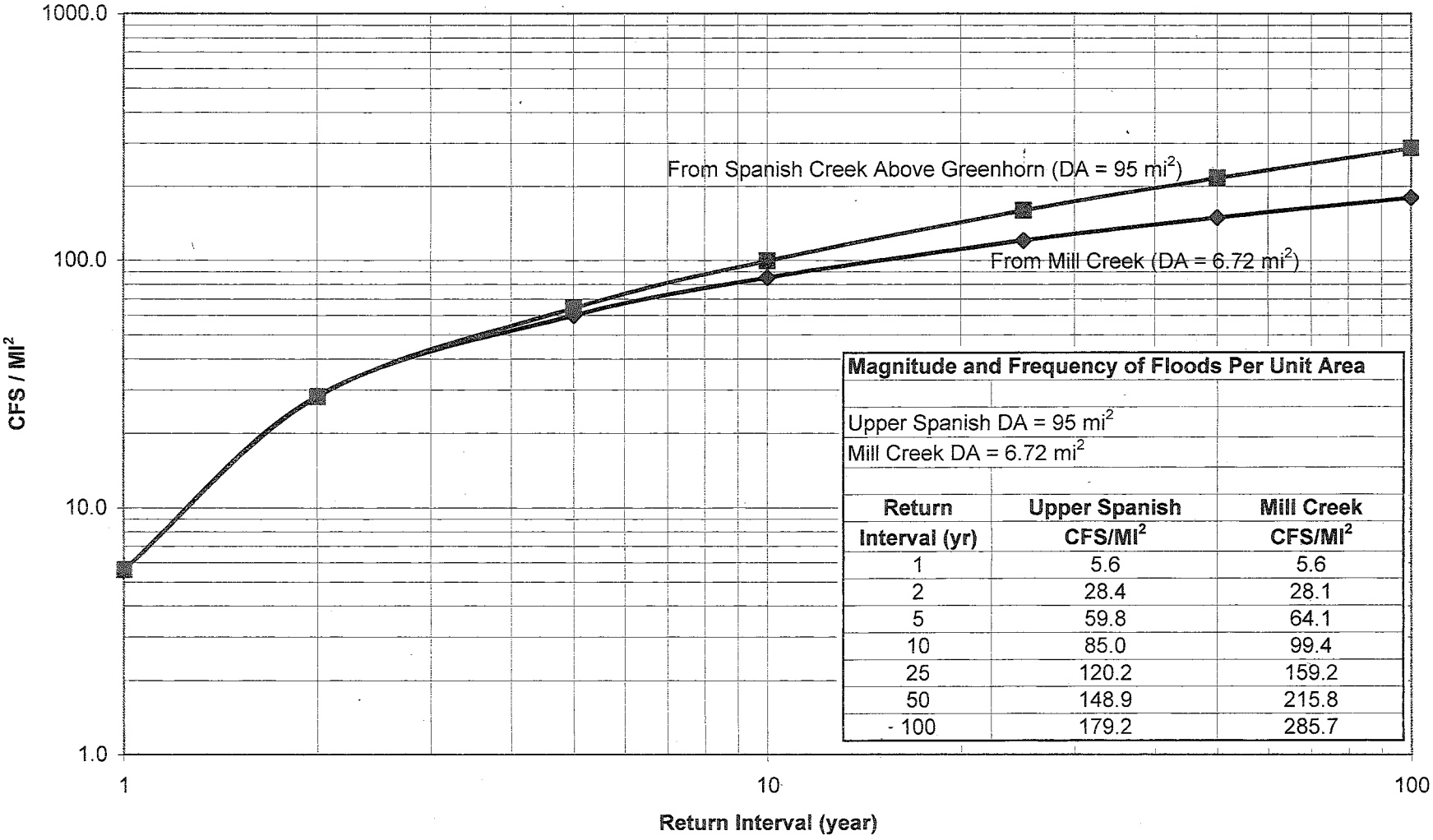
Appendix A

Flood Frequency Analysis

Upper Spanish Creek Watershed

Magnitude and Frequency of Floods Per Unit Area
Upper Spanish Creek



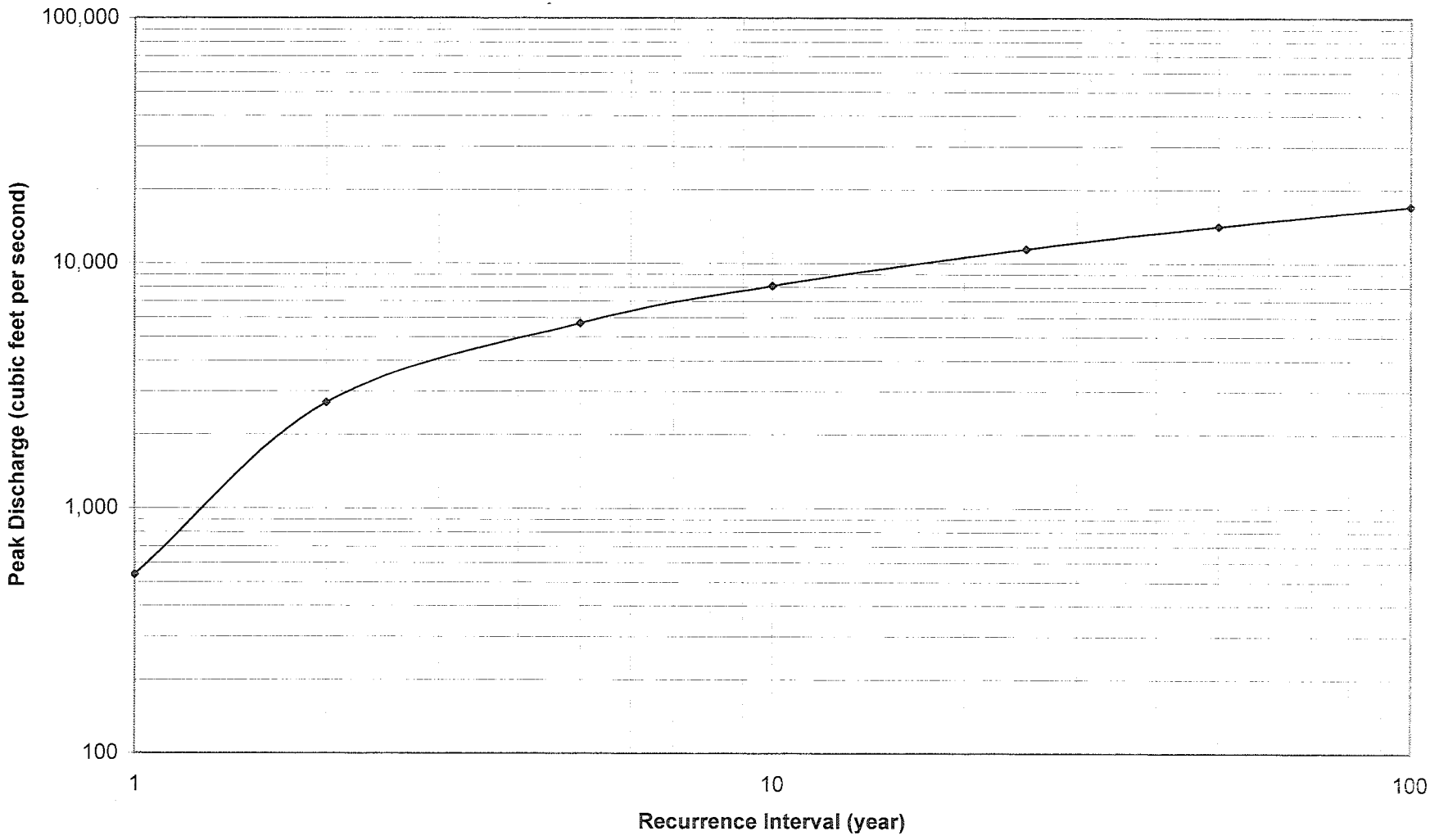
Magnitude and Frequency of Floods Per Unit Area

Upper Spanish DA = 95 mi²

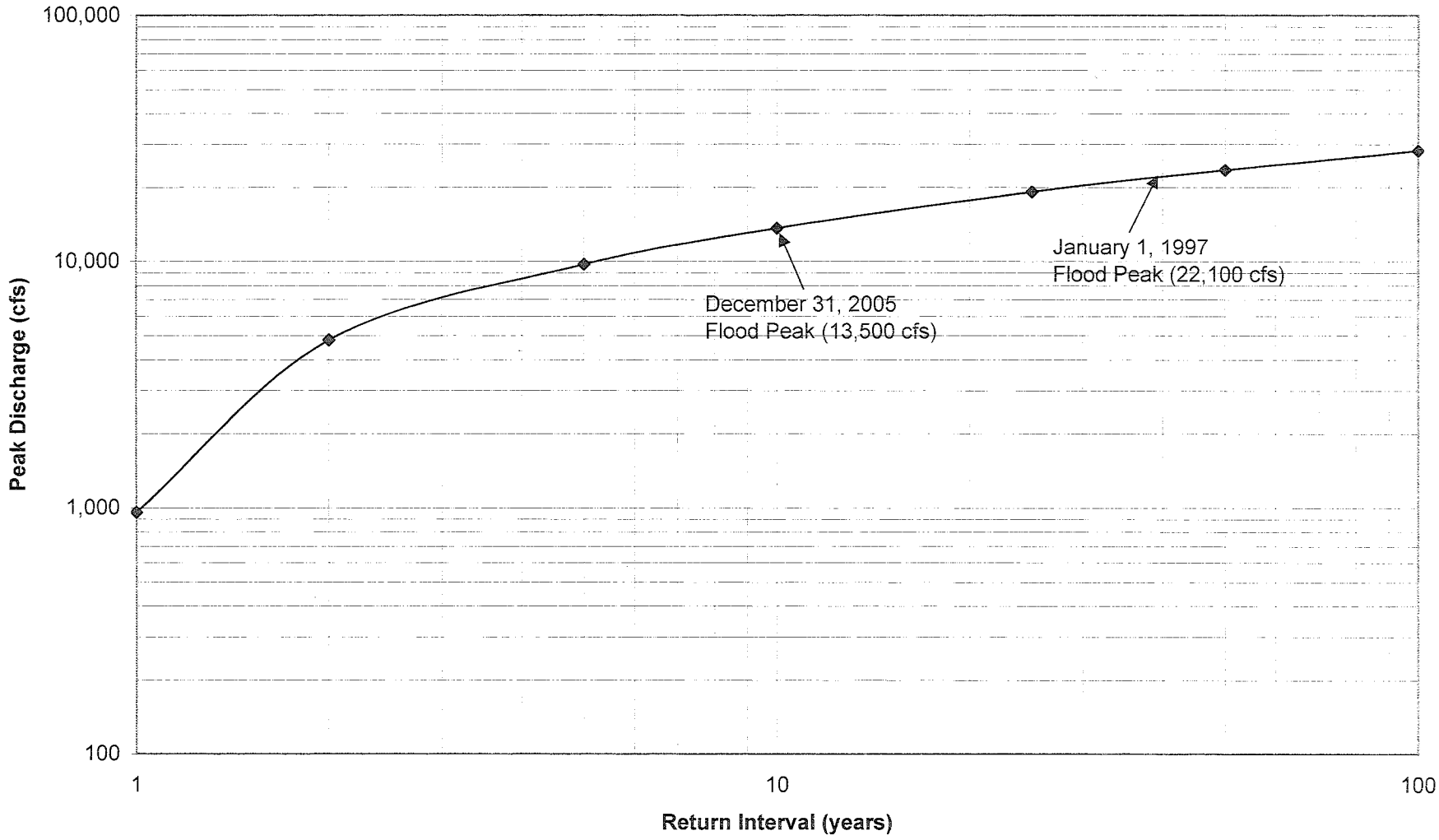
Mill Creek DA = 6.72 mi²

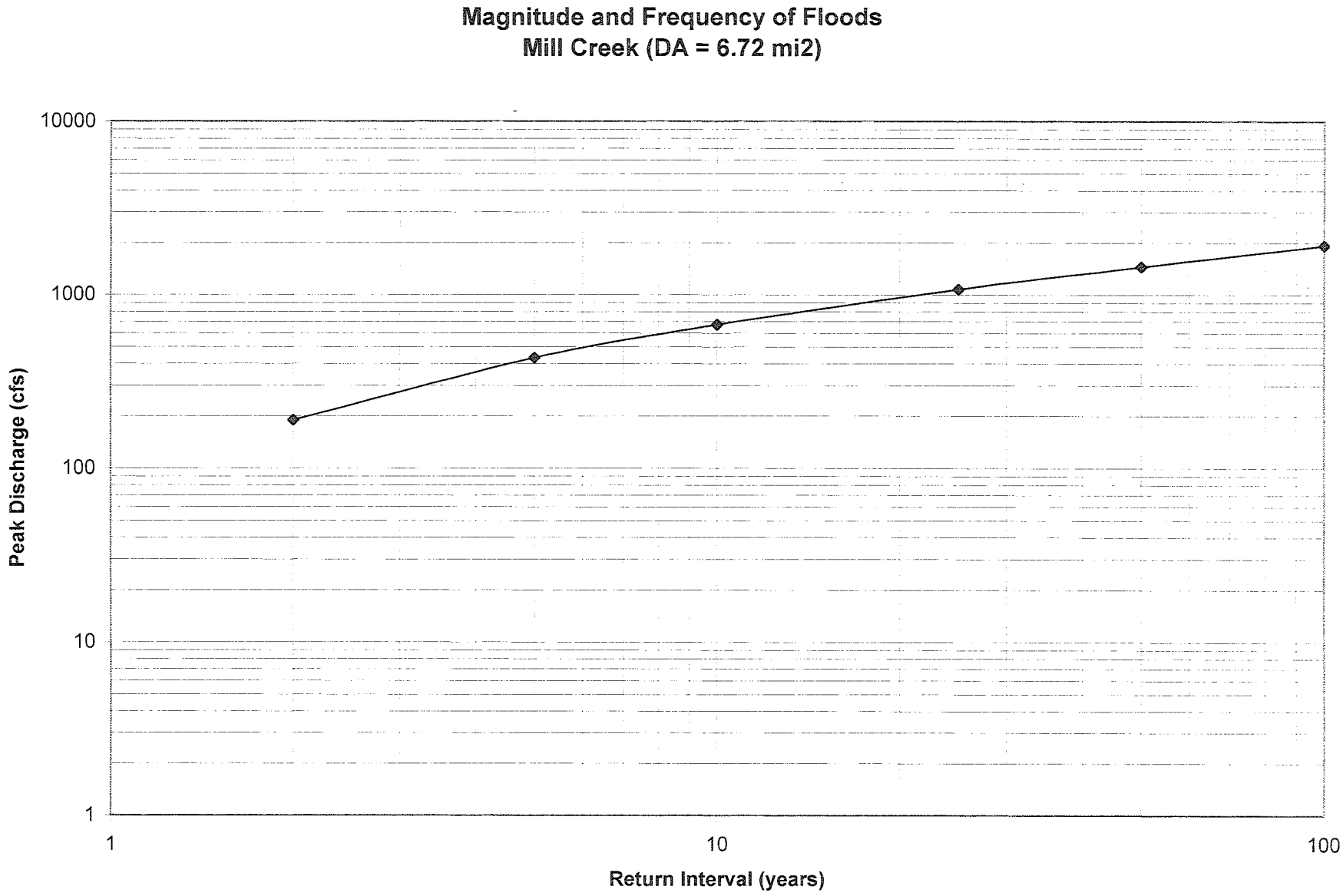
Return Interval (yr)	Upper Spanish CFS/MI²	Mill Creek CFS/MI²
1	5.6	5.6
2	28.4	28.1
5	59.8	64.1
10	85.0	99.4
25	120.2	159.2
50	148.9	215.8
100	179.2	285.7

Magnitude and Frequency of Floods
Upper Spanish Creek (DA = 95 mi^2)



Magnitude and Frequency of Floods
Spanish Creek at Keddie (DA = 184 mi^2)




Magnitude and Frequency of Floods
Mill Creek (DA = 6.72 mi2)
Peak Discharge (cfs)
10000
1000
100
10
1
1
10
100
Return Interval (years)

Flood Frequency Analysis For The Upper Spanish Creek Watershed								
	Drainage	Peak Discharge (cubic feet per second) at Indicated Recurrence Intervals						
Location	Area (mi^2)	1-yr (0.990)	2-yr (0.500)	5-yr (0.200)	10-yr (0.100)	25-yr (0.400)	50-yr (0.020)	100-yr (0.010)
Spanish Gage @ Keddie	184	958	4,790	9,706	13,625	19,135	23,551	28,169
Spanish abv Greenhorn @ 60% of Gage	95	575	2,874	5,824	8,175	11,481	14,131	16,901
Spanish abv Greenhorn by $Q_u=Q_g(A_u/A_g)^b$	95	535	2,694	5,678	8,075	11,415	14,141	17,025
b		0.89	0.88	0.82	0.80	0.79	0.78	0.77
A_u/A_g = 95/184 = 0.52								

STREAM GAGES IN THE SPANISH CREEK WATERSHED															
		Years of	Years of	Drainage	Mean Annual	Mean	Peak Discharge (cubic feet per second) at Indicated Recurrence Intervals								
Gage ID	Station	Operation	Record	Area (mi^2)	Ppt (in)	Elevation (ft)	1-yr (0.990)	2-yr (0.500)	5-yr (0.200)	10-yr (0.100)	25-yr (0.400)	50-yr (0.020)	100-yr (0.010)	200-yr (0.005)	
USGS 11402000	Spanish at Keddie[3]	1934-1995	61	184	68	3900	958	4,790	9,706	13,625	19,135	23,551	28,169	32975	
USGS 11401940	Mill Cr. nr Quincy[1]		11	6.72	45	5000		189	431	668	1,070	1,450	1,920		
USGS 11401900	Spanish Cr. abv Quincy[2]		5	69			842	3,587	7,211	10,810	17,174	23,569	31,708	42015	
FR-CRM	Spanish Cr. at Gansner Bridge	2001-present	5												
PC/FR-CRM	Spanish Cr. at Gopher Hill Bridge	1997-present	9												
FR-CRM	Wapaunsie Cr. At Gopher Hill	2004-present	2												
FR-CRM	Spanish Cr. abv Rock Creek	1994-1995	2												
FR-CRM	Rock Creek at Bucks Lake Rd Bridge	1994-95;2004-pre,	4												
FR-CRM	Slate Creek blw Forest Service Bridge	2004-present	2												
FR-CRM	Greenhorn Cr. nr Massack	1990-	3	44.18	33										
USFS	Little Schneider Cr.	1995													
USFS	Schneider Cr.	1995													
[1] Waananen 1977															
[2] USGS Unpublished															
[3] USGS Published															

Appendix B

Spanish Creek Rehabilitation

Project Concept Description

SPANISH CREEK REHABILITATION
PROJECT CONCEPT DESCRIPTION

The following is a brief description of the conceptual treatment for each project reach, beginning at the head of American Valley and ending at the mouth, downstream of the confluence with Greenhorn Creek. These project concepts were used to determine cost estimates to rehabilitate each stream reach. Basically, two treatment techniques are proposed. The FR-CRM has found that these treatments are very successful when treating streams and entrenchment banks.

Vortex Boulder Vanes and Vegetation (Figure B1) would be used along channel outcurves to hold the centers of flow convergence and high velocities away from the bank, allowing vegetation to not only stabilize the bank but also to reduce flow velocities against the bank to near zero at all flow levels, thereby dramatically reducing bank erosion and channel migration.

Channel Constrictions and Vegetation (Figure B2)would be used between meander bends to facilitate the energy of flowing water and bedload transport within sequences predetermined for the type of stream being treated. The treatment would be designed to create (1) a minor backwater effect immediately upstream of each constriction so that sediment can be deposited along the banks and (2) an increase in flow velocities at the constriction and high flow turbulence immediately downstream in a scour hole. The effects would be to help center stream flows, dissipate excess energy, transport bedload sediment and induce vegetation growth along the margins of the channel.

The following is a brief description of the treatments proposed for Spanish Creek in American Valley by treatment reach (Refer to Map 7, main text):

1. Gravel Management Reach. Total reach length is 6000 feet (1.1 miles). Approximately 2000 feet of eroding channel banks would be treated with a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings. Approximately 830 feet of the Feather River College channel bank was treated several years ago with rock riprap.

2. FRC – Upper Dyrr Reach. Total reach length is 3400 feet (0.64 miles). Four eroding channel banks, approximately 1700 feet, would be treated using a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

3. Dyrr Reach (immediately upstream of Highway 70). Total reach length is 1500 feet (0.28 miles). Two channel banks, totaling 450 feet, is scheduled to be

treated in 2006 using a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

4. Spanish Road – Beskeen Lane Reach. Total reach length is 3200 feet (0.61 miles). Eight channel-constrictions would be constructed at approximately 450 foot intervals in combination with bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings. Boulders and naturally occurring material would be used to construct each constriction. Existing trees and shrubs would be used as much as possible, as would existing boulder riprap banks located next to Spanish Creek Road.

5. Beskeen Lane at Channel Outcurve. A single entrenchment outcurve is threatening Beskeen Lane and a power pole. Approximately 350 feet of channel bank would be treated with a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

6. Entrenchment Bend Reach. The total length of this reach is 650 feet and includes the major bend in the entrenchment, a rock riprap bank, a concrete rubble dam, and approximately 650 feet of Spanish Creek Road. The bend has been treated with rock riprap to stop further channel migration. Stream flows are now eroding the bend at the upstream end of the riprap bank and threaten Spanish Creek Road. Treatment would include relocating approximately 650 feet of the Spanish Creek Road away from the bend and treating approximately 200 feet of the bend with a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

7. Concrete Rubble Dam. This dam supports a pond for pumping water to an irrigation diversion. The dam and some extraneous pieces of concrete rubble are forcing water against the bank immediately downstream of the riprap bank and then stream flows are directed against the opposite bank by the dam, causing excessive erosion of that bank. All of the concrete rubble would be removed, a channel constriction constructed to create a small pool for water diversion and the eroding bank would be sloped and further treated with vegetation transplants.

8. QCSD – Christenson Family Ranch Reach. Total reach length is 3800 feet (0.72 miles). Seven channel-constrictions would be constructed at approximately 450 foot intervals in combination with bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings. Boulders and naturally occurring material would be used to construct each constriction. Existing trees and shrubs would be used as much as possible. Approximately 500 feet of channel bank would be treated with a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation

transplanting, and biotechnical erosion control, including vegetation plantings. This bank, located at the Pence house and horse pasture, was previously treated with concrete rubble and channel straightening. A single power pole is also threatened. The concrete rubble would be made a part of the treated bank by burying it into the bank and using some of it as "footers" for the boulder vanes.

9. Historic RR Xing. Approximately 450 feet of channel length is affected by sheet-piling located in the center of the channel. A diversion dam was located here and now the channel is diverted around the pilings on both banks. A large gravel island has formed downstream of the pilings and erosion of both banks is occurring. Treatment would include removal of the pilings, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

10. Bengard - Bresciani Reach. Total reach length is 4500 feet (0.85 miles). Ten channel-constrictions would be constructed at approximately 450 foot intervals in combination with bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings. Boulders and naturally occurring material would be used to construct each constriction. Existing trees and shrubs would be used as much as possible.

11. Clear Stream Headcuts. Clear Stream flows from its relatively shallow channel on top of the meadow terrace to the bottom of the entrenchment downstream of the historic RR crossing. Approximately 250 feet of the Clear Stream channel would be treated with a rock, grade-drop structure, eliminating the headcuts.

12. Bresciani - Bengard Outcurves. Three entrenchment outcurves are accentuating the erosion of existing meander bends. Approximately 700 feet of channel banks would be treated with a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

13. Pourcho Bank. A single entrenchment outcurve is accentuating the erosion of a meander bend. Approximately 350 feet of channel bank would be treated with a combination of floodplain enhancement, boulder vane construction, bank sloping, vegetation transplanting, and biotechnical erosion control, including vegetation plantings.

Figure B1. Typical Boulder Vane Treated Bank, Plan View

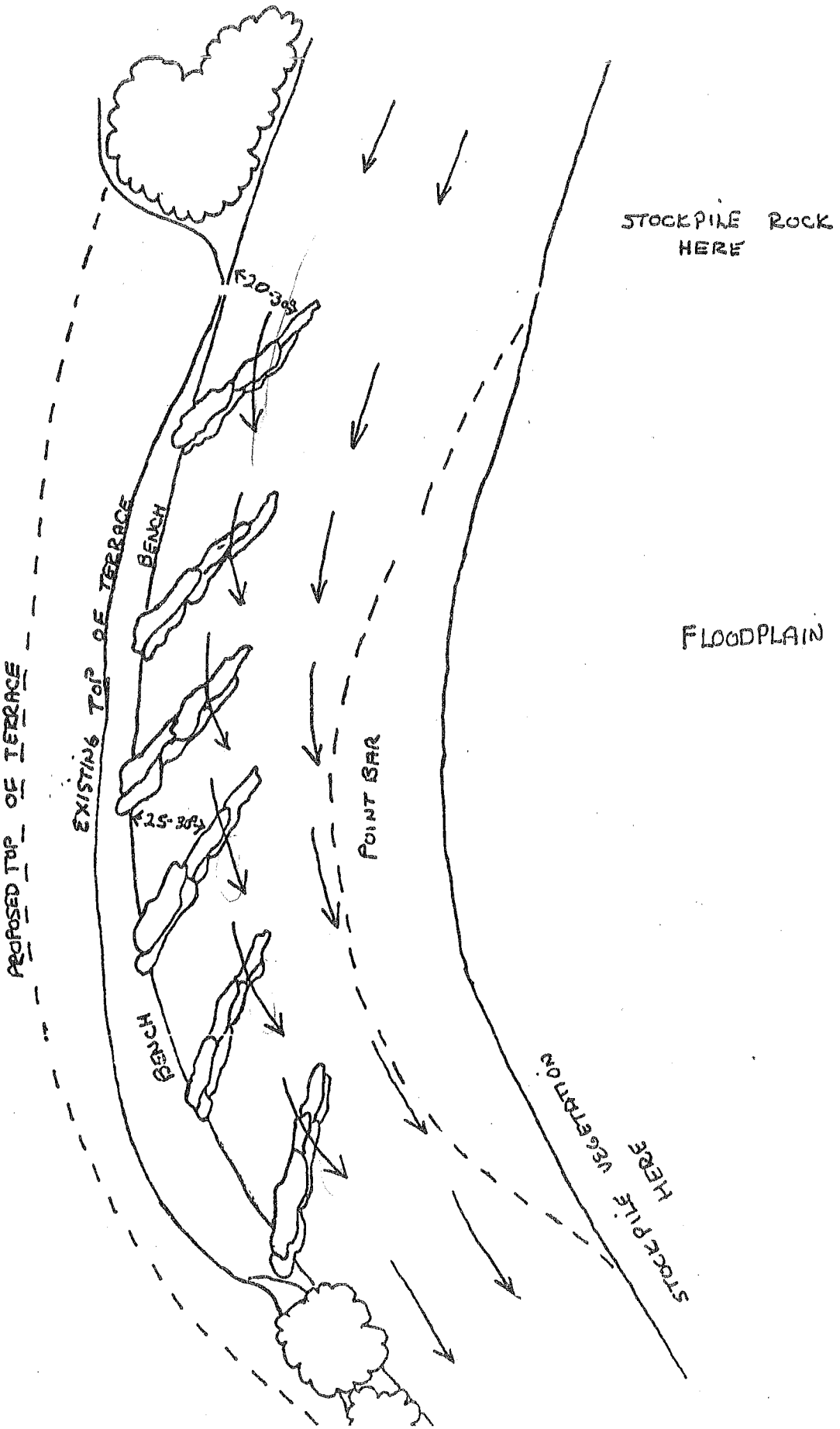


Figure B2. Typical Riffle-Pool Structure, Plan View