5/12/04

LANL Order
Reference

Post Cerro Grande Fire Offsite Contaminant Transport at Los Alamos National Laboratory

9979

Pueblo Canyon Geomorphic Study

- Characterize lower Pueblo Canyon stream channel
- Characterize stormwater runoff
- Predict and monitor changes in Canyon
- Recommend monitoring and stabilization projects

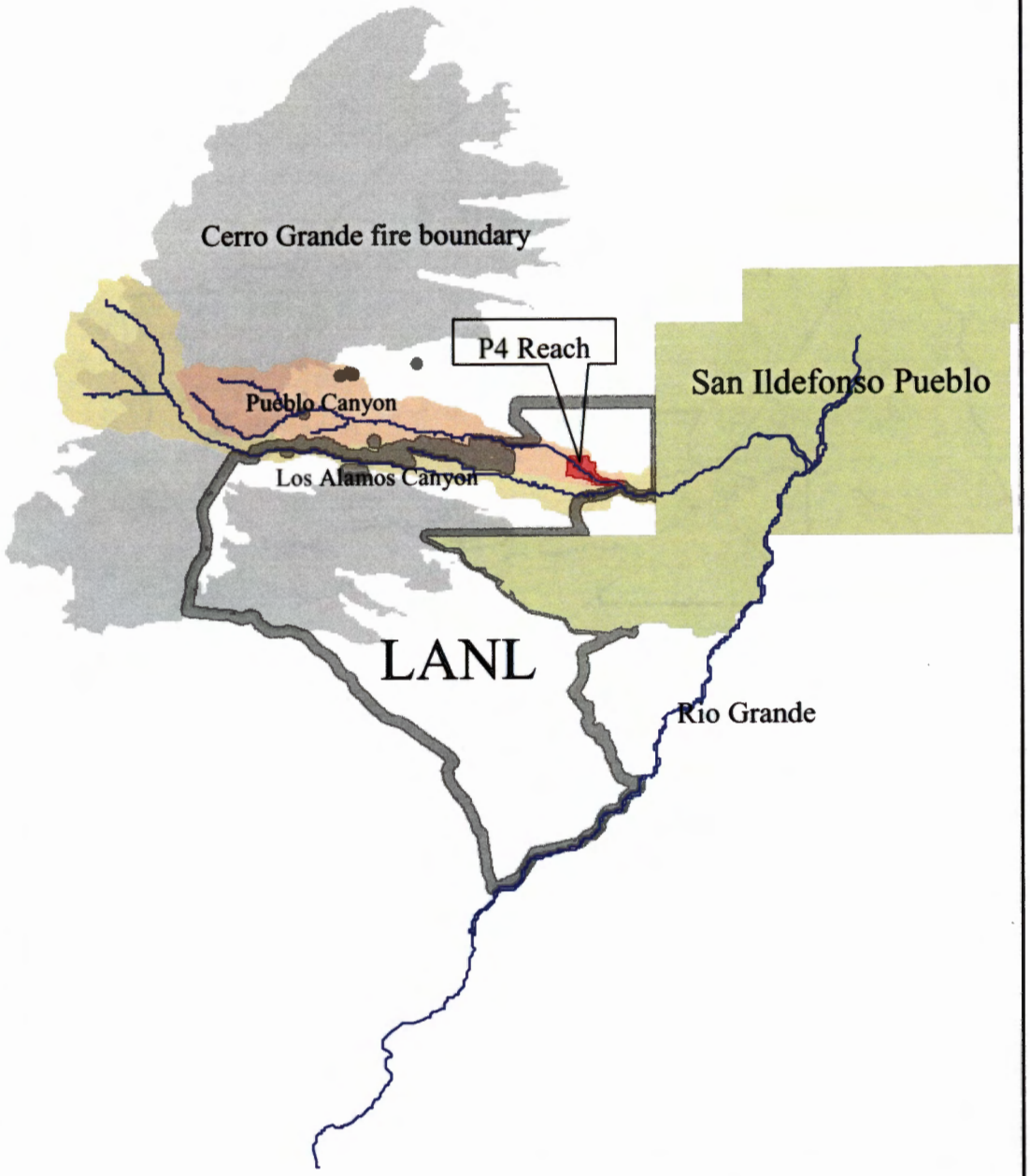
How

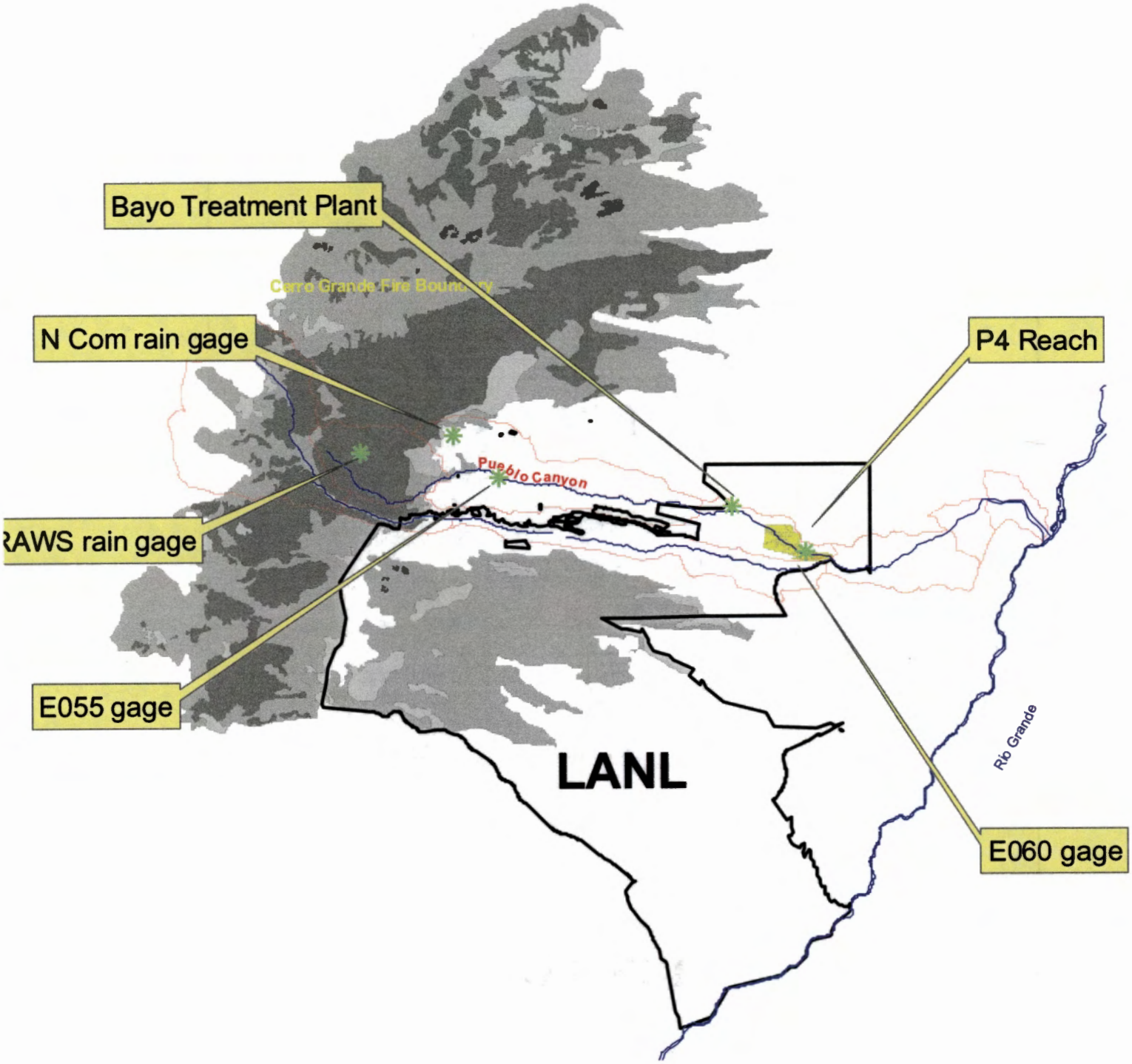
- Measure stream dimensions, pattern, and profile – 40 cross-sections, 1.1 mile profile
- Evaluate nature of current channel and its relationship to mapped contaminant levels
- Collect stormwater for physical and chemical analysis
- Evaluate stormwater measurements

Why

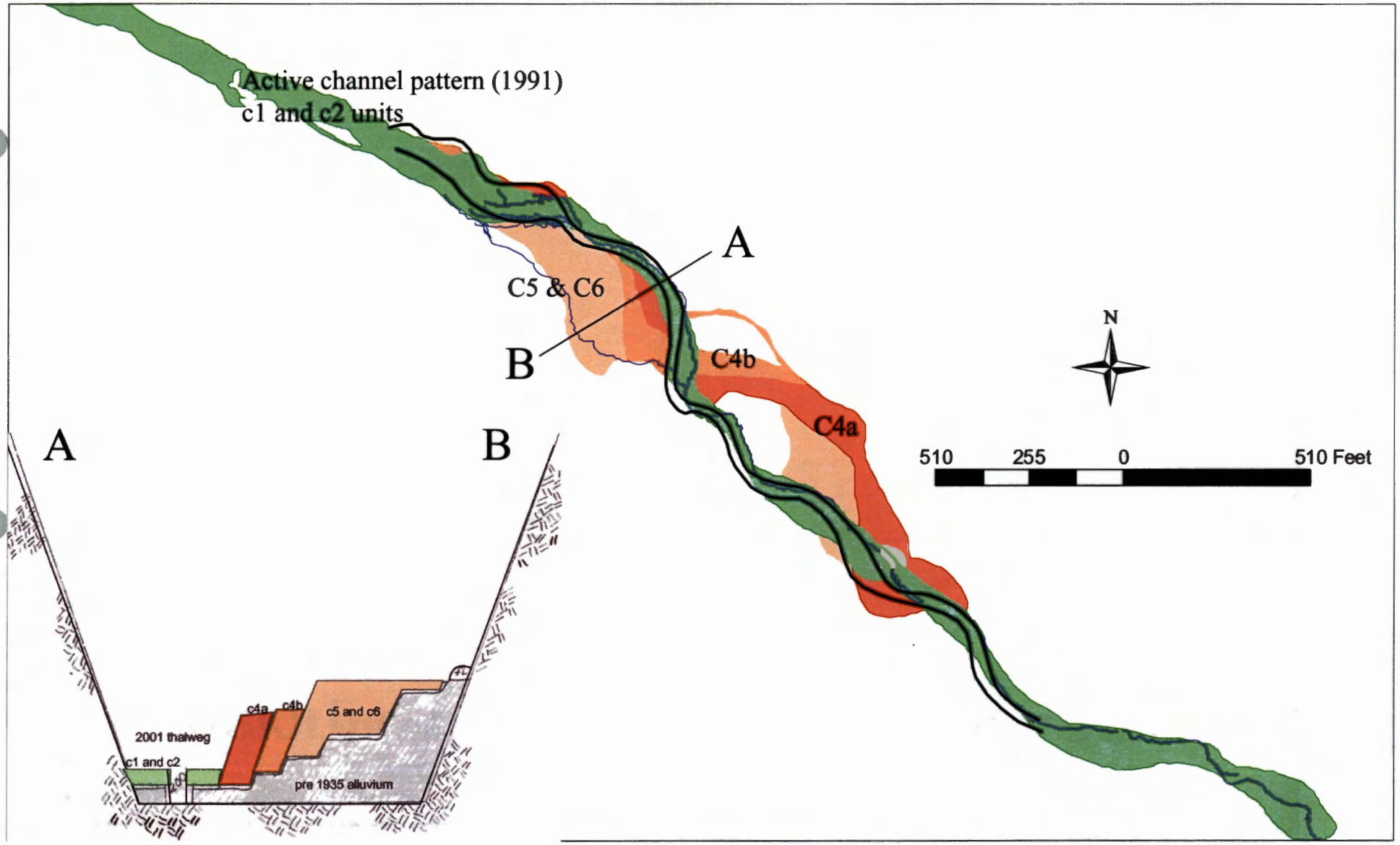
- Eighty Percent of the upper Pueblo watershed burned during Cerro Grande fire
- Watershed changes have resulted in significant stormwater runoff and sediment yield increases
- The Pueblo Canyon stream channel is adjusting to these increases
- LANL legacy contaminants exist in Pueblo Canyon and are subject to erosion

WHERE

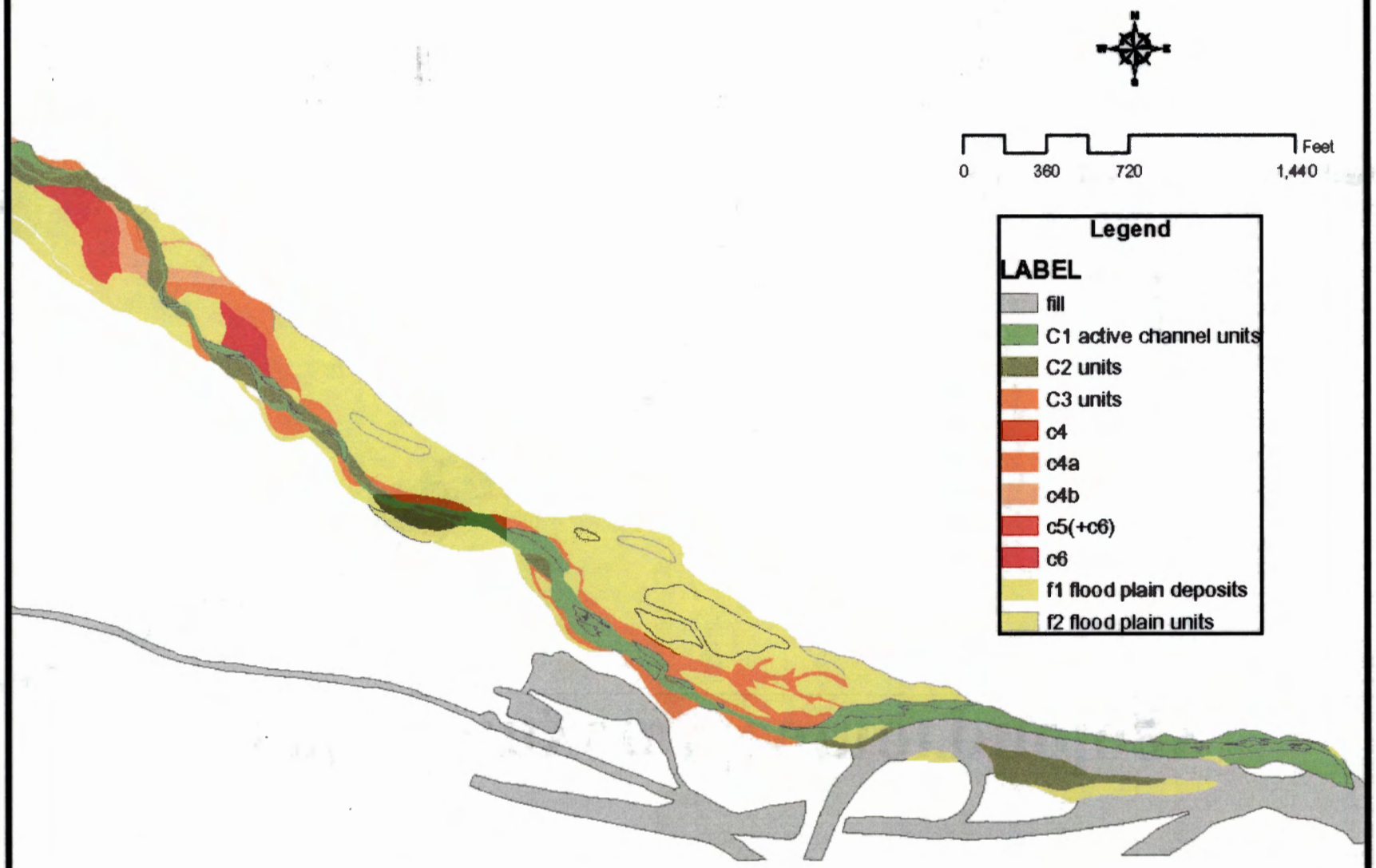

Cerro Grande fire boundary
P4 Reach
San Ildefonso Pueblo
Pueblo Canyon
Los Alamos Canyon
LANL
Rio Grande


Bayo Treatment Plant
Cerro Grande Fire Boundary
N Com rain gage
P4 Reach
Pueblo Canyon
RAWS rain gage
E055 gage
LANL
Rio Grande
E060 gage

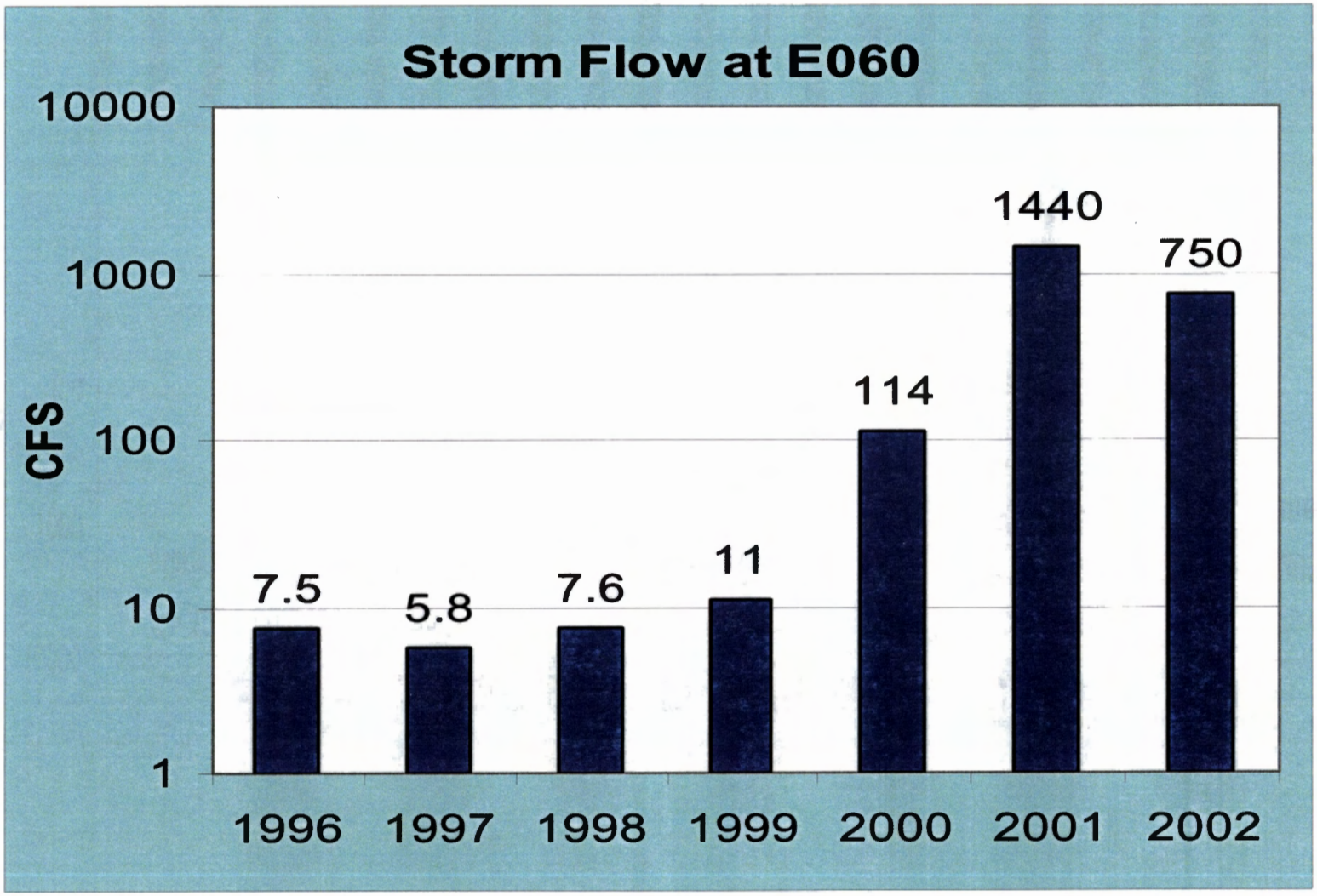
Pueblo Canyon Geomorphology

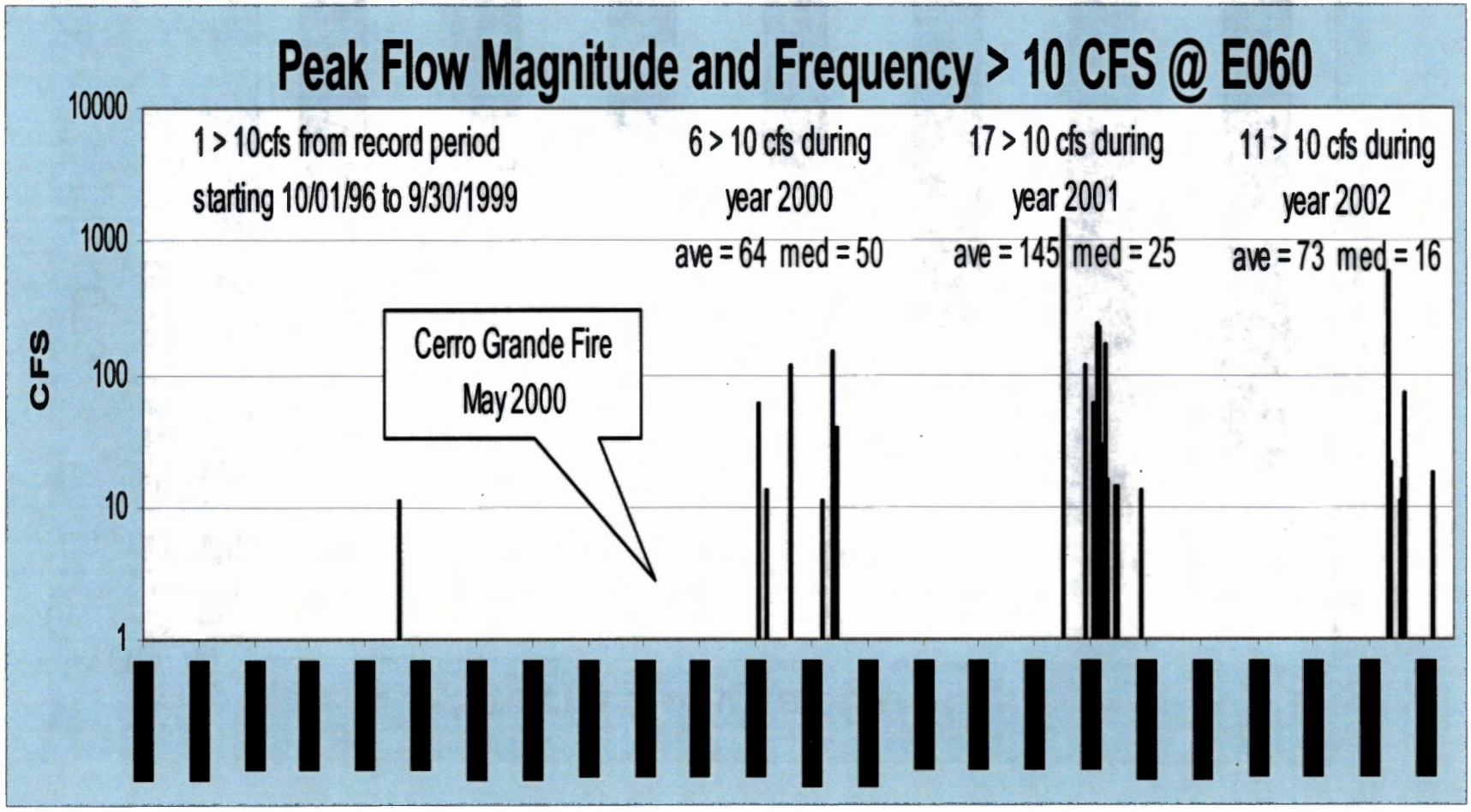


Geomorpic Units in Lower Pueblo Canyon

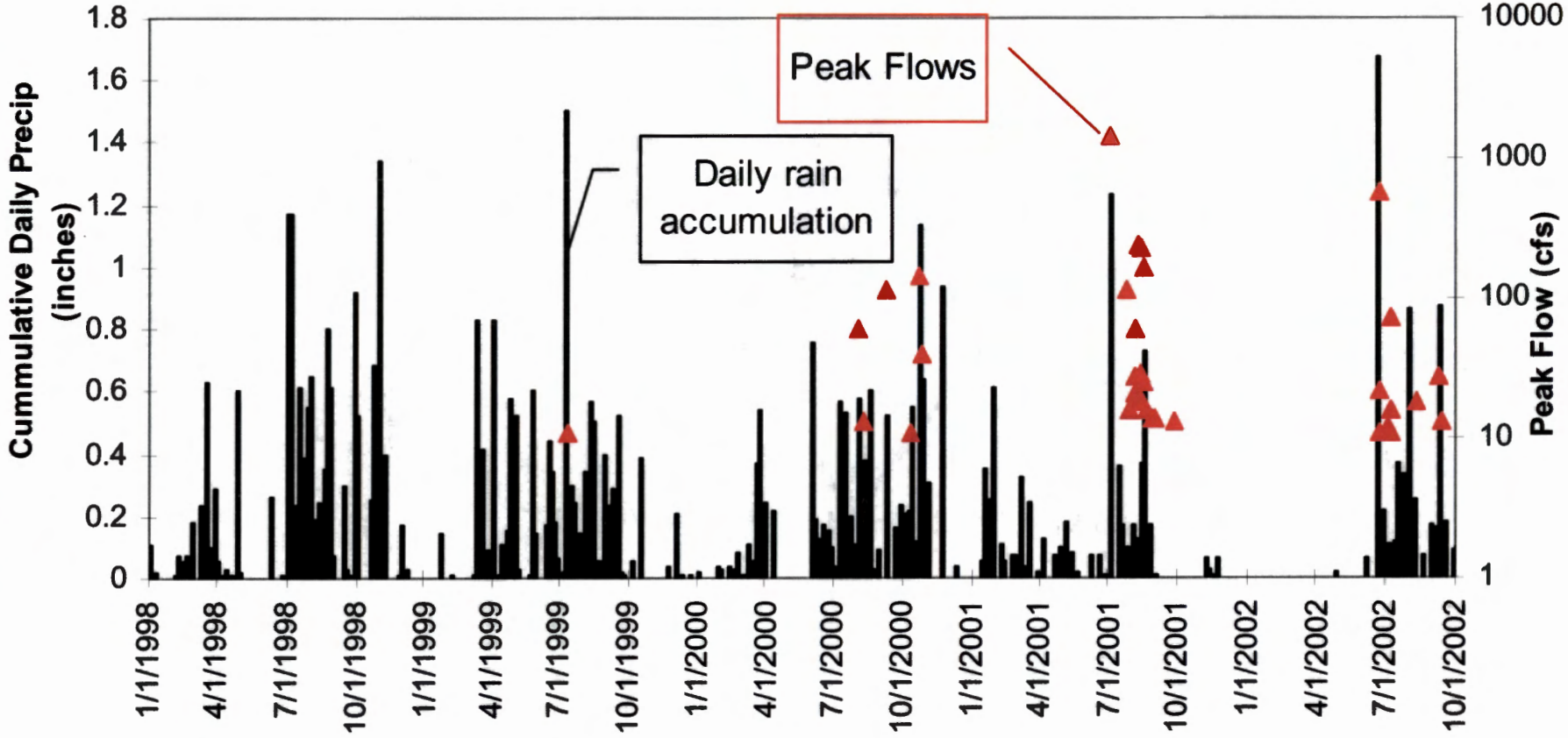


Peak Storm Flows in Pueblo Canyon (1996-2002)

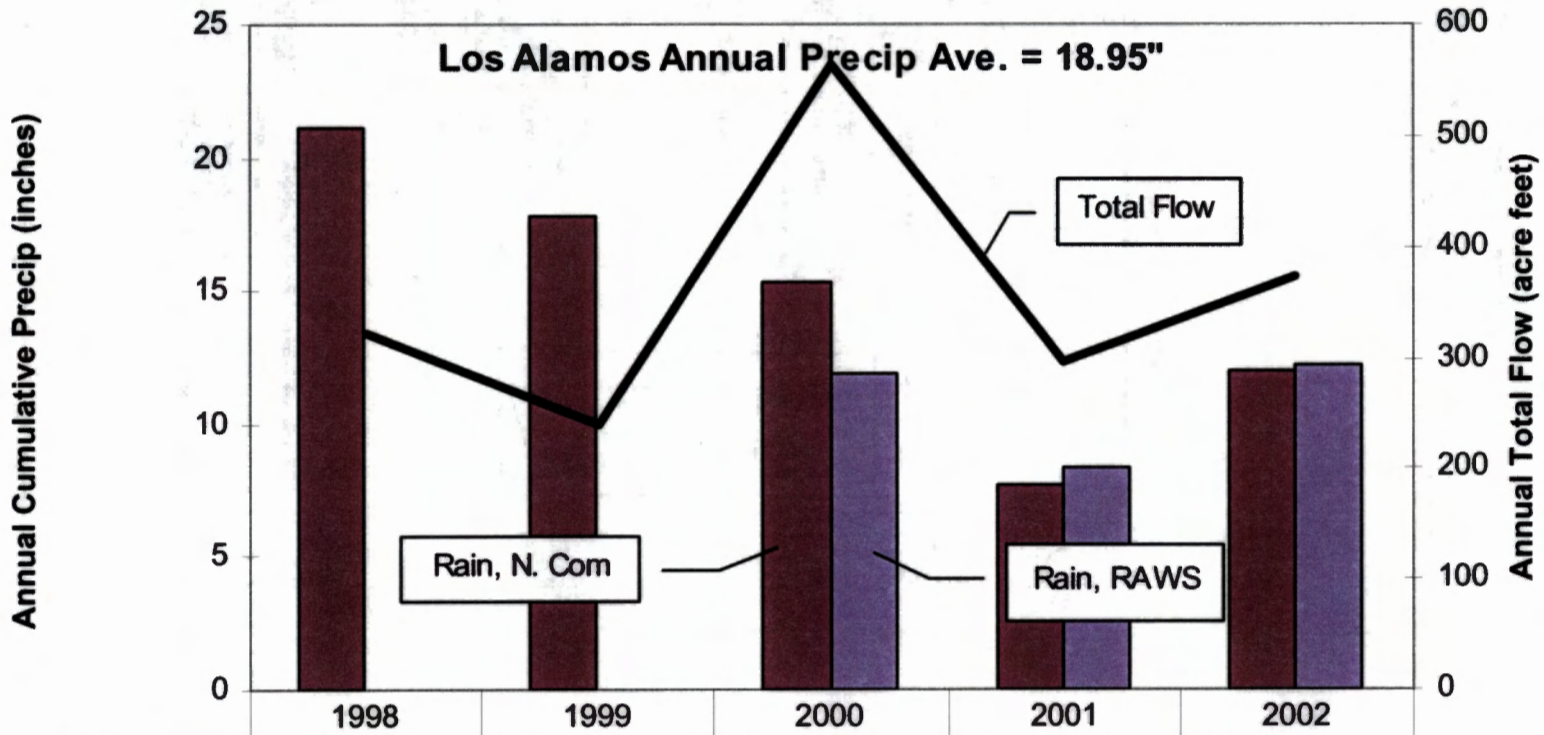



Peak Flow Magnitude and Frequency > 10 CFS @ E060
CFS
10000
1000
100
10
1
1 > 10cfs from record period
starting 10/01/96 to 9/30/1999
Cerro Grande Fire
May 2000
6 > 10 cfs during
year 2000
ave = 64 med = 50
17 > 10 cfs during
year 2001
ave = 145 med = 25
11 > 10 cfs during
year 2002
ave = 73 med = 16

Precipitation at North Community Rain Gage and Stormwater Runoff at E060



Annual Cumulative Precipitation Relative to Annual Total Flow



	1998	1999	2000	2001	2002
N. Com gage	21.15	17.85	15.37	7.73	11.98
RAWS gage	NA	NA	11.86	8.41	12.22
Total Flow	321	240.4	564	295.2	373.2

NMED Stream Morphology Project in Pueblo Canyon

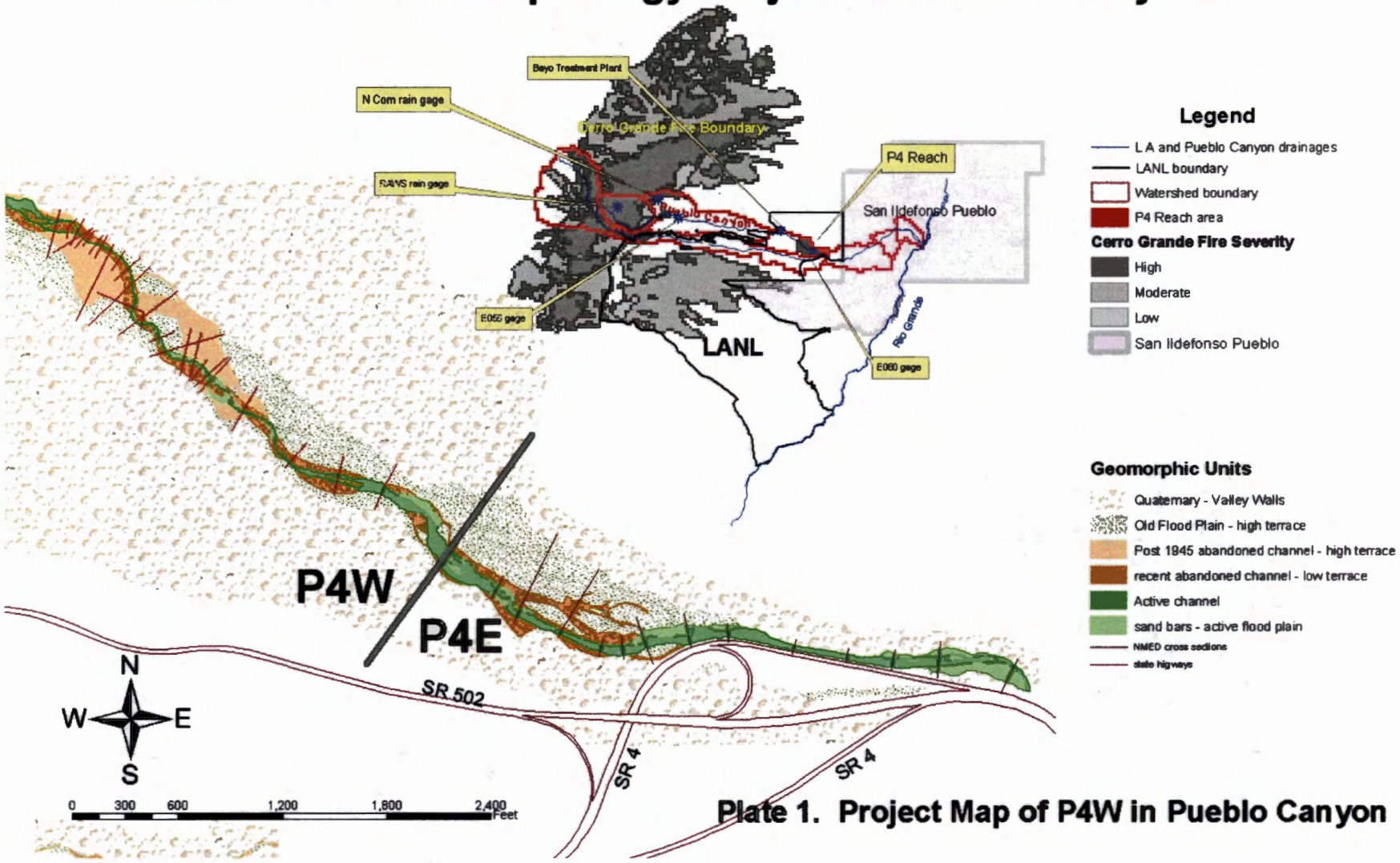
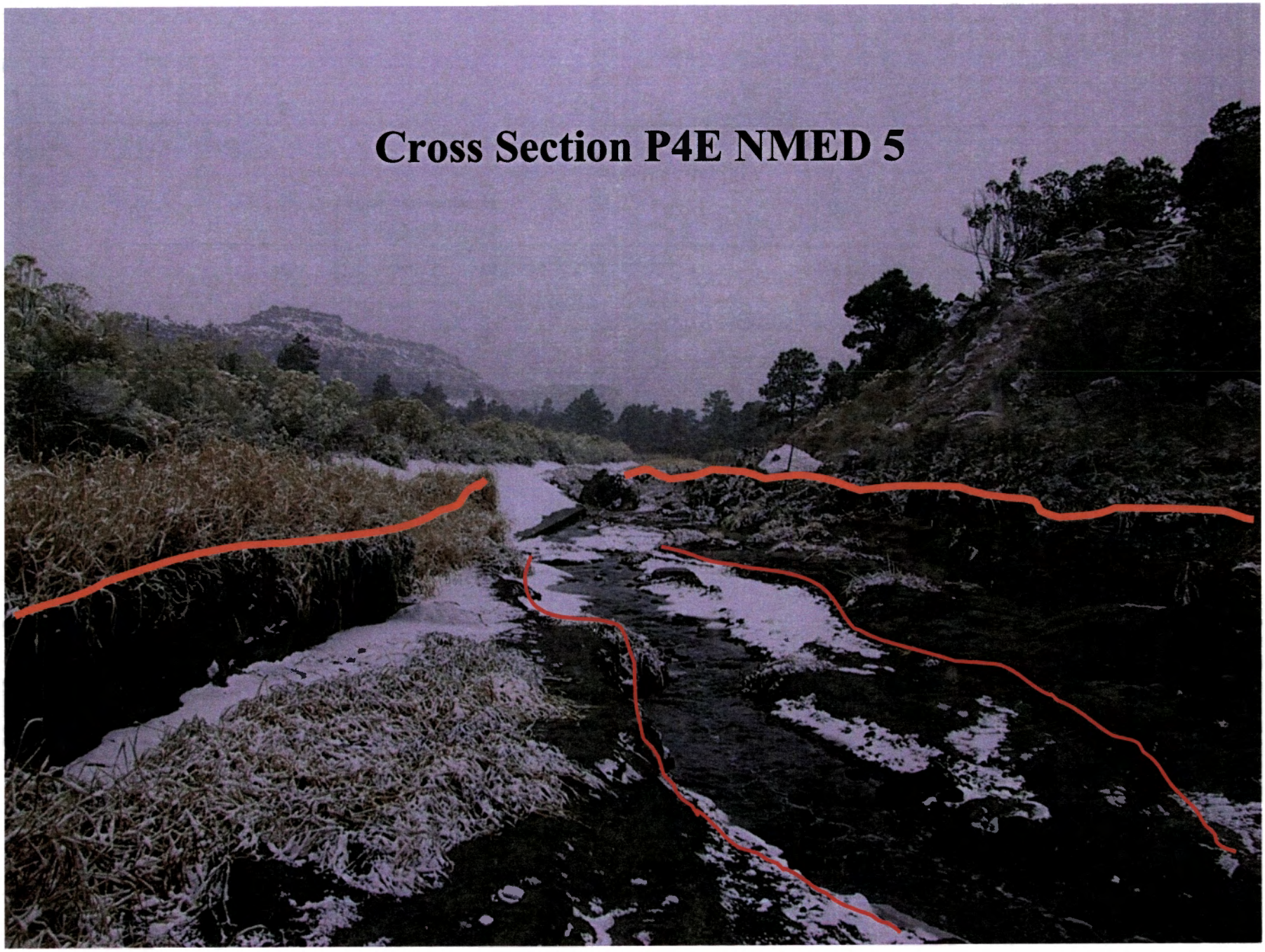
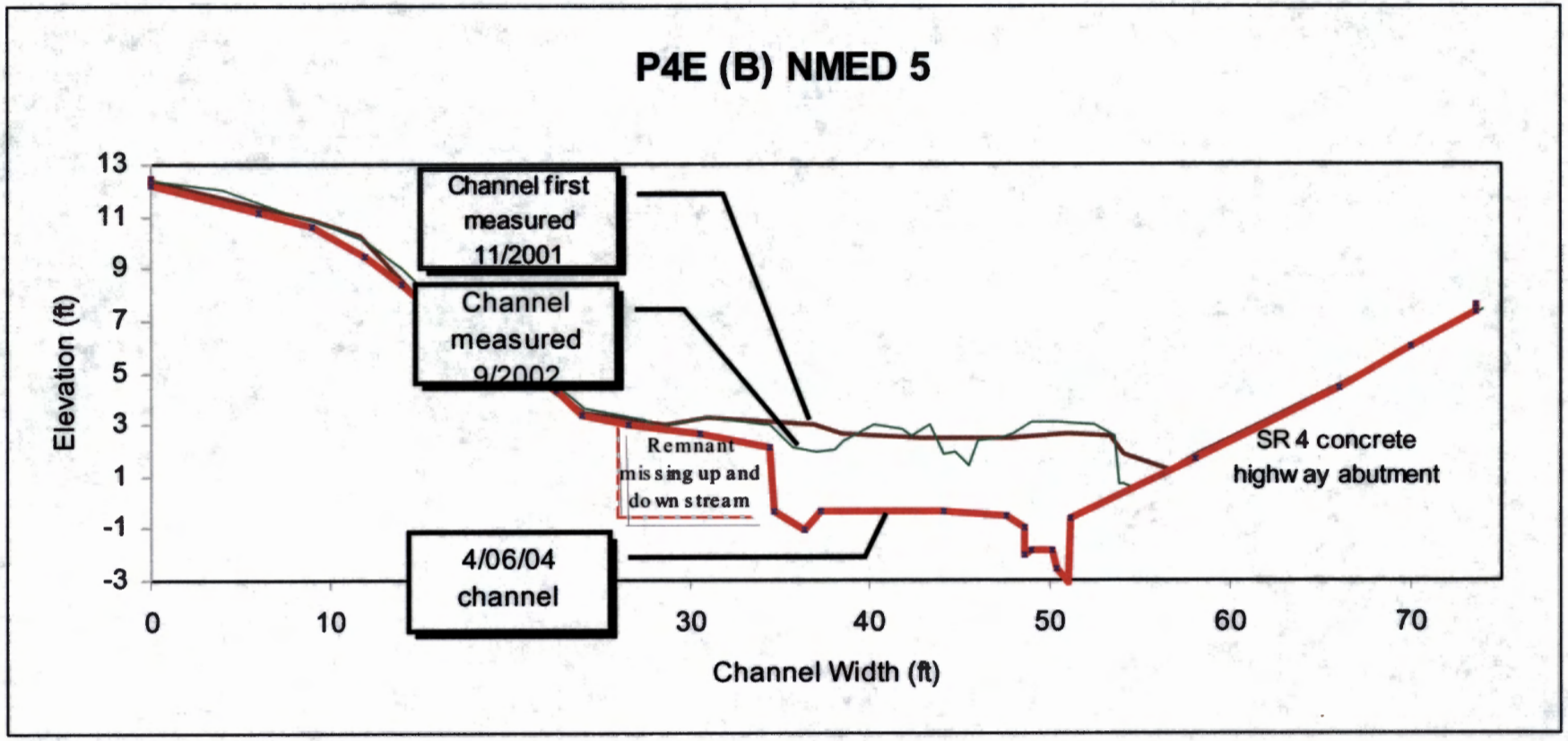


Plate 1. Project Map of P4W in Pueblo Canyon

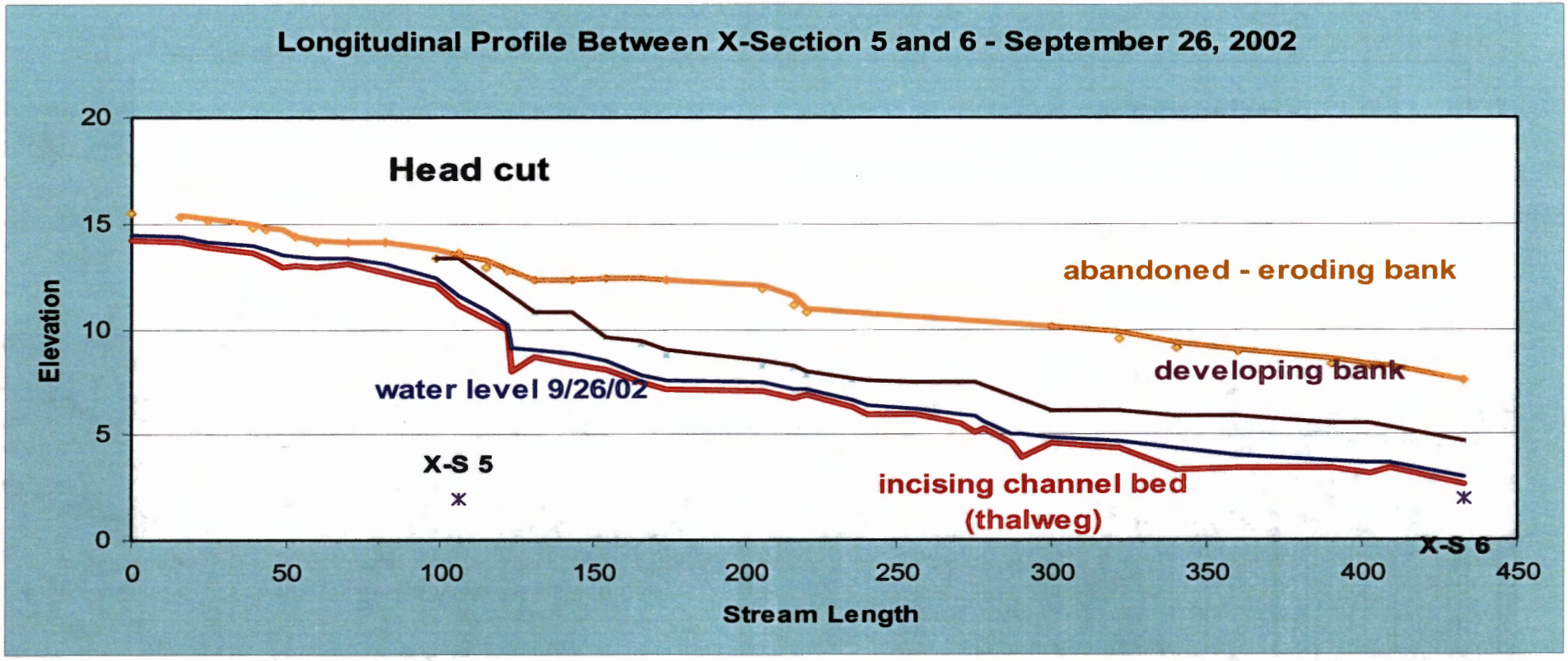
Upstream View of Head-cut at Cross Section P4E NMED 5


Cross Section P4E NMED 5

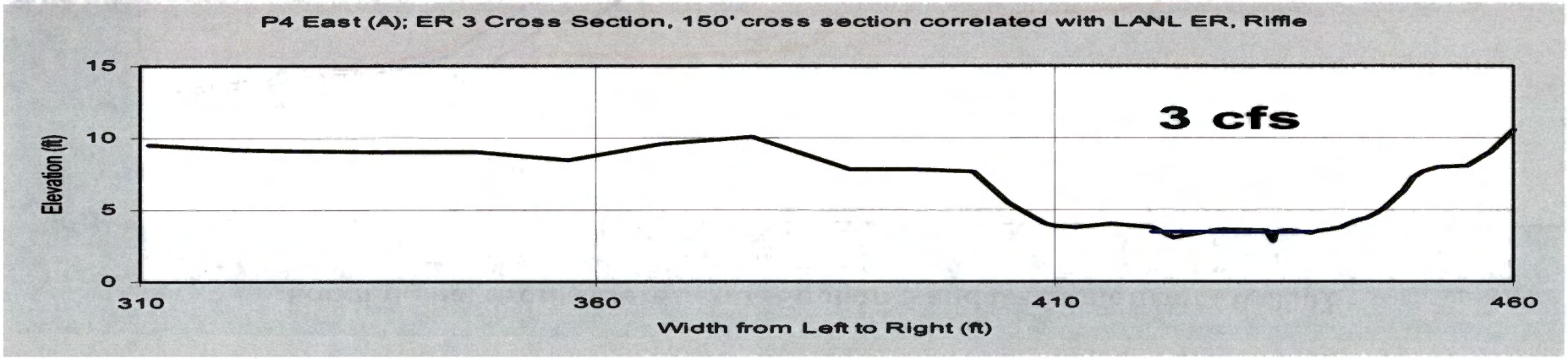
Channel Changes at NMED 5, P4E: Measured in 2001, 2002, and March 2004

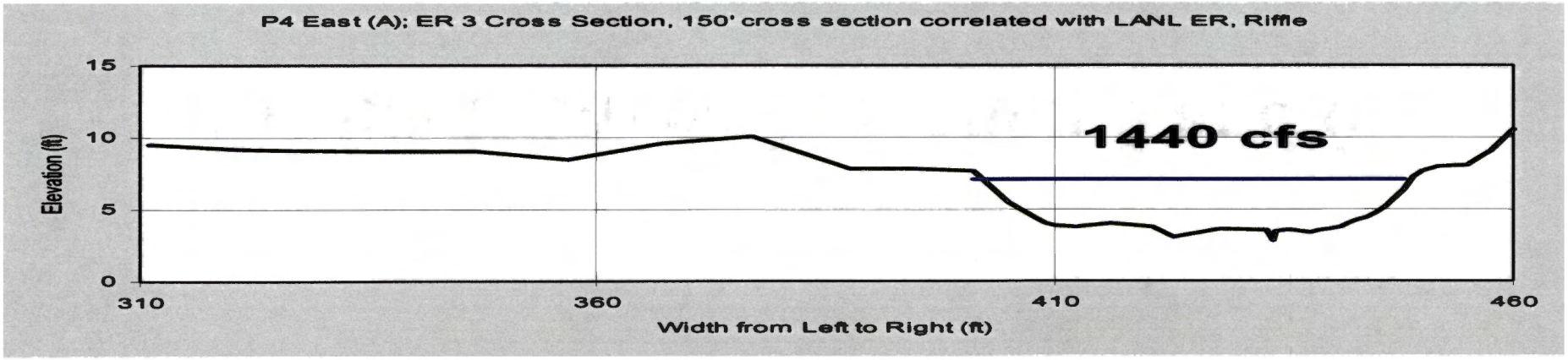


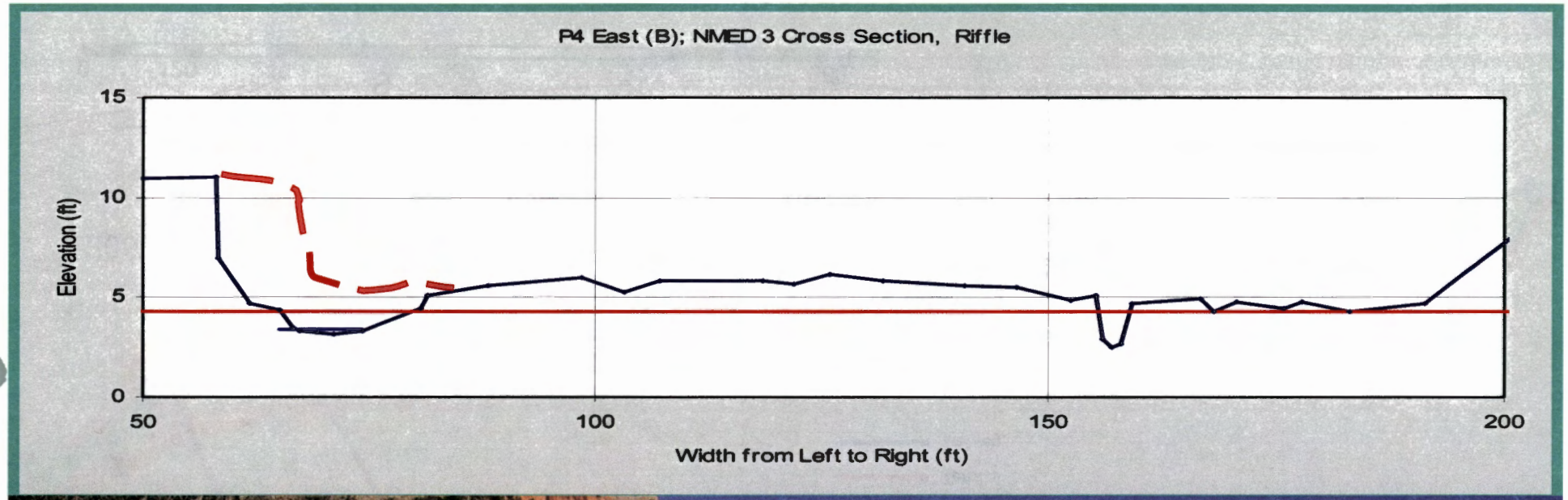
Profile between X-section 5 and 6

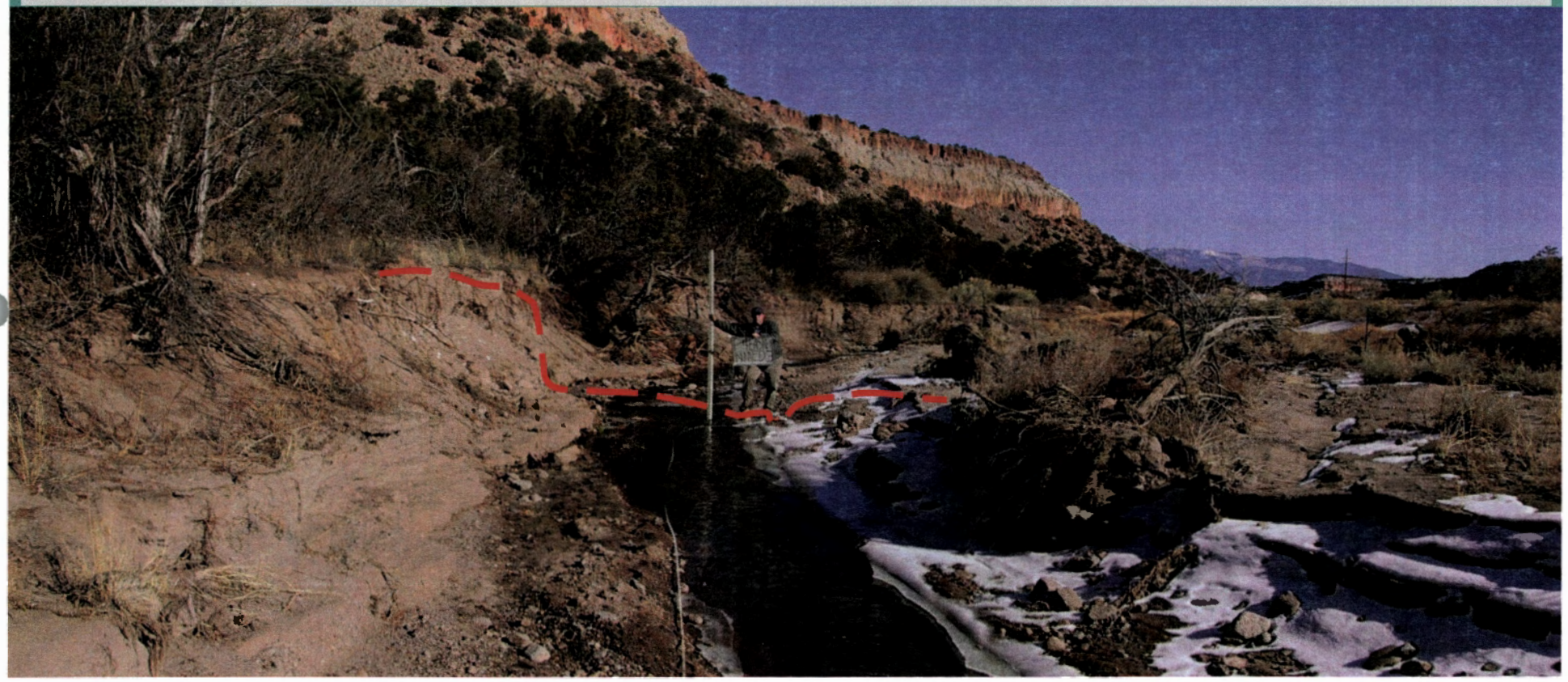


Downstream View of Cross Section ER-3

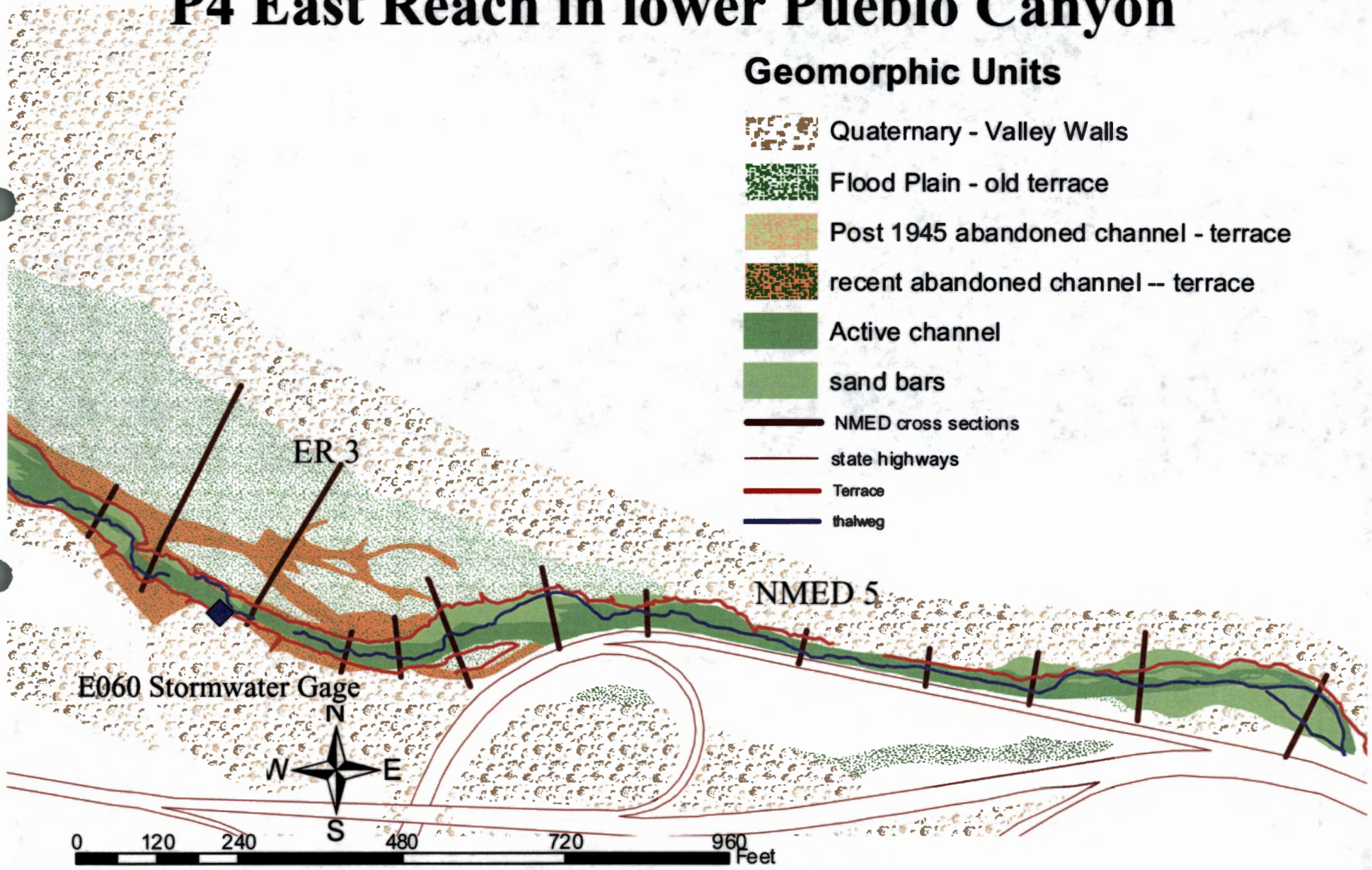





P4 East (B); NMED 3 Cross Section, Riffle
Elevation (ft)
15
10
5
0
50
100
150
200
Width from Left to Right (ft)

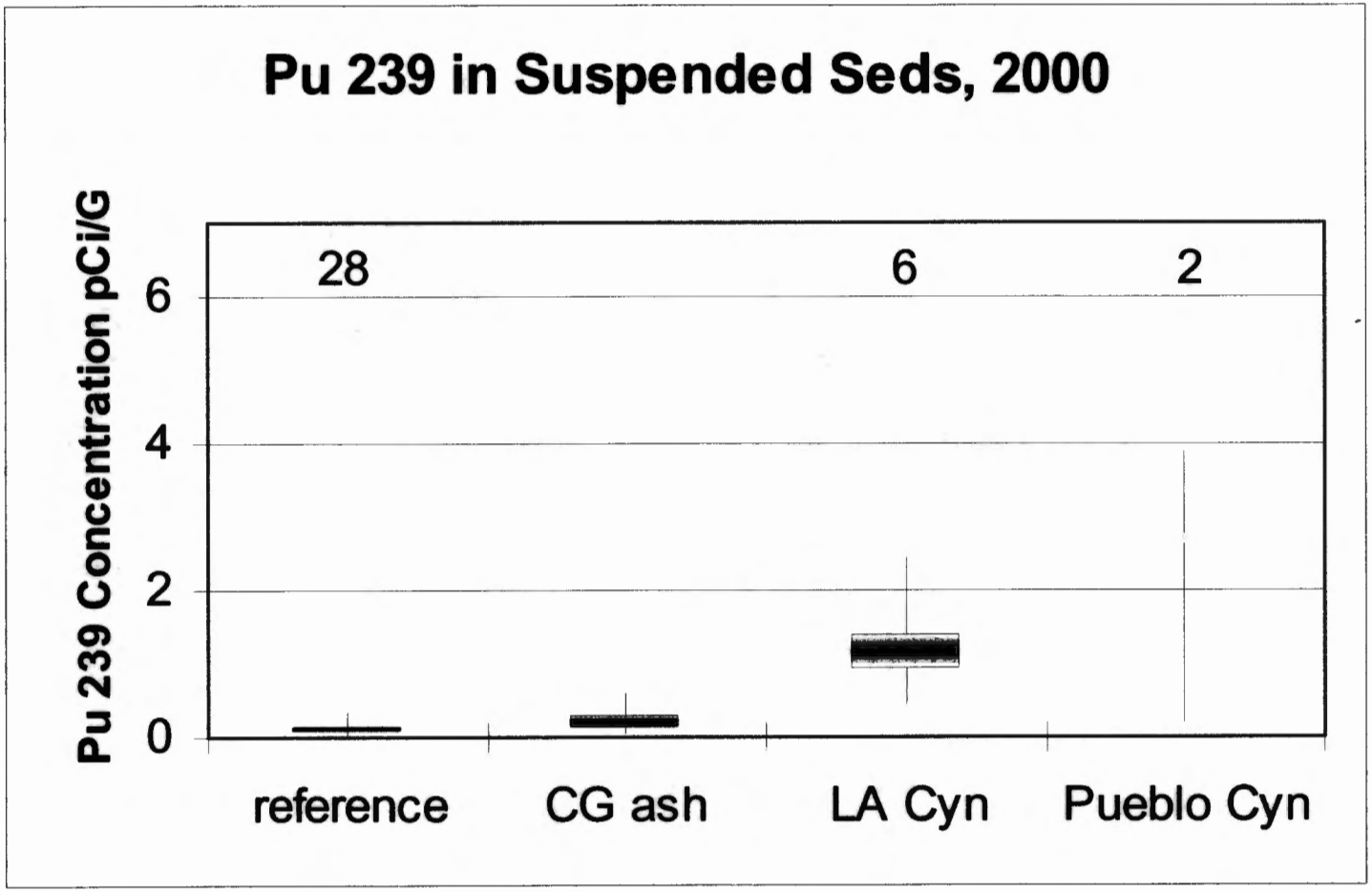


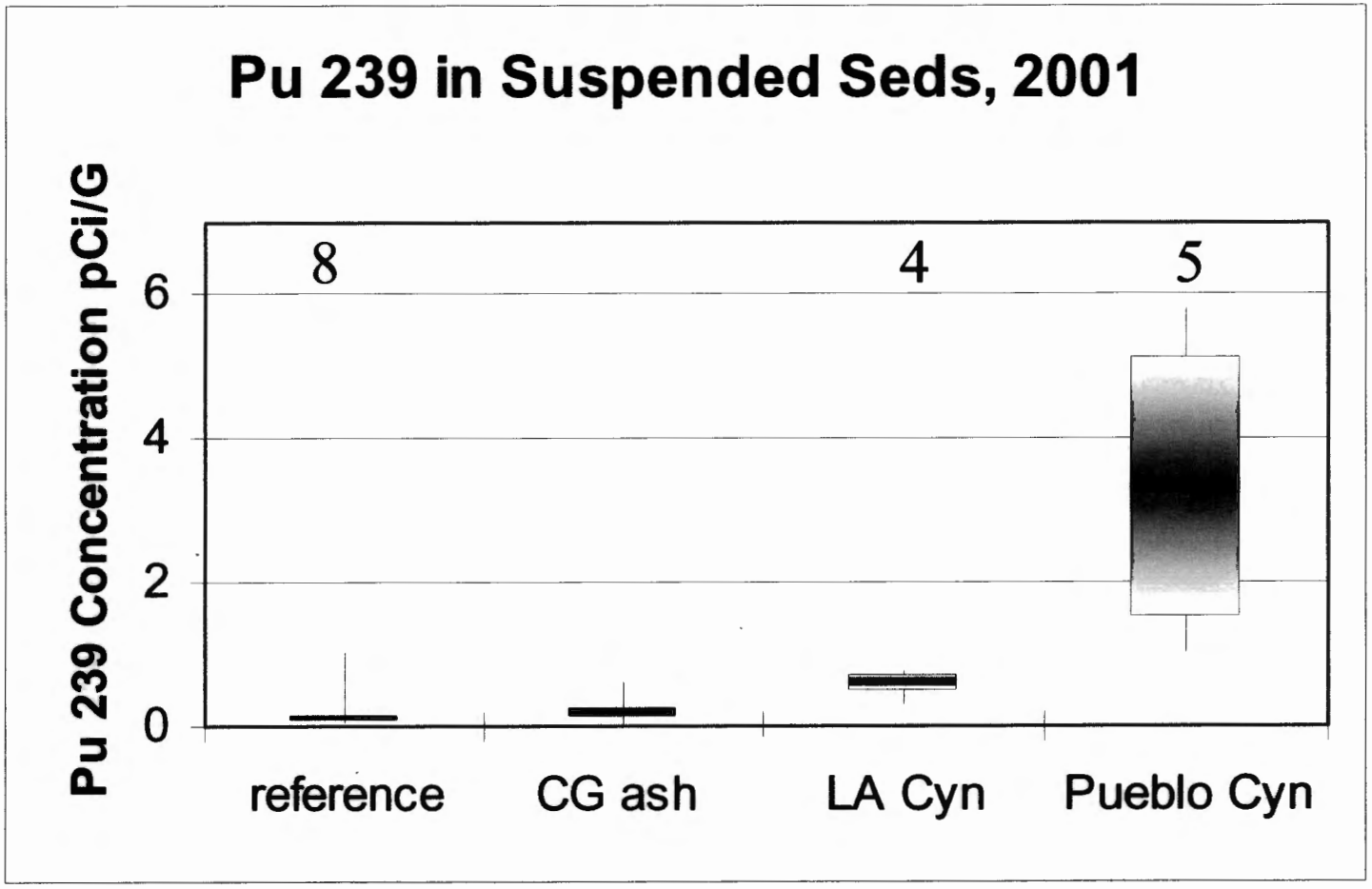
P4 East Reach in lower Pueblo Canyon

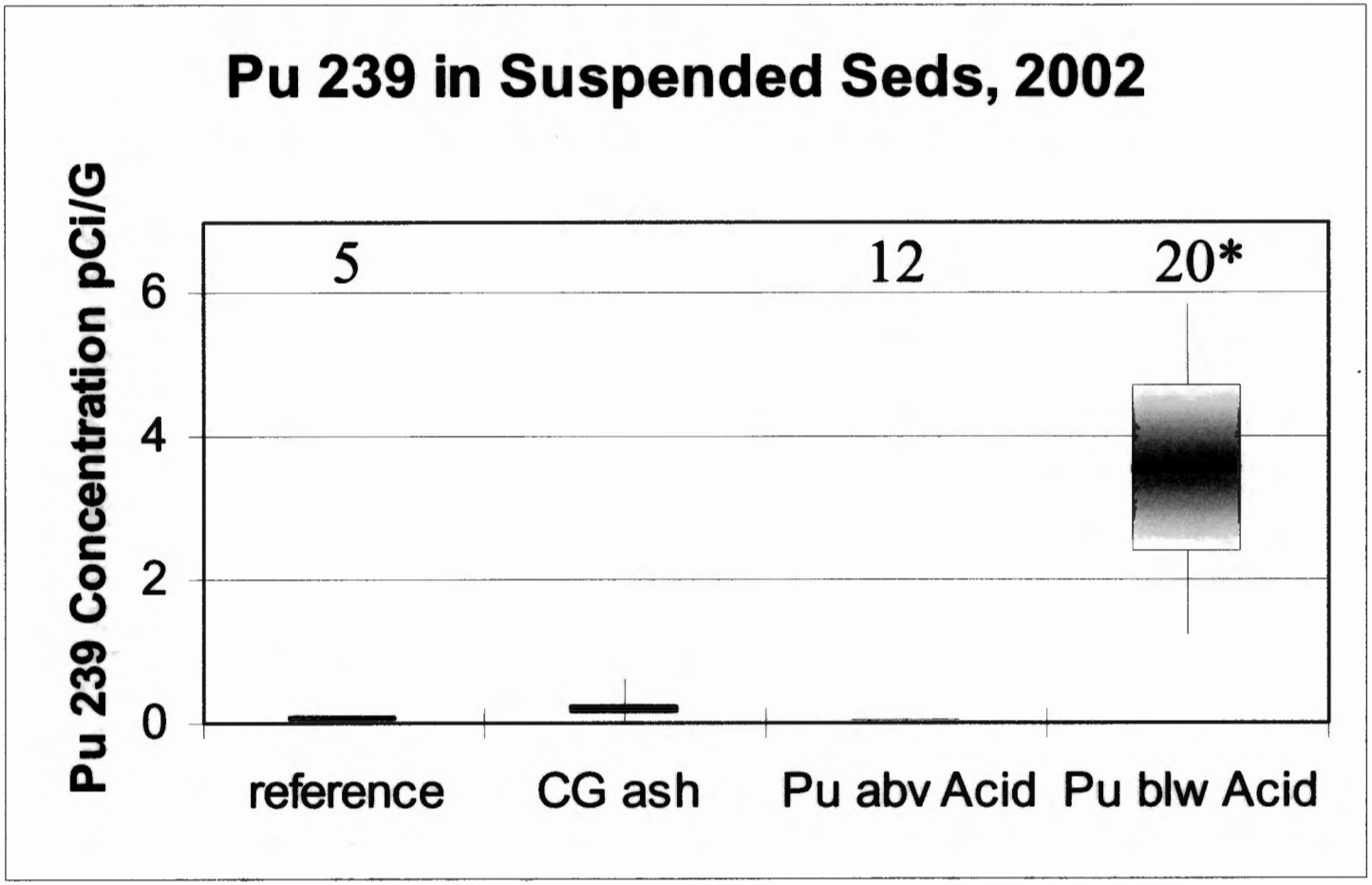


Post Cerro Grande Storm Water Monitoring

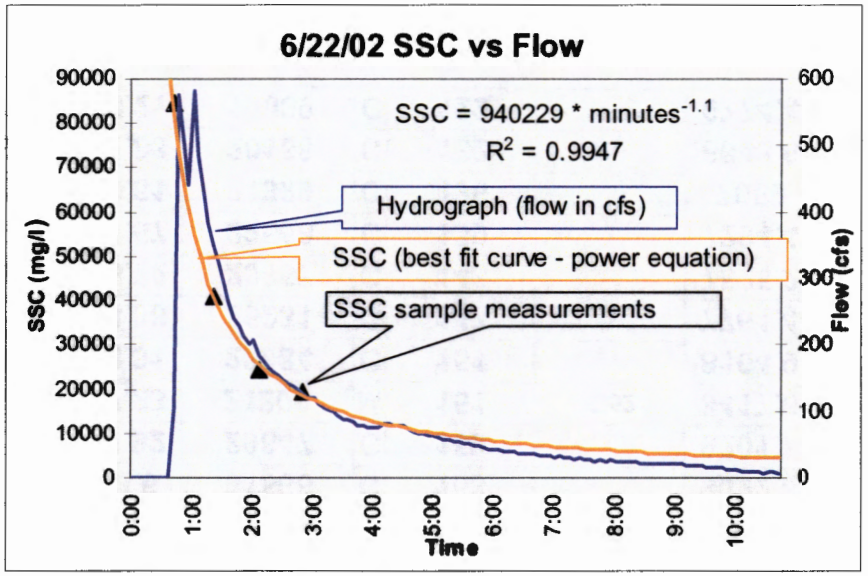
- 2000 - 36 Storm Water samples from 7 Canyons
- 2001 – 17 samples from 4 Canyons
- 2002 – 39 Samples from 4 Canyons
  - 34 from Pueblo Canyon
- 2003 – 18 samples from Pueblo Canyon

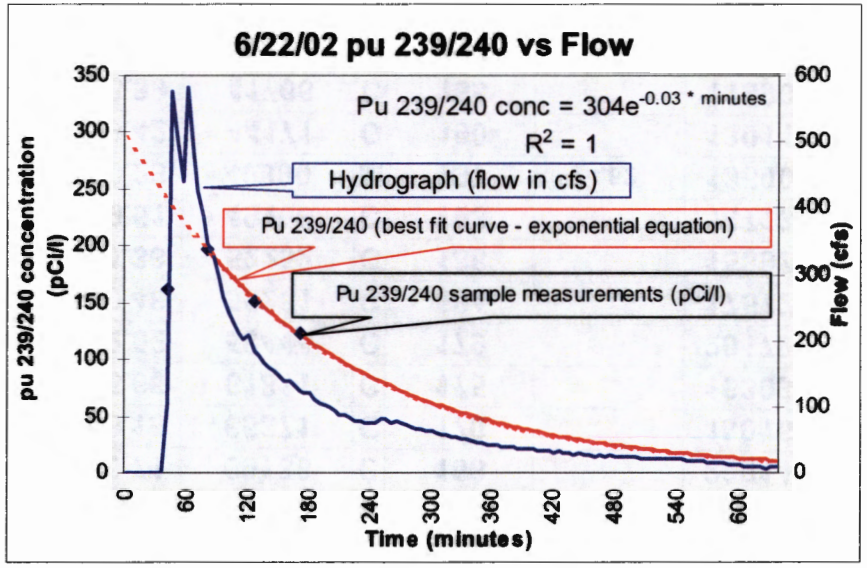

Pu 239 in Suspended Seds, 2000
Pu 239 Concentration pCi/G
0
2
4
6
28
6
2
reference
CG ash
LA Cyn
Pueblo Cyn


Pu 239 in Suspended Seds, 2001
Pu 239 Concentration pCi/G
0
2
4
6
8
4
5
reference
CG ash
LA Cyn
Pueblo Cyn



* Does not include 2 Acid Canyon samples of 9 & 22 pCi/g





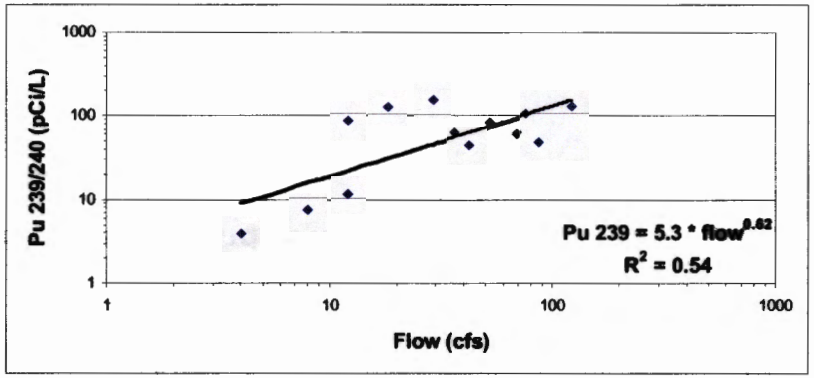
Daily accumulative	1.38"		
Max hourly rate: 9-10 pm	0.8" / hr	peak flow 3 hours 15 minutes after rain centr	
Peak flow: 00:45	575 cfs		
	to last meaurement	**5 hours**	**10 hours**
Pu 239/240 (mili curries)	10.47	12.41	12.8
Sediment (tons)	3087	3302	3316

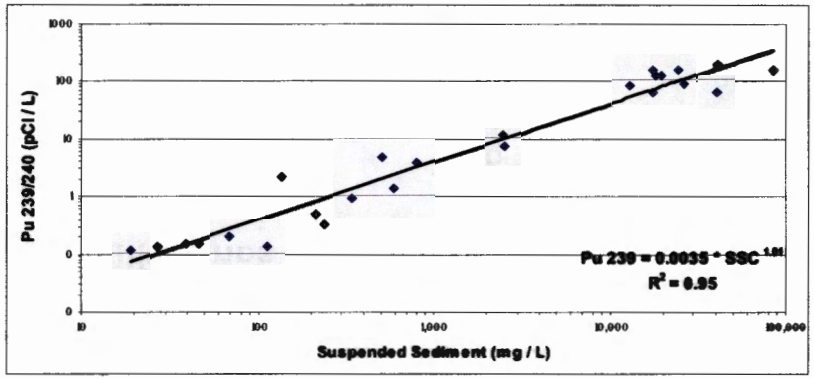
Time	Minutes passed	Flow CFS	SSC		Total PU-239 in Water	Total PU-239 in Suspended Sediments	Liters per Second	Pu-239/240 discharged over previous time
		CFS	mg/L		pCi/L	pCi/g	(LPS)	mCi
0:40	0	196.67	84500	M	161	1.67	5569.7	
0:45	5	706.71	69136	C	166		20014	0.63
0:50	10	636.15	65371	C	170		18016	0.96
0:55	15	575.66	61811	C	175		16303	0.89
1:00	20	712.52	58444	C	179		20179	0.97
1:05	25	620.48	55261	C	184		17572	1.03
1:10	30	561.33	52252	C	188		15897	0.93
1:15	35	519.51	49406	C	193		14713	0.87
1:20	40	480.23	40800	M	197	4.82	13600	0.83
1:25	45	459.42	44171	C	190		13011	0.77
1:30	50	423.39	41766	C	185		11990	0.70
1:35	55	393.23	39491	C	181		11136	0.63
1:40	60	364.85	37340	C	176		10333	0.57
1:45	65	351.16	35307	C	171		9944.9	0.53
1:50	70	331.34	33384	C	167		9383.5	0.49
1:55	75	318.6	31566	C	163		9022.8	0.46
2:00	80	324.92	29847	C	159		9201.7	0.44
2:05	85	297.23	24200	M	151	5.52	8417.6	0.41
2:10	90	288.31	26684	C	151		8164.9	0.38
2:15	95	274.06	25231	C	147		7761.4	0.36
2:20	100	265.72	23857	C	143		7525.2	0.33
2:25	105	257.57	22558	C	139		7294.4	0.31
2:30	110	249.61	21329	C	136		7069	0.30
2:35	115	241.83	20168	C	132		6848.6	0.28
2:40	120	239.21	19069	C	129		6774.4	0.27

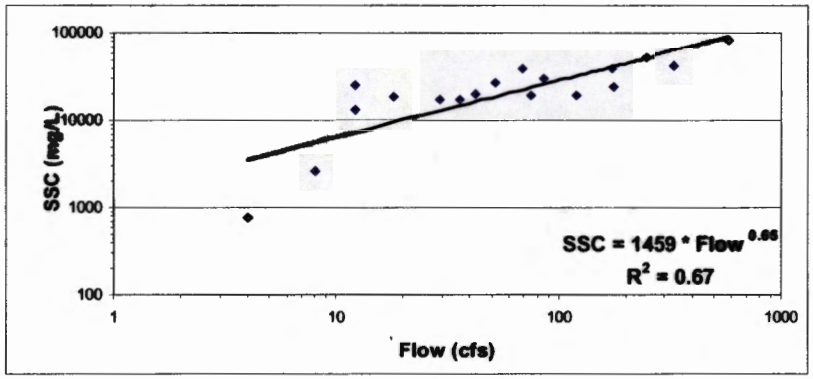
Plutonium 239/240 and Sediment Transported During Measured Storm Events

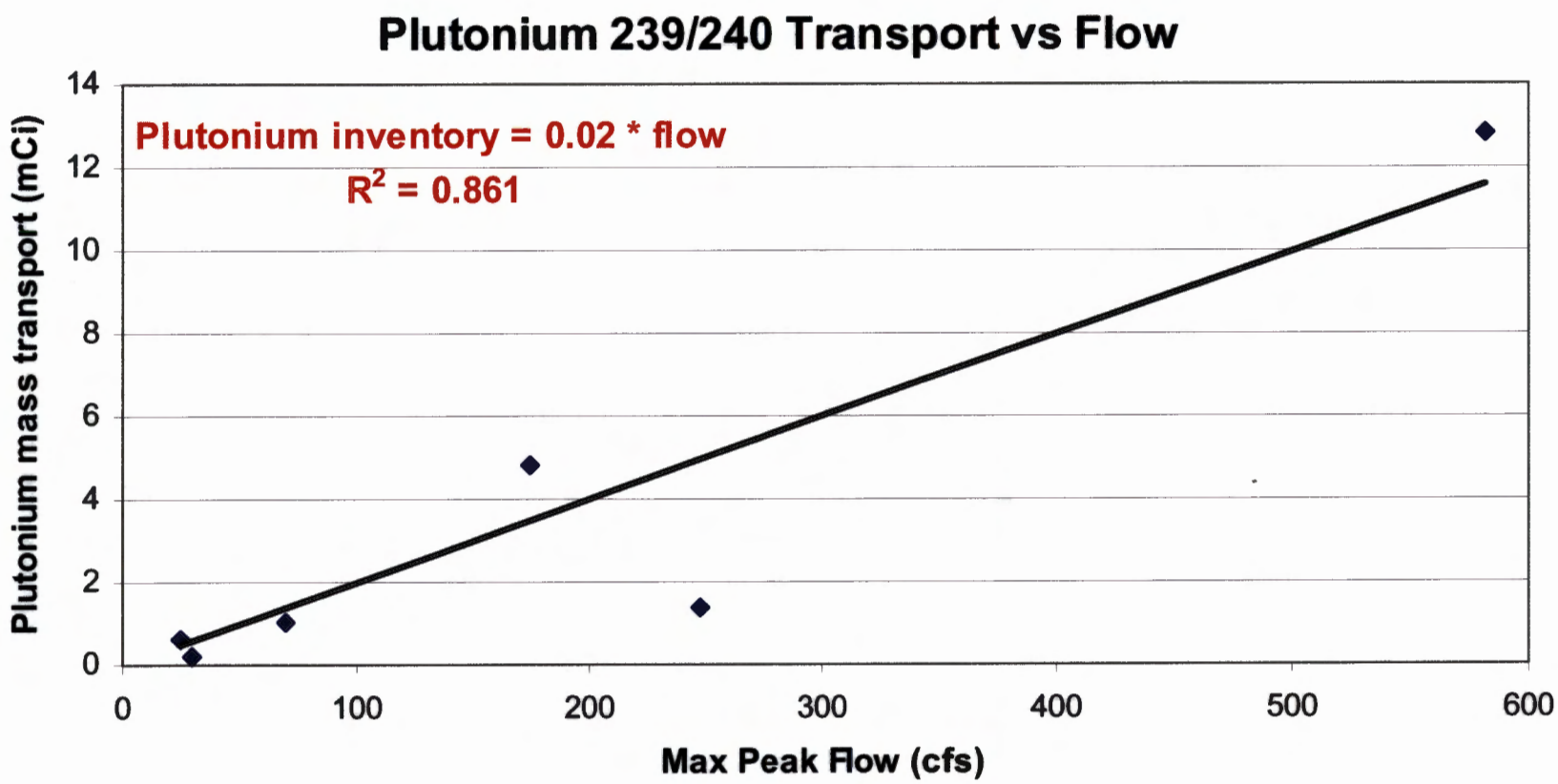
Sample Date	Pu Inventory Transported @ last measurement mili Curries	pu Inventory Transported over 5 hours mili Curries	Pu Inventory Transported over 10 hours mili Curries	tons sed at last measurement	tons sed at 5 hours	tons sed at 10 hours
8/11/2001	1.09	1.26	1.35	1053	1152	1170
8/16/2001	2.28	4.01	4.81	384	672	806
6/22/2002	10.47	12.41	12.80	3087	3302	3316
7/18/2002	0.43	0.57	0.60	65	87	91
7/26/2002	0.73	1.02	1.06	319	398	405
9/10/2002	0.02	0.13	0.22	6	23	32
Total inventory for 6 of 29 flows during 2001 and 2002						
	15.02	**19.40**	**20.84**	**4915**	**5634**	**5820**

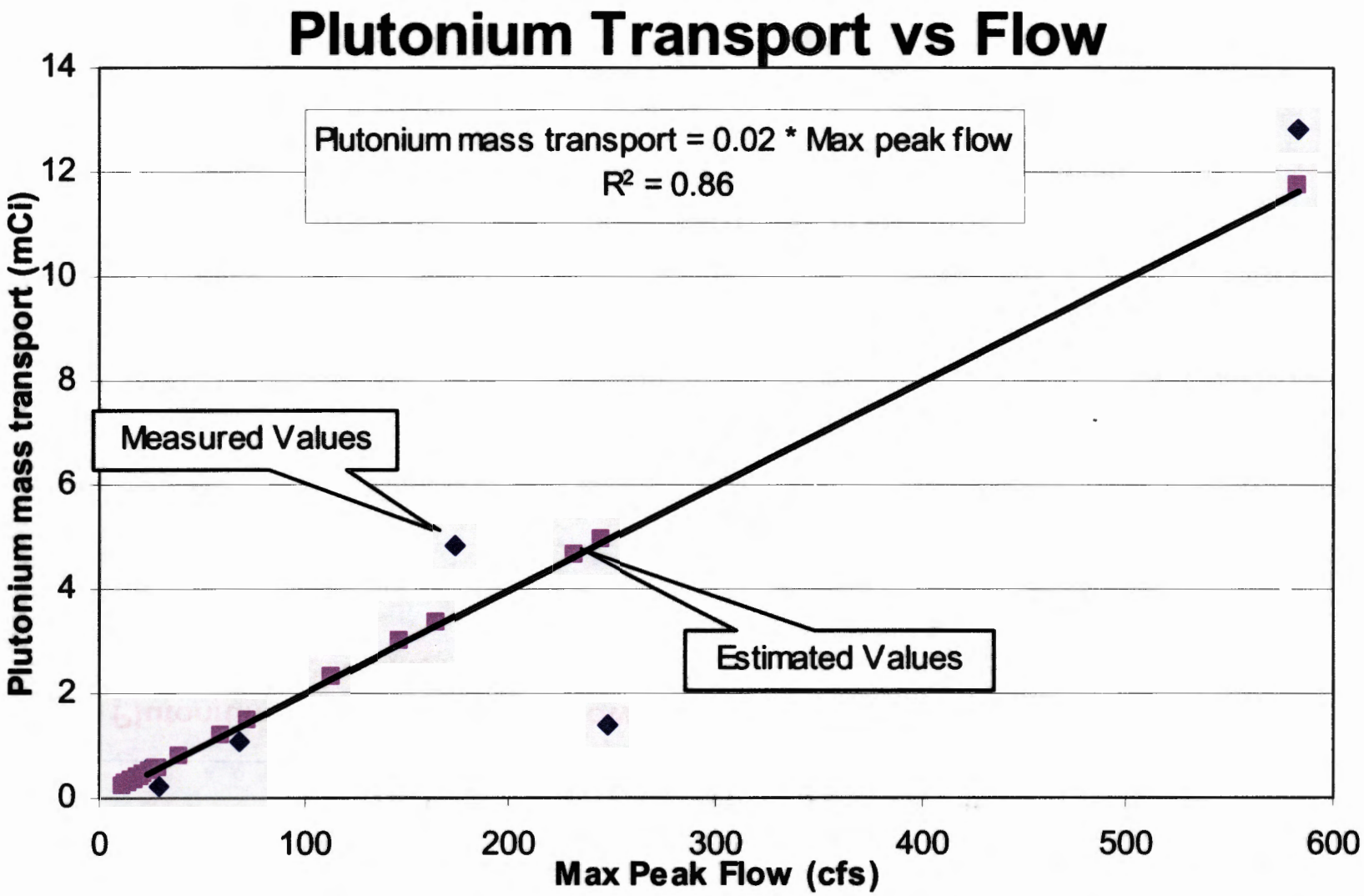
Flow, Suspended Sediment Concentration, and Plutonium 239/240 Concentration Rating Curves








Plutonium 239/240 Transport vs Flow
Plutonium inventory = 0.02 * flow
R2 = 0.861
Plutonium mass transport (mCi)
0
2
4
6
8
10
12
14
0
100
200
300
400
500
600
Max Peak Flow (cfs)


Plutonium Transport vs Flow
Plutonium mass transport = 0.02 * Max peak flow
R² = 0.86
Measured Values
Estimated Values
Plutonium mass transport (mCi)
Max Peak Flow (cfs)
0
2
4
6
8
10
12
14
0
100
200
300
400
500
600

Conclusions

- Channels destabilized
- Off site legacy contaminant transport rates increased
- Off site transport rates are now similar to estimates of transport rates during the 50's & 60's based on William Graff, March 1993