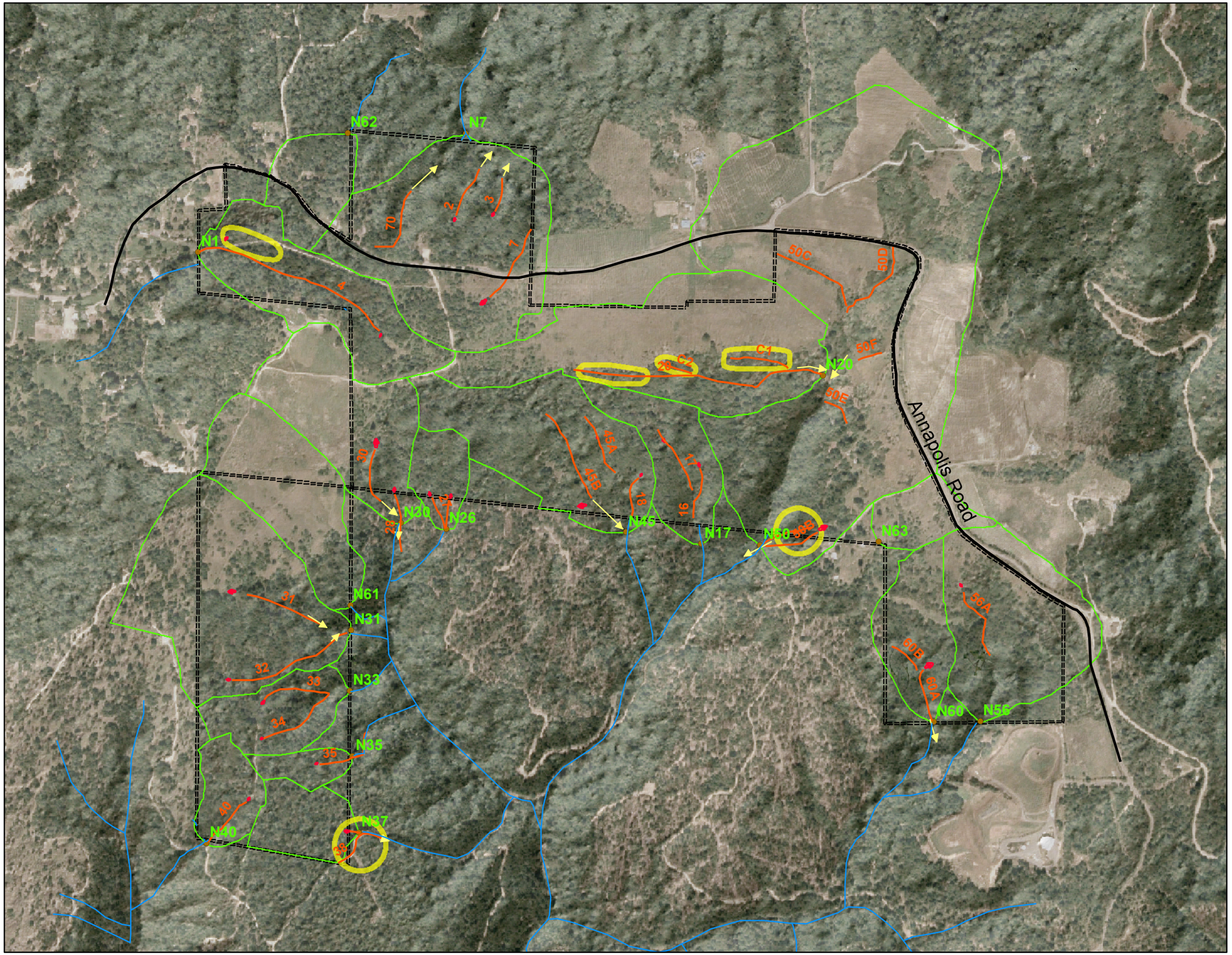
Appendix A-Erosion Mitigation Site Erosion Rate Estimates



Appendix-Mitigation Points
With
2007 Field Surveyed Streams

Proposed Artesa
Fairfax Vineyard
Annapolis, Sonoma County

Legend

- Streams
- Annapolis Road
- Continous bedrock
- Surveyed Streams
- Proposed sediment basins
- Mitigation Sites

0 300 600 1,200 1,800
Feet

N
W E
S

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Low range gully erosion estimate for ECP erosion mitigation sites 3 & 4 (THP sites C1 and C2)

Site C1

Distance					Bank	Length	Bank Height	Width eroded		Volume eroded	Type	Age marker	Age Category	Age estimate	Avg vol/yr	Channel dimensions	
Tape start	start	finish	cumu start	cumu finish				Max	Avg	ft3							
0	4	7	4	7	LB	3	1	0.7		2.1	undercut bank	none	2	10	0.21	16	
	16	25	16	25	LB	9	2.5	1.7	0.5	38.25	undercut bank	medium roots	2	10	3.825	16	
	16	20	16	20	RB	4	1.5	0.5		3	undercut bank	none	2	10	0.3	16	
	23	32	23	32	LB	9	2	1		18	undercut bank	medium roots	2	10	1.8	16	
	32	40	32	40	RB	8	2.5	1.2	0.8	24	undercut bank	med and fine roots	1	2	12	16	
	49	53	49	53	LB	4	1		0.7	2.8	undercut bank	medium roots	2	10	0.28	16	typical channel dimensions for first 65' is 4'x4'
65	11	16	76	81	RB	5	4	2		40	bank erosion	med and fine roots	1	2	20	16	
	5	16	70	81	LB	11	2.5		0.8	22	undercut bank	med and fine roots	1	2	11	16	surface runoff channel coincides, avg w2.0, avg d 0.5, length 55 (55 ft^3)
(+50ft)	33	36	98	101	RB	3	2.5	0.8		6	bank erosion	med and fine roots	1	2	3	10	at 83ft,channel dimensions w=4, d=2.5
	6	12	121	127	RB	6	1.3	0.3		2.34	bank erosion	med roots, fresh soil	1	2	1.17	10	bypassed 50ft channel due to brush, same channel dimensions
115																	
	28	30	143	145	LB	2	2	0.6		2.4	bank erosion	missing moss	1	2	1.2	10.5	channel dimensions w=3.5, d=3
	50		165													7	channel dimensions at 50ft; w=3.5, d=2; gully 4*4*5,4*2*5, 3*1*5, w/ no clear age markers (vol 99ft^3)
(+88ft)	79	88	194	203	?	9	1	1		9	channel bed erc	roots & missing mos	1	2	4.5	7	
203	11	20	214	223	RB	9	1.5	0.3		4.05	bank erosion	missing moss & fres	1	2	2.025	7	
	19	22	222	225	LB	3	1	0.5		1.5	undercut bank	fine roots	1	2	0.75	4.5	channel dimensions; w=3, d=1.5; gully w=4, d=4 (xs area 16ft2)
	28	33	231	236	RB	5	1	3		15	bank erosion	med and fine roots, l	1	2	7.5	4.5	
	28	33	231	236	RB?	5	3	0.5		7.5	bank erosion	roots of 10" tan oak	2	10	0.75	4.5	
	38	40	241	243	RB	2	1	3		6	bank erosion	missing moss & fres	1	2	3	4.5	
	39	43	242	246	LB	4	1	1.5		6	undercut bank	medium roots	2	10	0.6	4.5	
	65		268													3.5	channel dimensions w=3.5, d=1.0
	91		294													3.5	gully head LB, l=15,w=2.5, d=2.5 (vol 93.75ft^3)
	100		303													3.5	gully; w=5, d=3.5 (xs area 17.5 ft2)

Total volume eroded=	209.94	ft^3
total channel length	268	ft
channel capacity	3161.5	ft^3
eroded volume/channel length	0.8	ft^2
2yr eroded vol	132.3	
10yr eroded vol	77.65	
average bank height	1.79	
annual average for 2yr	66.15	
annual average for 10yr	7.765	
annual average per unit channel length 2yr	0.25	ft3/ft/yr
annual average per unit channel length 10yr	0.03	ft3/ft/yr
total erosion rate	0.28	ft3/ft/yr
rate/bank	0.14	ft3/ft/yr
divide by bank height	0.08	ft/yr
same as	23.42	mm/yr

74	ft3/yr	**Mass conversion @ 1.48 t/yd = 4.1 t/yr**	
		vol/unit length	
		retreat rate	

Low range gully erosion estimate for ECP erosion mitigation sites 3 & 4 (THP sites C1 and C2)

Site C2

Tape start	Distance start	Distance finish	cumu start	cumu finish	Bank	Length	Bank Height	Width eroded Max	Width eroded Avg	Volume eroded	Type	Age marker	Age category	Age estimate	Avg vol/yr	Channel dimensions	
	0	7	0	7	LB	7	1.5	0.2		2.1	undercut bank	med and fine roots, l	1	2	1.05	6	channel dimensions w=3, d=2; channel bottom 2' higher than mainstem
0																	
	0	7	0	7	RB	7	1.5	0.2		2.1	undercut bank	med and fine roots, l	1	2	1.05	6	
	8	20	8	20	RB	12	2	0.5		12	undercut bank	med and fine roots, l	1	2	6	6	
	12	23	12	23	LB	11	2.5	0.5		13.75	undercut bank	missing moss	1	2	6.875	6	
	19	20	19	20	RB	1	2	2		4	seepage pipe	med and fine roots	1	2	2	6	
	23	33	23	33	LB	10	2	0.2		4	undercut bank	fine roots & missing	1	2	2	6	
	23	33	23	33	RB	10	2	0.2		4	undercut bank	fine roots & missing	1	2	2	6	
	32	40	32	40	LB	8	2	1		16	undercut bank	med and fine roots	1	2	8	6	
	40	46	40	46	LB	6	4	1		24	bank slump	dead 3" manzanita	2	10	2.4	6	
	48	70	48	70	?	22	4	1.5		132	undercut bank	med and fine roots, l	2	10	13.2	6	
	60		60													6	gully dimensions;d=8, w=16 (xs area 128 ft ^{2})
	61	67	61	67	LB	6	3		1	18	bank erosion	med and fine roots, l	1	2	9	6	
	72	100	72	100	RB	28	8	1		224	undercut bank	lge, med fine roots, (	2	10	22.4	6	
	73	87	73	87	LB	14	3	0.3		12.6	undercut bank	med and fine roots, l	1	2	6.3	6	
	91		91													6	secondary gully dimensions; LB, l=50',w=8', d=4' (vol 1600ft^3) off to side; add to gully dimensions
(+91ft)																	
91	10		101													6	gully dimensions; d=10, w=12 (xs area 120 ft ^{2})
	7	12	98	103	LB	5	2	0.5		5	undercut bank	fine roots & fresh sui	1	2	2.5	6	
	14	17	105	108	LB	3	2		0.4	2.4	bank erosion	missing moss	1	2	1.2	6	
	23		114													6	doug fir roots span channel 3.5' above bed, est tree age 30yrs, dbh 18"
	18	23	109	114	LB	5	2.5	0.6		7.5	undercut bank	lge, med fine roots	1	2	3.75	6	
	18	23	109	114	RB	5	2.5	0.6		7.5	undercut bank	lge, med fine roots	1	2	3.75	6	
	26		117													3.75	channel dimensions w=2.5, d=1.5
	27	43	118	134	?	16	1	0.5		8	undercut bank	lge, med fine roots	1	2	4	3.75	
	34	45	125	136	RB	11	1	0.5		5.5	undercut bank	lge, med fine roots	1	2	2.75	3.75	
	38		129													3.75	3" dia doug fir root spans channel, 2' above bed, dbh=10" doug fir
	53	60	144	151	RB	7	1	1		7	undercut bank	med and fine roots	1	2	3.5	3.75	
	53	60	144	151												3.75	3"-5" firs on banks
	62		153													3.75	1" dia fir roots span channel 1' above bed
	65	70	156	161	RB	5	1	1.5		7.5	undercut bank	med and fine roots	1	2	3.75	3.75	
	65	70	156	161	LB	5	1.5	0.5		3.75	undercut bank	med and fine roots	1	2	1.875	3.75	
	65		156													6	channel dim; w=3, d=2
	77	80	168	171	LB	3	2	0.2		1.2	undercut bank	fine roots & fresh sui	1	2	0.6	6	
	80		171													6	gully dim; w=5, d=3.5 (xs area 17.5ft ^{2})
	84	90	175	181	LB	6	2	1		12	undercut bank	med and fine roots, l	1	2	6	6	
	88	97	179	188	RB	9	1.5	1.5		20.25	undercut bank	med and fine roots	1	2	10.125	6	
	100	106	191	197	LB	6	2	0.5		6	undercut bank	med and fine roots, l	1	2	3	6	
										562.15							

Total volume eroded	562.2	ft^3
total channel length	197.0	ft
channel capacity	1076.3	ft^3
eroded volume/channel length	2.9	ft$^{2/ft}$
2yr eroded vol	182.2	from subtotal function
10yr eroded vol	380.0	"
annual average for 2yr	91.1	
annual average for 10yr	38.0	
annual average per unit channel length 2yr	0.5	ft3/ft/yr
annual average per unit channel length 10yr	0.2	ft3/ft/yr
average bank height	2.3	ft
total volume eroded	129.1	ft3/yr **Mass conversion @ 1.48 t/yd = 7.1 t/yr**
volume eroded per channel length	0.7	ft3/ft/yr
rate/bank	0.3	ft/yr
divide by bank height	0.14	ft/yr
same as	43.6	mm/yr

High range gully erosion estimates for ECP erosion mitigation sites 4 & 5 (THP mitigation points C1 and C2)

C1

estimated age of gully	50	yrs
volume gully evacuated	55	ft^3
	99	ft^3
	93.75	ft^3

Matt O'Connor:
areas harvest in 50's, skid trails and tractor trails located near the base of gullies, hypothesize that gully initiated by this disturbance

distance	length	xs area of gully	vol	
70			55	volume of surface runoff channel
165			99	
222		16		
294			93.75	
303		17.5		
		16.75		average gully xs area

total length of channel/gully	253		
volume of gully	4238	ft3	
divided by age of gully-yrs	85	ft3/yr	erosion rate of gully
vol gullies and side channels	248	ft3	
	89.7	ft3/yr	erosion rate plus secondary gullies and surface channels

Mass conversion @ 1.48 t/yd = 4.9 t/yr

C2

distance	length	xs area of gully	vol	
60		128		
91			1600	secondary gully
171		17.5		

Matt O'Connor:
areas harvest in 50's, skid trails and tractor trails located near the base of gullies, hypothesize that gully initiated by this disturbance

estimated age	50	
total length of gully	197	ft
avg xs area gully	73	ft2
gully volume	14332	ft3
divided by yrs	287	ft3/yr
+secondary gully area	15932	ft3
total erosion rate	319	ft3/yr

Mass conversion @ 1.48 t/yd = 17.5 t/yr

22.4 t/yr

Matt O'Connor:
Total gully void for C1 and C2 divided by 50 yr in metric tons/yr

Sediment Savings Estimates-ECP Erosion Mitigation Sites 1, 2, 6 and 7

soil density (tons/cubic yard) 1.48

50 P (Site K in field notes); no mitigation proposed	Length (ft)	Width (ft)	Depth (ft)	volume (cy)	Tons	age (yrs)	rate (t/yr)
area of active erosion along creek related to concentrated flow off annapolis road	10	6	1	2.22	3.29	30	**0.11**

N50 (Site O in field notes); Site Enhancement and Erosion Mitigation Site 6 in ECP									High Range Estimate	Low Range Estimate
lower gully off of road, dissected fill slope	distance (ft)	Length (ft)	Width (ft)	Depth (ft)	volume (cy)	Tons	low age (yrs)	high age (yrs)	rate (t/yr)	rate (t/yr)
	0									
	0	5.5	4	5.2	4.2	6.3		50		0.13
	11	11	6.5	8.5	22.5	33.3		50		
	22	11.5	4	5	8.5	12.6		50		
	34	15	15	4	33.3	49.3		50		
	52	19	15	3	31.7	46.9		50		
	72	10	15	3	16.7	24.7		50		
	72									
						173.1	30	50	**5.8**	**3.5**

N50 (Site O in field notes); Site Enhancement and Erosion Mitigation Site 6 in ECP

upper gully, incised road surface	distance (ft)	Length (ft)	Width (ft)	Depth (ft)	volume (cy)	Tons		age (yrs)	rate (t/yr)	rate (t/yr)
	0									
	0	5	4	5.2	3.9	5.7		50		0.11
	10	10	4.5	3.8	6.3	9.4		50		
	20	10	3.7	4.5	6.2	9.1		50		
	30	10	2.8	2.7	2.8	4.1		50		
	40	10	4	3.5	5.2	7.7		50		
	50	10	2.8	1.3	1.3	2.0		50		
	60	15	2	2	2.2	3.3		50		
	80	20	4	2.3	6.8	10.1		50		
	100	35	4.5	1.6	9.3	13.8		50		
	150	40	2.5	1.2	4.4	6.6		50		
	180	35	3	2	7.8	11.5		50		
	220	35	2.5	1.7	5.5	8.2		50		
	250	15	5	0.5	1.4	2.1		50		
	250									
						93.5	30	50	**3.1**	**1.9**
Total N50 (Site O in field notes); Site Enhancement and Erosion Mitigation Site 6 in ECP								total	**8.9**	**5.3**

Sediment Savings Estimates-ECP Erosion Mitigation Sites 1, 2, 6 and 7

N37 (Site 36/38 in field notes) Site Enhancement and Erosion Mitigation Site 7 in ECP

Eroded logging road

In addition to the suggested culvert to drain outflow from sediment basin 1 work on the road should be incorporated into the plan. Repair the existing gully and add water bars to divert flow off of the road surface to prevent future erosion problems.

THIS SITE REMOVED FROM PROJECT MITIGATION-LOCATION DETERMINED TO BE ON ADJACETN PROPERTY, WORK COMPLETED BY ADJACENT PROPERTY OWNER

distance (ft)	Length (ft)	Width (ft)	Depth (ft)	volume (cy)	Tons	age (yrs)	rate (t/yr)	rate (t/yr)
0	20	1.8	0.8	1.1	1.6	5		
40	38.5	2.5	0.3	1.1	1.6	5		
77	30	3	0.5	1.7	2.5	5		
100	41.5	4	0.5	3.1	4.5	5		
160	40	5	0.5	3.7	5.5	5		
180	30	3	0.6	2.0	3.0	5		
220	30	4	0.5	2.2	3.3	5		
240	10	4	0.5	0.7	1.1	5		
240								
					23.0	5		**4.6**

N1 (Site 1 in field notes); Site Enhancement and Erosion Mitigation Site 1 in ECP

Eroded road

distance (ft)	Length (ft)	Width (ft)	Depth (ft)	volume (cy)	Tons	age (yrs)	rate (t/yr)
0							
0	15	1.3	0.5	0.4	0.5	5	
30	25	1.5	0.7	1.0	1.4	5	
50	35	2	0.5	1.3	1.9	5	
100	60	1	0.5	1.1	1.6	5	
170	50	1.3	0.7	1.7	2.5	5	
200	25	4	1.5	5.6	8.2	5	
220	25	4	0.6	2.2	3.3	5	
250	15	4	0.5	1.1	1.6	5	
250							
					21.2	5	**4.2**

(Site 20 in field notes); Site Enhancement and Erosion Mitigation Site 2 in ECP

No active erosion. Increased runoff from proposed vineyard may induce erosion therefore an energy disipator at the outlet of the culvert is advised.

NA

Appendix B-Soil Creep and Rockslide Creep Rate Estimates

Creep rate sediment input calculations for sediment budget

units of length are ft unless otherwise noted

SUBBASIN	1	2	3	4
Mainstem	4100	840	3720	2400
		1920		
ft	4100	2760	3720	2400
m	1250	841	1134	732

Matt O'Connor:
See Figure 4 in Erosion Analysis

Sub-drainage

1st order channels	1	2	3	4
	600	600	1080	1680
	840	600	1200	480
	1041	960	1325	1230
	1000	662	1200	840
	883	600	631	1800
	480	800	120	1560
	694	480	1200	320
	480	536	500	120
	694	1200	840	120
	960	240	120	120
	960	120	500	120
	480	120	120	300
		410	250	360
		1320	300	480
		360	360	1320
			380	1200
			360	840
			240	1320
			240	820
			120	720
			120	720
			960	840
ft	4881	9008	12166	17310
m	1488	2746	3709	5277

Matt O'Connor:
Six segments in bold italic font-applied CGS dormant rockslide creep rate (low 5 mm/yr, high 10 mm/yr)

SUBBASIN	1	2	3	4	
1rst order	**creep rate of 1.6 mm/yr**				
creep (m3/yr)	5	9	12	17	
mass (t/yr)	8	16	21	30	mass at 1.77 t/m3

2nd order channels				
	600	536	694	320
	189	410	600	250
	1136	662	1230	
		946	915	
			400	
			280	
ft	600	2554	4119	570
m	183	779	1256	174

2nd order					
	creep rate of 1.6 mm/yr				
creep (m3/yr)	1	2	4	1	
mass (t/yr)	1	4	7	1	mass at 1.77 t/m3

3rd order channels				
		1830	4500	2330
				2271
ft		1830	4500	4601
m		558	1372	1403

3rd order					
	creep rate of 1.6 mm/yr				
creep (m3/yr)	0	2	4	4	
mass (t/yr)	0	3	8	8	mass at 1.77 t/m3

4th order channels					
ft	3379	662			
m	1030	202			

	creep rate of 1.6 mm/yr		banks 2 m high		
creep (m3/yr)	7	1	0	0	
mass (t/yr)	12	2	0	0	mass at 1.77 t/m3

Matt O'Connor:
1100 ft subtracted to account for length of historically active rockslide affecting one bank

Stream channel bank creep-typical at 1.6 mm/yr (NCRWQCB rate)					
creep total m3/y	12	14	20	22	
total mass t/yr	21	25	36	39	121 metric tons

Matt O'Connor:
total from soil creep for 2 banks 1m high (2 m for 4rth order)

Matt O'Connor:
sum of channel lengths in 1rst and 2nd order channels (shown in bold italics in channel segment table) intersecting dormant rockslides

Rockslide activity	channel length (m)		Low range	High range	
Dormant	1694	creep (m3/yr)	16.9	33.9	
		mass (t/yr)	30.0	60.0	metric tons
Historically Active	335	creep (m3/yr)	16.8	33.5	
		mass (t/yr)	29.7	59.4	

Matt O'Connor:
applied as 1 bank 2 m high

Matt O'Connor:
a portion of channel (1100 ft) in sub basin 4

Matt O'Connor:
applied to one bank 2 m

Stream channel bank creep-rockslides at CGS creep rates		
Total creep-rockslides	Low range	60
metric tons	High range	119