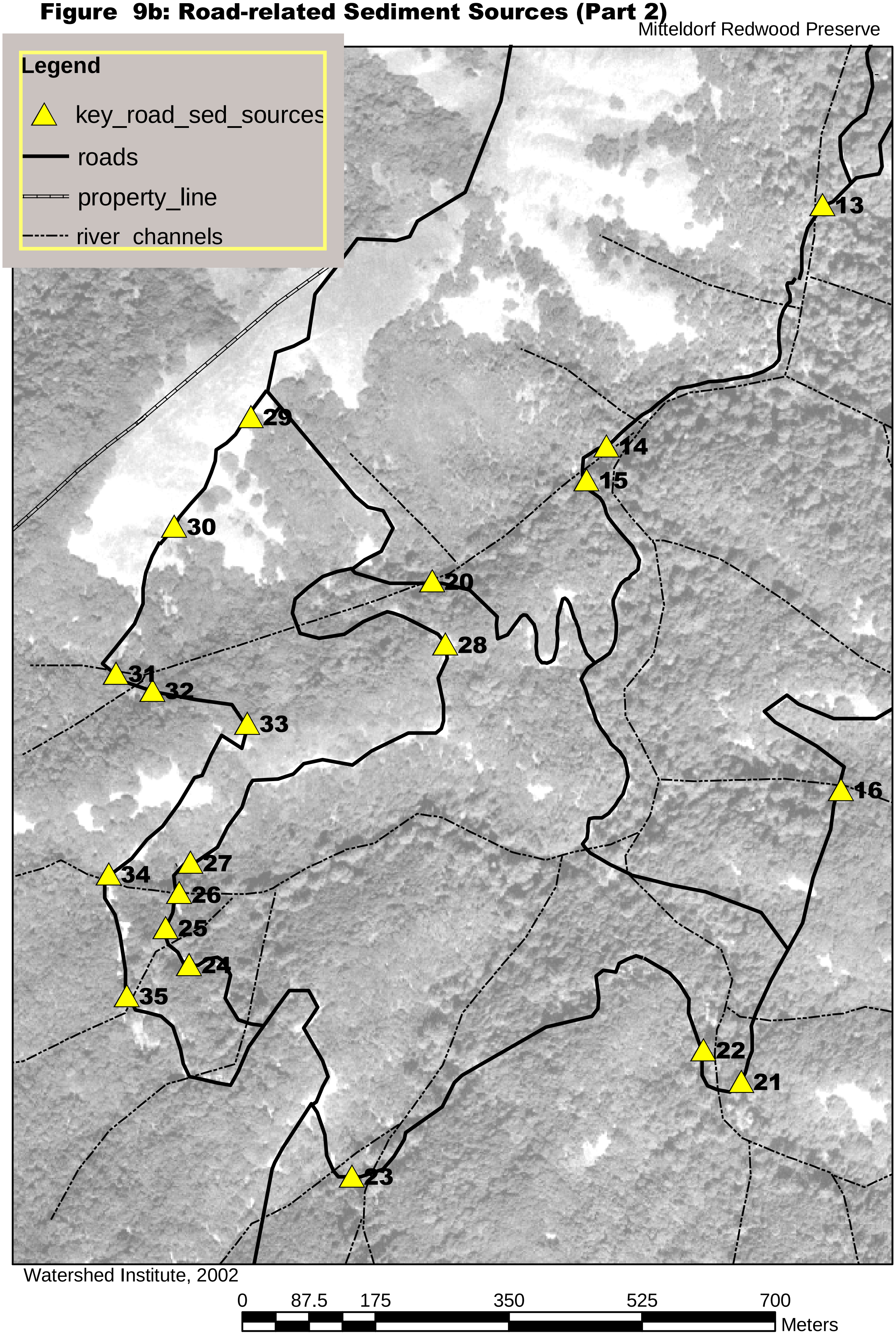


Table 7: Description of Road-related Sediment Sources

[1]Site #	Sediment Source Type	Comments
1	Culvert	Site 1 and 2 must be restored together
2	Culvert	Site 1 and 2 must be restored together
3	Culvert	Low potential for future erosion
4	Landslide	
5	Culvert	Road could wash out if culvert plugs
6	Cutbank	Roadcut
7	Culvert	Yields to lower Williams Canyon
8	Landslide	
9	Culvert	
10	Gully	Hill slope
11	Culvert	Culvert has low potential to be plugged
12	Gully	Gully
13	Culvert	Failed culvert
14	Gully	Repair of site 15 will reduce erosion at site 14
15	Culvert	Diverted water from this site has cut gully site #14
16	Culvert	50% plugged-in need of maintenance
17	Culvert	Partially plugged culvert
18	Gully/Culvert	Minor gullying of road/ culvert plugged
19	Culvert	Road could wash out if culvert plugs
20	Gully	Gully cut through landing/ directly upstream from sites 14 and 15/ restore with vegetation without heavy equipment
21	Culvert	Barrel on site contains fluid-must be removed
22	Landslide	Diverted flow appears to be entering crack in the landing fill
23	Culvert	
24	Culvert	Flow could potentially divert onto road for 80 ft. before re-entering channel
25	Culvert	Culvert carries spring flow-70% plugged
26	Culvert	Humboldt crossing
27	Culvert	Fill saturated- sedges on road surface
28	Landslide	Potential for slope failure if ground is saturated
29	Culvert	
30	Culvert	Culvert needs maintenance
31	Culvert	
32	Culvert	High potential for culvert to be plugged
33	Culvert	Culvert plugged
34	Culvert	
35	Culvert	

Notes for Table 7:

1. Site # shown on Figure9

Table 8: Three-class Priority Level of Road-related Sediment Sources

[1]Site #	Sediment Source Type	[2]Priority Level	[3]Future Erosion (yrds^3)	[4]Erosion Potential	[5]Delivery %	[6]Diversion Potential on Stream Crossings
1	Culvert	2	100*	High	80% if plugged	High
2	Culvert	2	30*	High	Not Determined	High
3	Culvert	3	10*	Low	80-90%	High
4	Landslide	2	10	Medium	50%	N/A
5	Culvert	1	40	High	100%	High
6	Cutbank	3	3	Low	10%	N/A
7	Culvert	2	10*	Medium	80%	No
8	Landslide	2	50	Medium	50%	N/A
9	Culvert	2	10*	Low	50%	High
10	Gully	1	60	High	80%	N/A
11	Culvert	3	5*	Low	80%	No
12	Gully	2	70	High	20%	N/A
13	Culvert	1	300	High	100%	No
14	Gully	2	150*	High	80-90%	N/A
15	Culvert	1	30	High	100%	High
16	Culvert	1	10*	Low	Not Determined	High
17	Culvert	2	10*	Medium	Not Determined	High
18	Gully/Culvert	1	20*	High	Not Determined	High
19	Culvert	1	20*	Low	100%	High
20	Gully	2	10*	High	70%	N/A
21	Culvert	2	20*	High	Not Determined	No
22	Landslide	1	20	High	90%	N/A
23	Culvert	2	10	Medium	80%	High
24	Culvert	3	10	High	80%	High
25	Culvert	2	5*	Medium	Not Determined	High
26	Culvert	1	70*	High	60-80%	High
27	Culvert	2	20*	High	Not Determined	High
28	Landslide	1	160	High	50%	N/A
29	Culvert	3	20*	Medium	50%	High
30	Culvert	3	10*	Medium	50%	No
31	Culvert	3	10*	Medium	50%	No
32	Culvert	3	10*	Medium	50%	No
33	Culvert	3	10*	Medium	50%	No
34	Culvert	3	15*	Medium	50%	No
35	Culvert	3	10*	Medium	50%	No
Total annual future erosion			**1360**			

Notes for Table 8:

1. Site # shown on Figure 9
2. Priority Level -- 1=high priority, 2= medium priority and 3= low priority

3. Future Erosion – An estimate of the amount of sediment that will be mobilized from the site. An asterisk indicates poorly determined values.
4. Erosion Potential – An index of the probability that significant erosion will occur at the site.
5. Delivery %-- An estimate of the percent of material that will be delivered to the stream channel system.
6. Diversion Potential – The potential for flood waters to divert if the culvert is plugged. (There is no diversion potential if the flood waters spill over the road and back into the stream channel. There is high diversion potential if the flood waters are diverted and flow down the road or ditch.)
7. N/A- Not applicable

In Table 8, we have assigned each site a priority value from 1 to 3 with 1 being the highest priority for restoration. In Table 9 we further prioritize the ten priority 1 sites listed in table 8. The ranking was done using best professional judgment of the estimated future sediment erosion volume, erosion potential delivery ratio, and feasibility of restoration. In cases where sites are sub-equal in the impact they would have on the creek sediment load, the ranking was arbitrary.

Table 9: Ranked Highest-Priority Road-related Sites (1 is highest priority)

[1]Site #	Priority	Restoration Activity
13	1	Remove remaining fill
15	2	Remove buried culvert so flow can rejoin natural channel
26	3	Remove failing Humbolt Crossing
22	4	Divert flow away from crack in landing fill; remove failing slope
16	5	Unplug culvert
18	6	Unplug culvert
28	7	Remove failing sidecast road fill
10	8	Redirect flow and install energy dissipators
5	9	Replace culvert with lager diameter to reduce plugging risk
19	10	Remove culvert and restore Dewing stream channel

Figure 10 shows details of the highest priority site (site 13; Table 9). The remaining second and third priority sites in Table 8, are chiefly culverts that are partially, or completely blocked. All culverts in this watershed clearly require at least annual maintenance.

In addition to the individual sediment sources listed in table 8, there is also sediment eroded from the bare road surfaces throughout the watershed. Minor erosional features (rills) are pervasive on the road and trail surfaces in the watershed. We estimate the sediment yield from road surface erosion in the following general way. Annual sediment yield=road width (10 ft) X road length (52800 ft) X erosion rate from rilled roads (0.03 ft/yr) X %roads rilled (50%) X delivery ratio (80%). This amounts to a rough estimate of 6300 ft^3/yr or 230 yd^3/yr of sediment delivered from the general road surfaces to the creek channel. Reducing the amount, and velocity, of water runoff on the road surfaces, can reduce road rilling. The kinds of solutions that an erosion-control consultant might employ include, road outsloping, water bars,, rolling dips, and open-top box culverts. Professional erosion control consultants should be hired to design and place those kinds of erosion-control measures. Figure 11 shows roads that should be decommissioned.

Figure 10: Map of Site 13 (Table 9; Fig.9).

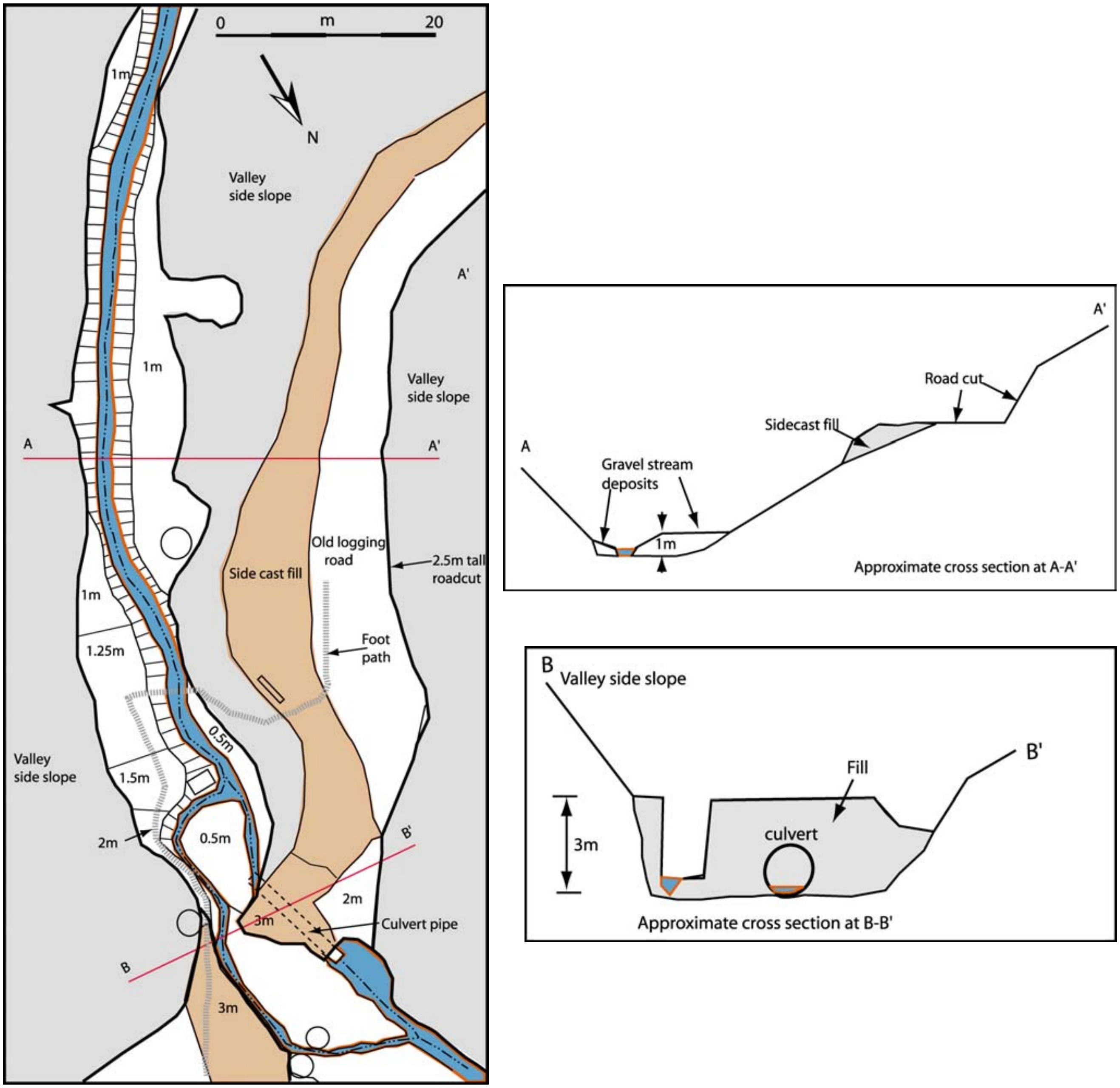
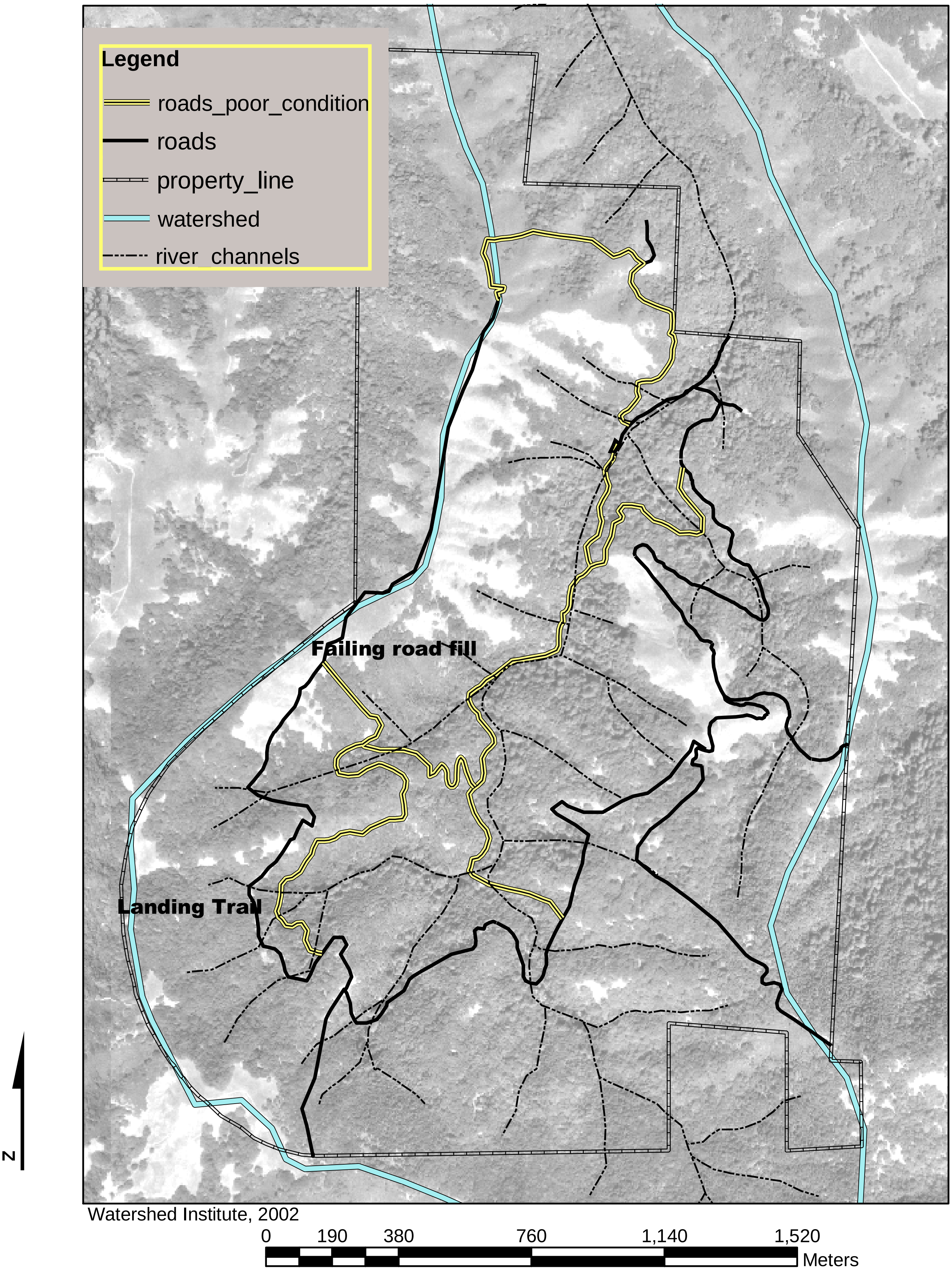


Figure 11: Roads in Poor Condition

Mitteldorf Redwood Preserve



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We recommend decommission unnecessary roads as the best means of reducing road-generated sediment, both from individual sites and general surface erosion. We estimate that 3.7 miles of road with severe erosion sites are not required, and should be decommissioned (Fig. 11). Most of this road system is already abandoned and designated as trail on the BSLT map of the Preserve, so the total mileage of roads to be decommissioned in the future is far less than 3.7 miles. The highest priority roads for decommissioning are where the side-cast road fill is failing. The highest priority for decommissioning is the "Landing Trail," which parallels the "Headwaters Road" (Fig. 11). Another critical site is the road below the "Ladder Trail;" however, heavy equipment currently has no access to that site (Fig. 11). Road decommissioning should be planned with the consultation of experts.

3. Migration barriers

Ten potential fish migration barriers (Fig. 12) were located and described (Tables 5 and 10). The barriers, variously comprise woody debris, sediment, and bedrock, are either too long or too high for trout to jump during high flows. They are prioritized for removal/restoration based upon the following criteria.

1. Would removal of the barrier provide access to upstream sites bearing significant spawning gravel?
2. Do we believe that human disturbance caused the barrier to form?

Based upon the first criteria, no migration barriers were considered high priority in Dewing Canyon. Of the 10 potential migration barriers described on BSLT property in Williams Canyon, only 4 exist below the lodge. Although the four below the lodge are not necessarily the worst debris jams, they were assigned priorities one through four because they are the most important for ensuring access to spawning gravel located near the lodge. No significant spawning gravels were noted upstream from the lodge.

Of the four barriers located downstream from the lodge, site 9 is significantly more serious than sites 7, 8 or 10. Lastly, any debris jam, whether natural or anthropogenic, can induce channel erosion and excess sedimentation.

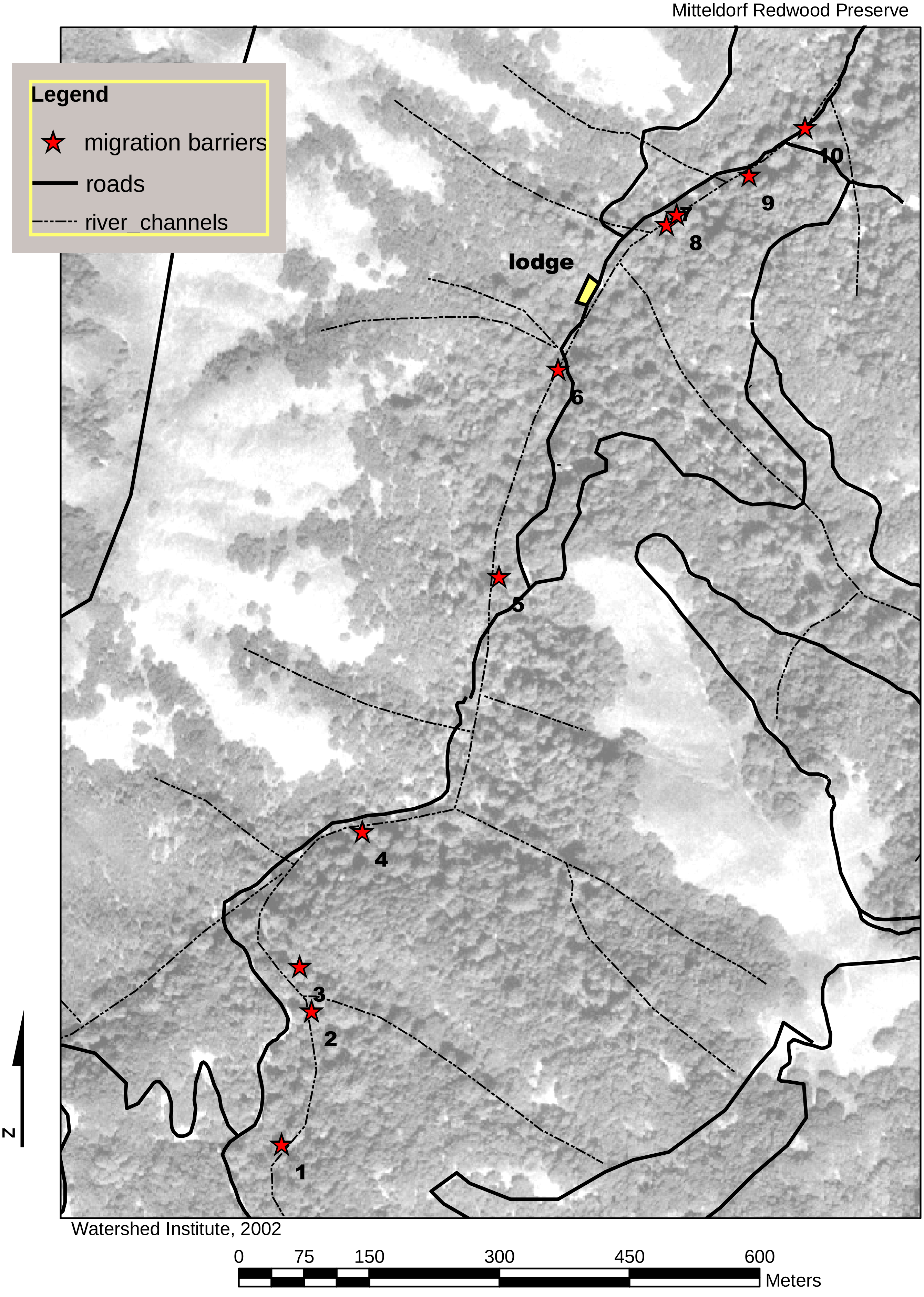
Table 10: Ranked Migration Barriers

[1]Site #	Priority	Comment
1	10	debris dam with passable side detour
2	8	redwood stump with 6 m relief
3	9	incised to bedrock with 6 m relief
4	6	large barrier- log and boulder dam- sediment trap
5	5	large barrier with back pool sediment deposits
6	7	woody debris jam, 10 m long
7	2	debris dam with back pool sediment deposits
8	3	woody debris dam
9	1	large barrier- subterranean flow with 2-3 m relief
10	4	debris dam with 1 m relief

Notes for Table 10:

1. Site # shown on Figure 12

Figure 12: Migration Barriers



To ensure fish access to high quality spawning sites, we recommend that any significant, human–induced migration barriers be removed from the reach of river between the BSLT property and the confluence with San Jose Creek. There are currently no insurmountable barriers between the confluence and the coastal lagoon (personal communication, Marty Gingras, California Department of Fish and Game, 2002).

D: Management Activities and Prioritization

Logging and road construction in the upper Williams Canyon watershed has yielded a locally degraded landscape. The watershed is impaired in terms of excess sediment delivery and barriers to anadromous fish migration. Although the watershed management plan detailed below has the single outcome of improving anadromous fisheries, the suggested management activities will provide many other benefits related to improved water quality and maintaining water quantity here and farther downstream. Indeed, if the environmental conditions of the watershed are prime for anadromous fish, then the watershed will also support many other levels of the food web. The scope of the plan includes restoration of the river channel and sediment budget to pre-logging watershed conditions, but does not include fisheries enhancement beyond what would naturally occur in the watershed. First, we outline the kinds of activities that should be performed, and then we order them, recognizing the limiting factors in the environment.

In order for upper Williams Canyon to contribute to the sustainability of anadromous fisheries, San Jose Creek, below Williams Canyon, and all the way to the sea, must meet certain minimum criteria.

1) There must be sufficient flow to sustain the migration of adult fish from the sea to potential spawning grounds in the upper watershed.
2) There must be no insurmountable migration barriers for upstream migration.
3) There must be enough flow to support the seaward migration of adults and yearlings. Because fish spawn during falling limb of annual hydrograph, adult fish and fingerlings may get trapped in upper watershed if debris jams form significant barriers at low-flow conditions in Spring.
4) The chemical and physical water quality must be adequate without seasonal high biological oxygen demand.
5) The substrate in the spawning redds must be clean enough to support eggs.
6) There must be food supply and shelter to sustain the fish before they migrate to the sea.
7) There must be adequate bank and log protection for fish to avoid predation.

We now consider the above criteria as potential limiting factors in supporting anadromous fisheries. During high flow conditions achieved during winter storms there are no insurmountable barriers to upstream fish migration between the sea and the confluence of Williams Canyon Creek and San Jose Creek (personal communication, Marty Gingras, California Department of Fish and Game, 2002). The channel condition changes markedly where Williams Canyon joins San Jose Creek. San Jose Creek, upstream from the confluence is severely aggraded with at least 1 m of coarse sand that buries the natural cobble and bedrock substrate. Furthermore, there is virtually no base flow during the dry months. What little moisture seeps down the channel flows as a trickle of groundwater above the bedrock, but beneath the excess sand in the channel. In contrast, Williams Canyon Creek, upstream from the confluence, has significant perennial base flow and comparatively minor impairment by excess fine sediment. Although there is clearly too much sand and small gravel material in the Williams Canyon channel, it is minor compared with San Jose Creek.

Given that the above criteria exist, Williams Canyon can potentially contribute to the sustainability of anadromous fisheries in the following ways:

1. Contributing perennial flow to support fish in Williams Creek and San Jose Creek, through to the coastal lagoon system,
2. Providing high quality water with low temperature, low sediment load, and an appropriate healthy balance of large woody debris, nutrients, and oxygen,
3. Provide passage to the areas where spawning gravels exist, and
4. Providing the physical geomorphic structure and riparian vegetation required for spawning, hiding, and feeding.

In terms of optimizing the overall sustainability of anadromous fisheries in the San Jose Creek watershed, we feel that the three areas of focus for Williams Canyon are:

1. Maintaining surface water supply,
2. Reducing excess sediment, and
3. Improving fish passage.

1) Maintaining Surface Water Supply

The above factors are listed in prioritized order. It is our opinion that every effort should be taken to preserve the water supply coming from the upper watershed. Williams Creek provides perennial flow to San Jose Creek. We noted this flow even during the 2001-2002 hydrologic year, which was the driest in the last several years. If Williams Canyon has a typical hydrologic system, then we can suggest two sources of water that feed the creek during the dry seasons: local interflow and the regional bedrock water table.

Local interflow occurs when some of the precipitation on the canyon ridges and divides naturally infiltrates into the porous, but thin, soil horizon that mantles the granitic bedrock. The water then slowly flows down slope in a shallow underground river, perched atop the less permeable granite bedrock surface. This system stores storm water, and gradually releases it to the creek channel in innumerable tiny seeps and springs.

Because the soil layer is quite thin in Upper Williams Canyon, it cannot store a great volume of water, so we strongly suspect that the regional bedrock groundwater system may also contribute flow to the creek. Although granitic and metamorphic rocks are not typically considered to be sustainable sources of groundwater, outcrops of the granitic and metamorphic bedrock of the Santa Lucia Range are pervasively fractured and faulted. “Fracture porosity” in granitic bedrock can hold a considerable store of ground water in this region as evinced by the successful water wells drilled on the adjacent Rancho San Carlos property to the north.

Considering the strong link between perennial surface flow and groundwater, it is clear that best management practices will be those that foster groundwater recharge and groundwater conservation. We recommend the following management activities.

1. Reduce storm run-off by maintaining a healthy forest and associated plant communities.

2. Limit well-water extraction from the regional groundwater systems, which likely are very slow to recharge.
3. Advocate groundwater conservation among upper watershed partners on adjoining parcels, which almost certainly share the same granitic aquifer system.

2) Reducing excess sediment supply

There are four chief sources of sediment entering Williams Canyon Creek:

1. deep-seated landslides involving bedrock,
2. shallow soil slips involving regolith, and,
3. streambank erosion of terrace material, and
4. sediment generated from failing road systems, including slope failure of road fill.

Not all sediment entering the channel is deleterious for fish. A constant supply of gravel is essential for maintaining redds throughout the spawning area downstream. On the other hand a chronic supply of sand and finer material tends to clog the pores of the redds. The landslides are a good source of fresh gravels derived from granitic bedrock. The streambank erosion and failing road system are chronic sources of fine sediment.

It is our opinion that little can be done to reduce the episodic deep-seated landslides or soil-slips. No active deep-seated slides were observed, but soil slips have occurred during the 1980's and 1990's (Fig. 13). For example, the 1994 aerial photograph used as the map base in this report, does not show the soil slips documented in Figure 2 and Figure 13. Similar slope failure features are typical throughout mountainous regions of California associated with the El Nino events of the late 1990's. These features do not appear to be caused or triggered by any ongoing human activities. These kinds of slope failures have roots in the geologic past, predating the conversion to European grasses, following introduction of Mexican Cattle in the early 1800's. These slope failure features ultimately supply the gravels required for a healthy fishery.

We do not rank general streambank protection as a high priority in the watershed because it is very hard to achieve, considering the accessibility issues and the low-light conditions which limit the appropriate types of riparian vegetation one can use. Hardening banks locally using stone or logs can induce erosion downstream from the site. Therefore, we recommend that the in-channel sediment sources be left to heal themselves through natural shaping and armoring.

We do place a high priority on reducing the sediment poised to enter the channel from the failing road system. These sediment sources include both upland settings and near-channel settings where the roads cross or parallel stream channels. There is a large volume of sediment stored in unstable road fill. We have described some site specific sediment sources, including plugged culverts and failing road fill and landings. We have also outlined the roads that should be further assessed and decommissioned. In summary we recommend reducing the sediment load associated with roads and landings, and advocating sediment control among other San Jose Creek watershed partners.

3) Removing Migration Barriers

We recommend removing unnatural fish migration barriers located downstream from the Mitteldorf lodge. We also recommend advocating migration barrier removal among downstream watershed partners to ensure fish access to the Williams Canyon watershed.

Figure 13: Large Landslides

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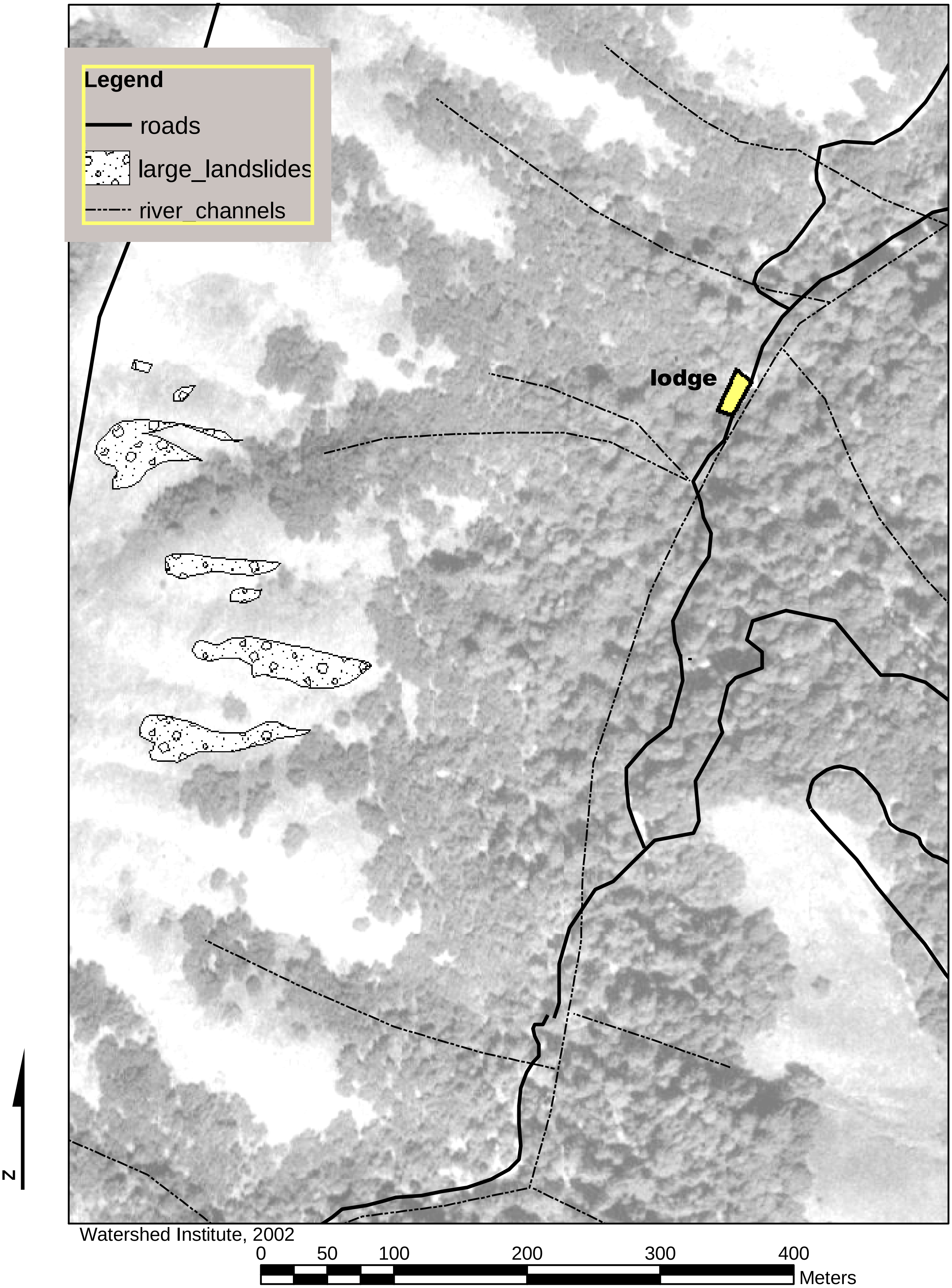

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