FINAL DRAFT

A Post Project Appraisal of the Restoration/Rehabilitation of Alamo Creek

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ABSTRACT

Alamo Creek is located 2 miles east of Danville California and drains a watershed of 7.4 square miles. The watershed has historically been used as a grazing land for cattle. The grazing coupled with increased urbanization of the watershed has caused channel incision thereby preventing normal flooding and preventing riparian establishment. The Windemere housing development initiated a restoration project in 1999 designed by Philip Williams Associates to prevent further channel incision, create a floodplain, form a healthy riparian zone, and stabilize the banks. The project reach runs from the north to the south for 11,600' along the east side of the channel. This post-project appraisal found that 4 years after the project channel incision has been greatly reduced, a 100-150 meter floodplain now exists, and an early seral stage riparian zone exists with a 83% survival rate. Despite the project reaching its restoration goals the creek has not been completely restored, rather it has been rehabilitated. The right-bank along the entire reach is unstable and does not support riparian growth and heavy sedimentation along with vegetation encroachment is strangling and suffocating the low energy channel.

INTRODUCTION

This report evaluates the success of the restoration project designed by Philip Williams and Associates (PWA) on the main branch of Alamo Creek in Danville, California during May of 1999. PWA is a hydrologic consulting firm located in Marin county California that has been operating for decades and has performed some of the earliest stream restoration projects in the San Francisco Bay area. The project was initiated and funded by the adjacent Windemere Housing Development, which began construction of 8,000 units in 1996.

Alamo Creek is located just east of Danville California in Contra Costa County. The creek's three dominant branches (West, East, and Main) converge one mile east of Danville proper near Bolinger Canyon Road (Figure 1). The main branch then flows south along the Windemere housing development for 11,600 linear feet. Alamo creek drains 7.28 square miles of rolling grassland, on which cattle grazing began in the late 1880's and has persisted to the present day. The removal of the Valley Oak in conjunction with heavy grazing has increased the velocity of flow resulting in channel incision and preventing normal floodplain inundation. As incisions increases channel capacity increases which greatly increases floodstage discharge. This process has jeopardized the riparian zone and created bank instability.

The initial design proposal by the Windemere development sought to only correct the bank instability to prevent the creek from migrating westward toward their property and undermining the development. However, when informed of this plan PWA under Jeff Haltiner proposed to expand the project to include the development of a riparian corridor and designs to prevent further channel incision (Jeff Haltiner PWA 2003). Windemere then adopted this plan because it served both the creek's ecosystem and their development simultaneously. The project objectives included creating a stable bank, a healthy riparian zone, and preventing further channel incision. In order to accomplish these objectives PWA created 7 different treatment zones that fulfilled the project objectives for each of 7 unique site conditions (PWA1999). The site implementations and treatment goals are described in table 1.

TREATMENT 1	
DESIGN	**OBJECTIVE**
Rock Grade Control Structures Sills	Prevent Channel Incision Stabilize Bank Slope Prevent End Round Erosion
TREATMENT 2	
DESIGN	**OBJECTIVE**
Grading Create 30' Depression Riparian Planting Wetland Planting	Create Floodplain Create Seasonal Wetland
TREATMENT 3	
DESIGN	**OBJECTIVE**
Log Spur Brush Mattresses Branch Packing Create Point Bar	Prevent erosion on meander bends that curve toward the Windemere Property. Increase roughness
TREATMENT 4	
DESIGN	**OBJECTIVE**
Similar to T3 Except wider 150' Point Bar	Prevent Erosion and increase roughness
TREATMENT 5	
DESIGN	**OBJECTIVE**
Rock revetments	Prevent further channel Incision
TREATMENT 6	
DESIGN	**OBJECTIVE**
Grade Control Structures	Prevent Channel Incision
TREATMENT 7	
DESIGN	**OBJECTIVE**
Grade to 3:1 slope Riparian Planting	Bank Stability

This report is an analysis of these 7 treatments and the projects stated objectives. To determine the effectiveness of this restoration project the critical cross sections were resurveyed and a vegetation analysis was performed. The amount of channel incision post-project, the bank stability and slope, and health of the riparian zone were used to determine the success of the project.

METHODS

HISTORICAL REVIEW & RESTORATION PLAN REVIEW

The goal of this paper involves a thorough examination of the restoration project implemented on Alamo Creek in 1999 by Philip Williams & Associates. Unlike many other creeks in the region, which have been subject to many different restoration efforts, this is the first restoration project conducted on the main branch of Alamo Creek. The three plans created by PWA (Alamo Creek Restoration: Background, Analysis, and Conceptual Design 10/99) were obtained and reviewed by the author to acquire the project's objectives, goals, design plans, and hydrologic analysis. By comparing the description of the watershed and channel conditions in PWA's documents to historical photos and maps it became apparent that the site has undergone significant changes since the 1996 historical photos and the 1981 topographic map of the watershed. Figure 1 shows the open grasslands that existed in 1996 now contain over 8,000 houses with more planned. This complicated resurveying the site because directly adjacent to riparian zone construction on the Windemere housing project is in progress. Unfortunately, PWA and the construction used the same orange rebar landscaping markers to delineate their design. This problem coupled with contradicturary linear measurements in the plans prevented the exact relocation of the original cross sections.

RESURVEYING

To compare the current channel conditions to the design parameters of PWA, without the exact cross sections, it was necessary to relocate two of the seven treatment types designed by PWA and resurvey them to test for design stability. The treatment types were several hundred meters long, which made them easy to find, and were surveyed by PWA, which allowed them to compared easily. The author analyzed the channel stability on treatment types two and three because these treatments incorporated less hard engineering making them the most dynamic and giving them most potential to change form. The author located treatments 2 & 3 by measuring 1,100 meters upstream of the project endpoint and 400 meters downstream of Bollinger Canyon Road respectively. The design plans gave the exact linear location of these two points making them an appropriate choice. A cross section measured from the left terrace near the Windemere construction to the right terrace on cattle grazed grasslands. The author measured elevation at every change

in slope and at the thalweg. Standard surveying equipment and techniques were used to gather the information.

VEGETATION SAMPLING

Establishing a riparian zone was one of the main objectives for PWA. The success of the riparian zone reflects on the success of the project and therefore, it was necessary to develop a riparian zone. In the design plans of PWA riparian planting occurred only on the left bank of the stream and was not yet implemented north of Bollinger Canyon Road. To randomly choose and measure vegetation plots the author divided the left bank into fifty by fifty foot plots running parallel to the channel and calculated the restoration reach minus the riparian corridor north of Bollinger Canyon Road (11,600'-6800') to create a series of plots running parallel to the channel. These plots were then numbered and three plots were chosen using a random number chart.

The survey sampled the fifty by fifty-foot plots for percent cover, species composition, and individuals both dead and alive. Total number of successful individuals divided by total number of stems planted generates the survival percentage. A survival percentage of $\geq$ 70% after three years is necessary for a successful project. As the project matures that percentage will naturally decrease (McBride 2001).

SITE CONDITIONS

Many other site conditions were photographed and documented by the author to establish the success of the project both within its objectives and its overall success at restoring natural processes to the channel. These include but are not limited to the stability of the right bank, the condition of the channel downstream of the restoration reach, sedimentation of channel, vegetation encroachment of the channel, and watershed dynamics (Figures 3-5). These aspects were not sampled because many were not addressed in the restoration plans, however they were considered in the overall effectiveness of the project in restoring natural processes.

RESULTS/DISCUSSION

RIPARIAN ZONE

Grading of the floodplain channel established a wide corridor close to the water table for riparian vegetation to thrive. PWA planted Willow, Live Oak, Sycamore, Cottonwood, Coyote Brush, California Blackberry, Cattail, and Tule throughout the floodplain and on the banks. An irrigation system was set up and is still in use. PWA's design plans included irrigating the riparian vegetation for 5 years from the date of planted to insure that the roots have sufficient time to grow down to the water table. (PWA Alamo Creek 1998, 1999, 2001)

The planting of trees on the bank was relatively sparse with approximately 12 individuals per square 100' however, in the floodplain directly adjacent to the channel willows planting was dense to provide soil stability and roughness in flood events. As can be seen in table 2 the mortality percentage on the banks was much higher than in the floodplain. Despite this higher percentage the overall survival is high on both the floodplain and the banks and in terms of the project objectives the riparian zone has been a success. However, the vigorous growth in the floodplain caused some sections of the reach to be strangled by Tule and Cattail. The vegetation encroachment in some areas is so densely packed that the channel has effectively turned into a linear wetland (Figure 3). While this is good for reducing stream energy and slowing incision it is contributing to heavy sedimentation in the channel. In the three cross sections measured, the channel contained 6-10" of fine silts and clays. This has caused the channel bed to become anoxic and has most likely suffocated much of the natural benthic organisms. Vegetation encroachment is degrading the natural processes of the channel, but may be effective at removing pollutants (Horne & Goldman 1994). This sedimentation may be scoured away during the next flood event, but it may not remove that much sediment due to the dense vegetation and if the sediment is removed it will aggregate downstream and decrease downstream channel capacity. This could lead to flooding in areas downstream of the restoration reach.

VEGETATION PLOT # 1 — Location 6,850' Upstream of Project End — 50'X50' — Lower Left-Bank

20% Coverage

Species	Alive	Dead	Unidentified Dead	Total Individuals	Mortality
Willow	21	6			
Sycamore	2				
Coyote Brush	1				
Live Oak	1		6	37	**32%**

VEGETATION PLOT # 2 — Location 5,550' Upstream of Project End — 50'X50' — Floodplain

30% Coverage

Species	Alive	Dead	Unidentified Dead	Total Individuals	Mortality
Willow	31				
California Blackberry	10		2	43	**5%**

VEGETATION PLOT # 3 — Location 2,400' Upstream of Project End — 50'X50' — Left Bank

10% Coverage

Species	Alive	Dead	Unidentified Dead	Total Individuals	Mortality
Sycamore	6				
Coyote Brush	3				
White Shrub	5		7	21	**33%**

Vegetation was not planted on the right-bank of the project. PWA did not cite a specific reason for excluding the right-bank riparian zone. The project goals included stabilizing the banks through riparian plants. The left-bank adjacent to the Windemere property has been carefully graded and planted however, the right-bank adjacent to pasture land has little or no grading or riparian planting. The effect of this exclusion can easily be seen in (figures 4). The bank slope ranges from 45 to near vertical. Bare soil is dominant on meander bends and high erosion has undermined the fence-line (figure 5). This may also be leading to sedimentation in the channel and diminishes the projects overall success.

CHANNEL INCISION

PWA included channel incision as an objective in 3 out of 7 treatment types and as the primary goal of the restoration project (Table 1, PWA 1999). There are several methods to measure channel incision however, arguably the most accurate or effective method is a longitudinal profile. This appraisal did not conduct a longitudinal profile because the channel reach is 11,600' long and excessive time would be

required to perform such a measurement would be too excessive. In addition, the channel itself is inundated with dense stands of tule and cattail, which severely hampered the cross sectional measurements and undoubtedly would have greatly impeded or made the longitudinal profile infeasible (Figure 3). The author gauged incision by closely examining the post-project cross sections against the as designed cross sections.

The as designed cross sections that correlated with the appraisal cross sections fell in treatment 2 & 3. The height difference between the top of the left bank terrace (on right side of figure 7a) and the thalweg was 7.2m (154.3-147.1). The average distance from the left bank terrace and thalweg in the post-project appraisals' cross sections 1 & 3 was 7.35 (Figure 7a & 7b). These calculations show that the channel has incised 0.15m. Although, given that this method is not accurate this amount of incision may be discarded as calculation error. Furthermore, a visual inspection of the channel did not reveal any structures that were undermined or undercut that would suggest further channel incision. Unfortunately the same analysis could not be created with cross section 2 due to unreliable results. At this time, without a longitudinal profile it appears that the channel shows no significant levels of incision, evidently due to the channel grading, riparian planting, and grade control (Figure 8).

BANK STABILITY

Although bank stability was not a major objective it was recognized by PWA as an important factor in maintaining a healthy riparian zone and was part of treatment 1 and 7. By comparing treatment 2 & 3 design cross sections to the three post-project cross sections (Figure 6, 7a, 7b) and current site photographs it can easily be seen that the left bank down the entire cross section is stable and supports a healthy riparian zone. The design plans proposed a 3: 1 slope on the left bank that has been maintained and the bank shows no signs of landslides, undercutting, or undermining. PWA chose to grade a floodplain and a 3: 1 slope on the left side of the channel but avoided planting riparian vegetation or grading a 3: 1 on the right side of the channel. It was not clear why this discrepancy was created as there may have be complications with the property owner on the right-bank however, the Windemere property only exists on the left side of the creek.

Consequently, the right-bank has a much steeper slope than the left bank (45-vertical) and in many places it is devoid of vegetation (Figure 4). Bank destabilization occurred in many of the sections where hard engineering such as rocking the banks was not employed. This is specifically evident in figure x 50' upstream of cross section 2 at the outside of a meander bend that has eroded the right-bank. This observation may support the case for hard engineering in this project and the success of the project may be due to hardening the banks, creating rock grade control structures, and rock splash pools in conjunction with the riparian zone. This is not an ideal design for restoring the creek's natural processes however, with so much of the creek being unnatural due to grazing and development it may be an unpleasant but necessary design.

CONCLUSION

The success of any restoration project hinges on the project reaching its stated objectives and goals. PWA's goals for the 11,600' section of Alamo Creek restoration near the Windemere property were to limit channel incision, create a floodplain, form a healthy riparian zone, and provide structural support to areas of erosion and road crossings. The three cross sections measured in this post-project appraisal show that a wide between 100-150 meter floodplain was created and that channel incision is relatively non-existent. The survival rate of the riparian zone is nearly 83%. A survival rate of 83% 4 years after planting demonstrates that the riparian zone is healthy and perhaps too effective at reducing flow velocity because of sedimentation. Stabilization and riparian planting of the right-bank was not included in the objectives and it may damage the overall effectiveness of the restoration project. Despite PWA accomplishing its stated goals and objectives this project may not be considered by all environmentalists as a successful restoration. A stream restoration project should restore the stream or creek's biological functions (Kondolf 2000). The high degree of sedimentation, vegetation encroachment, and channel hardening as a result of this project may detract from its underlying objective as a restoration. This project most certainly has its values but may be more appropriately called a rehabilitation.

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Figure 3

These two images illustrate the vegetation encroachment in the main channel. The densely packed tule and cattail stands have given the channel attributes of a linear wetland.

Figure 4

Figure 5a

This image looks across the tule congested channel at a meander bend onto the steep right bank that is devoid of vegetation due to bank destabilization and erosion.

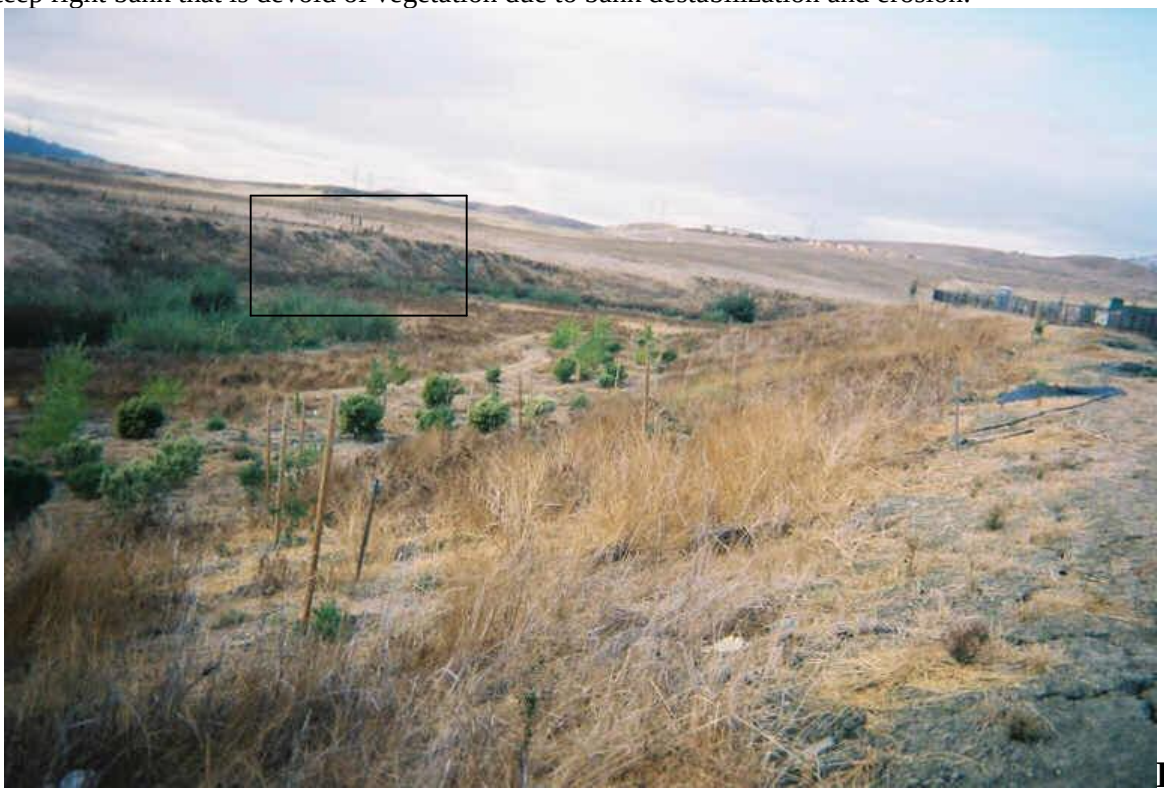


Figure 5b

Although the image is poor it can be seen that the fence line is being undermined due to an unstable bank.

Figure 8

Wide view of the project before the rainy season looking downstream showing the wide floodplain, gently sloping left bank, riparian corridor within the floodplain, congested channel, and steep right bank.

Figure 1

The West Branch flows into the Main Branch from the northwest (upper left side of image) while the East Branch, which cannot be seen in this image, flows parallel to the road (centrally bisecting image) into the Main Branch. The construction of the Windemere Housing Development can be seen in the upper right corner. In this image the development extends to the riparian corridor on the Main Branch.

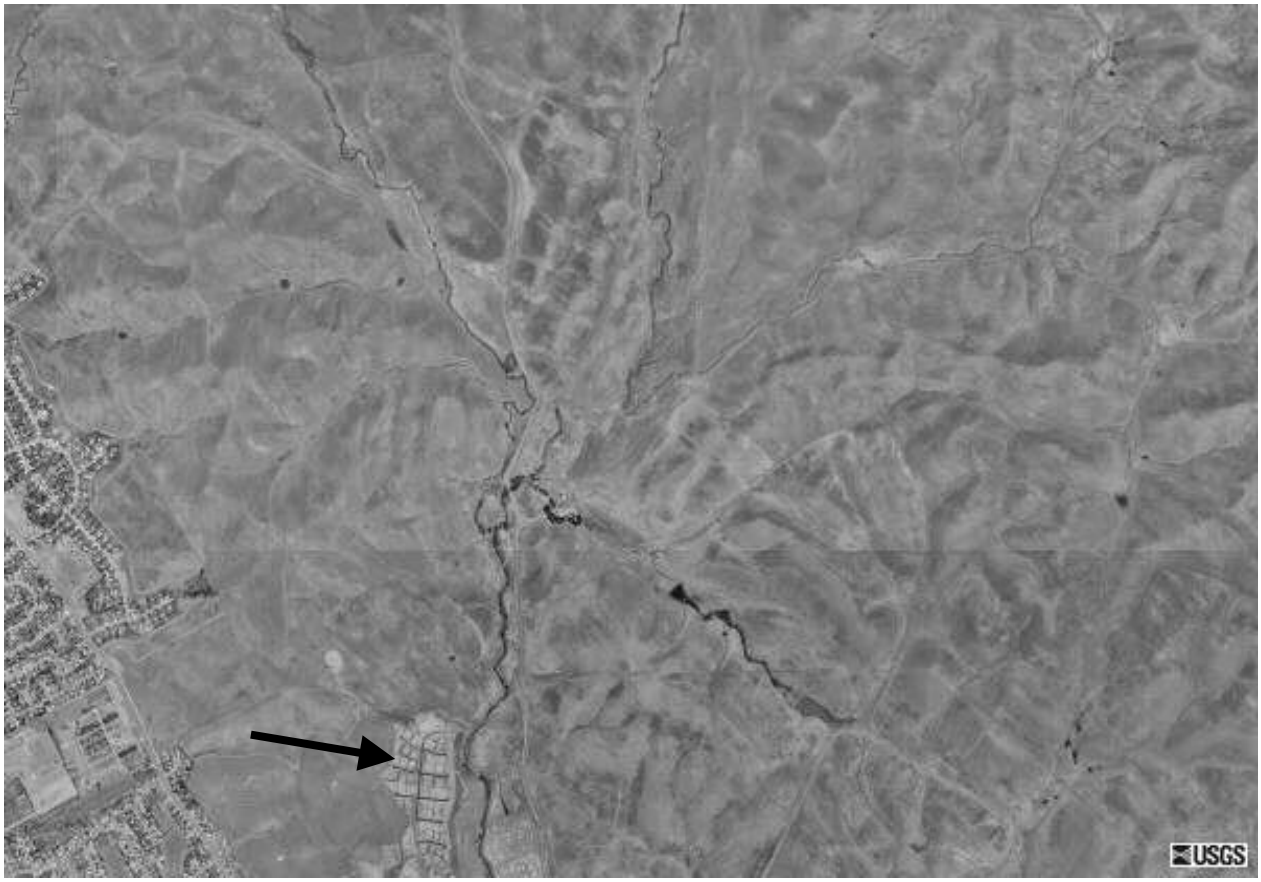


Figure 2

This image taken in 1993 shows how little development existed in the Alamo Creek watershed. The peninsula shaped residential area (shown with arrow) can also be seen in Figure 1.

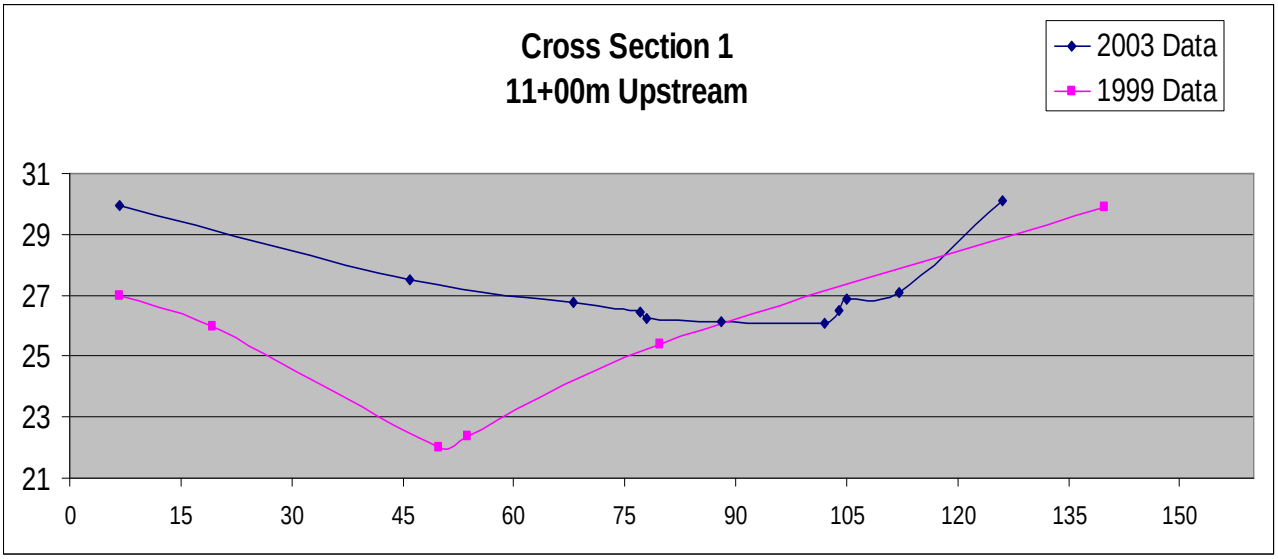


Figure 9

This graph shows the pre-design cross section compared to the current cross section. Unfortunately, these two cross sections were not taken at exactly the same location but they are within 100m of each other. It can be seen that a wide floodplain now exists and the left bank has a more gradual slope.

Revisions from the second draft

1) I discarded figure 1 and added an aerial photo from 2002 to compare to figure 2.

2) I cleared up page two and deleted some of the redundancy.

3) I made a concerted effort to change everything that I could to an active voice even though I am sure that some passive voice still pervades.

4) I added a graph comparing treatment 3 to my cross section 1. I regret that I could not compare cross section 2 to any treatment because the two graphs had too much variation.

5) I included all my citations and tried to qualify my statements.

6) I also changed the figures in the way you suggested by moving the figure number to the bottom right side.

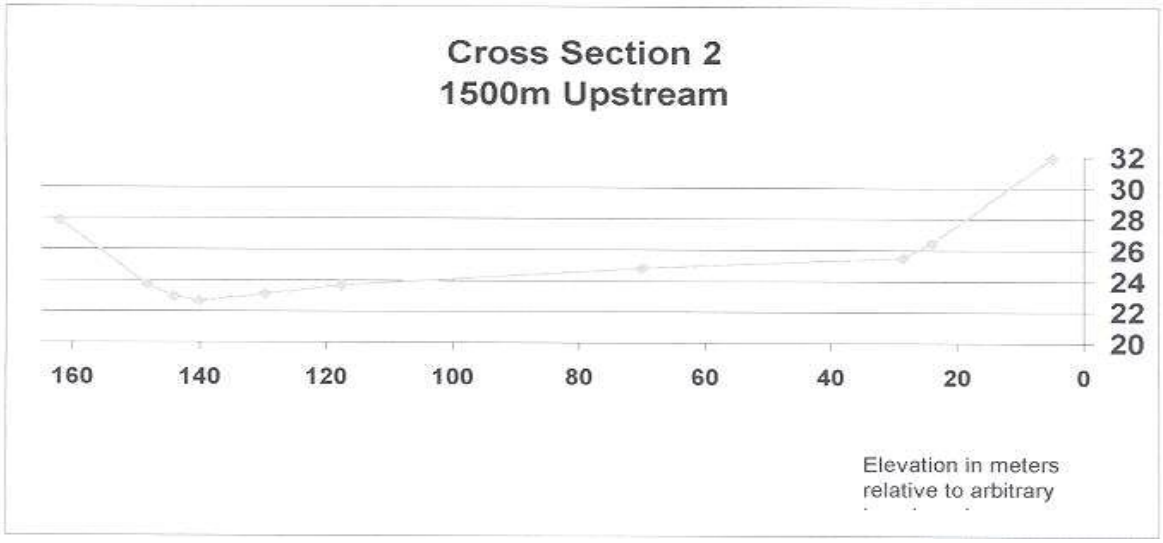

Cross Section 2
1500m Upstream
32
30
28
26
24
22
20
160
140
120
100
80
60
40
20
0
Elevation in meters
relative to arbitrary

Figure 6

Field Survey Data

Cross Section 1 Survey Data

Distance m	Height ft	Distance mX2	Elevation*m
3.4	3	6.8	29.93627
23	10.95	46	27.48457
34	13.2	68	26.79012
38.5	14.25	77	26.46805
39	15	78	26.23457
44	15.38	88	26.11728
51	15.55	102	26.06461
52	14.2	104	26.48148
52.5	13	105	26.65185
56	12.3	112	27.0679
63	2.4	126	30.12346

Cross Section 2 Survey Data

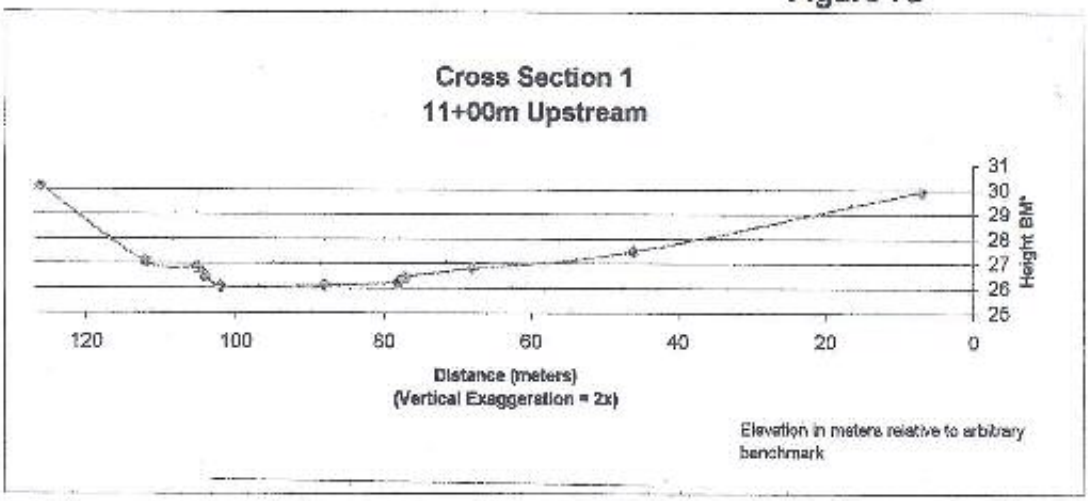
Distance m	Height ft	Distance mX2	Elevation* m
2.5	-3.5	5	31.94444
12	14.3	24	26.45062
14.3	17.4	28.6	25.49383
35	19.6	70	24.81481
58.8	23.3	117.6	23.67284
64.8	25.1	129.6	23.11728
70	26.5	140	22.68519
72	25.6	144	22.96296
74.1	23.1	148.2	23.73457
81	9.8	162	27.83951

Cross Section 3 Survey Data

Distance m	Height ft	Distance mX2	Elevation*m
6.7	-1.5	13.4	31.32716
19	16.8	38	25.67901
20	18.8	40	25.06173
30	28.4	60	22.09877
65.7	31.7	131.4	21.08025
66.6	33.7	133.2	20.46296
70.4	33.9	140.8	20.40123
72.3	33.6	144.6	20.49383
75	29.5	150	21.75926
86	19.1	172	24.96914

*Elevation is arbitrary and relative to Benchmark, which is Windermere property fenceline.

Figure 7a



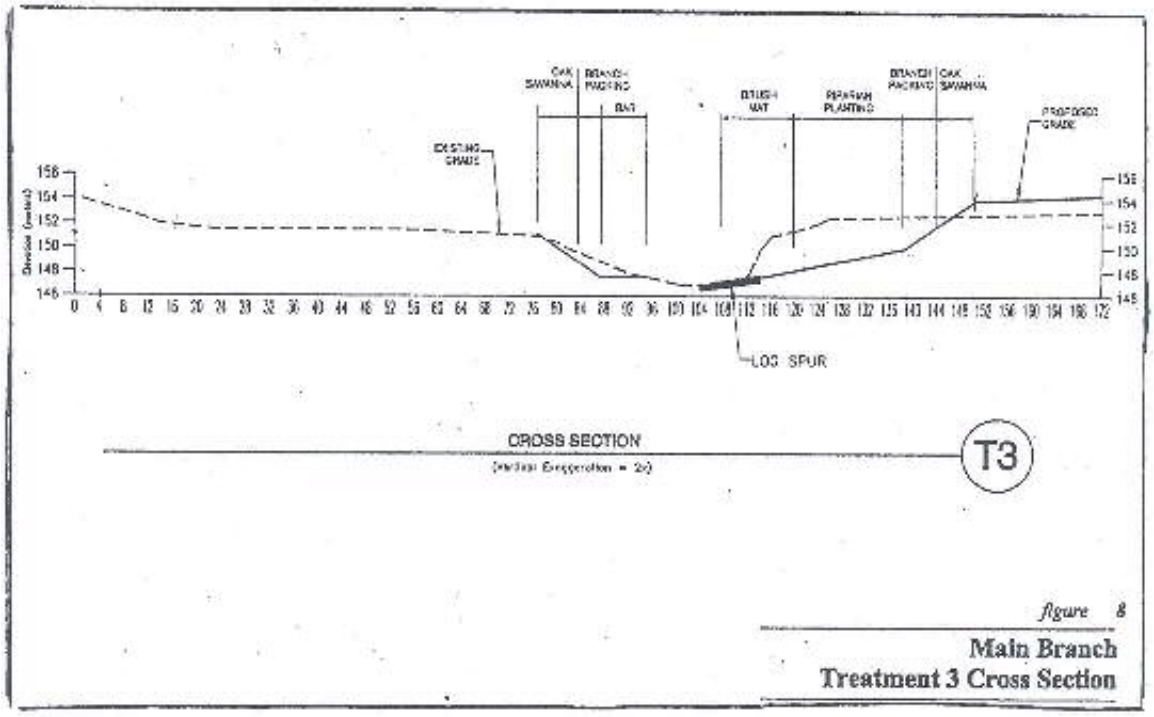


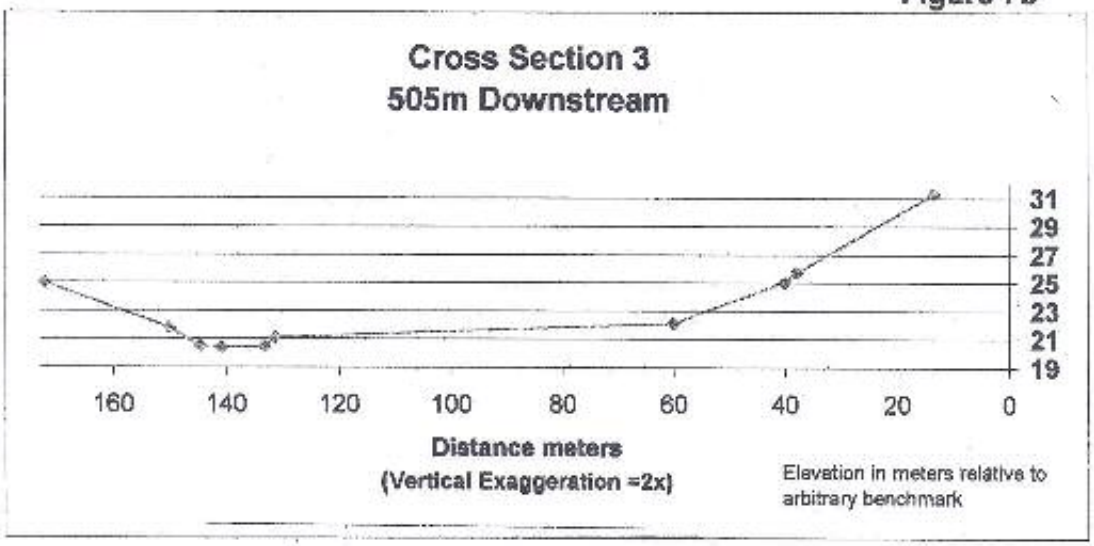
figure 8

Main Branch
Treatment 3 Cross Section

As can be seen when comparing the as designed treatment three to cross section 1 a wide flood-plain still exists and the proposed grade on the right of the figure has maintained its slope at approximately 3 : 1. However, on the right bank (left side of figure) the slope has increased resulting in bare soil, no vegetation and sediment erosion into the channel.

Lower figure adapted from PWA 1999

Figure 7b



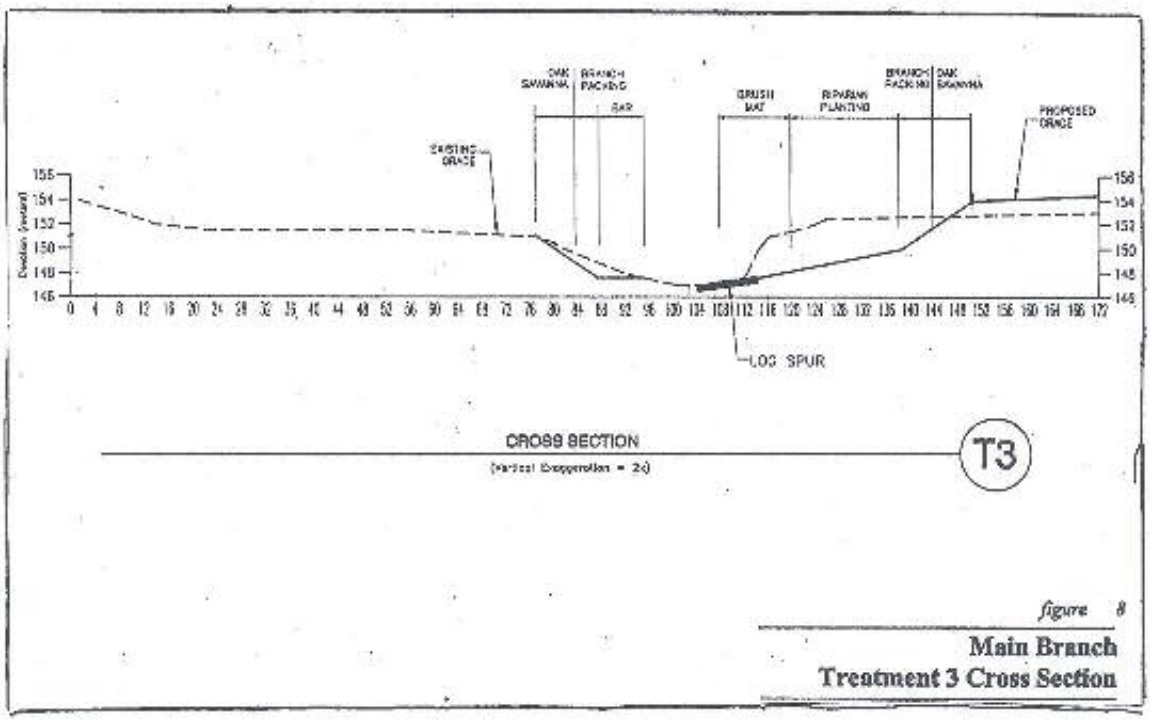


figure 8

Main Branch
Treatment 3 Cross Section

As can be seen when comparing the as designed treatment three to cross section 3 a wide flood-plain still exists and the proposed grade on the right of the figure has maintained its slope at approximately 3 : 1. However, on the right bank (left side of figure) the slope has increased resulting in bare soil, no vegetation and sediment erosion into the channel.

Lower figure adapted from PWA 1999