OROVILLE DAM RELICENSING

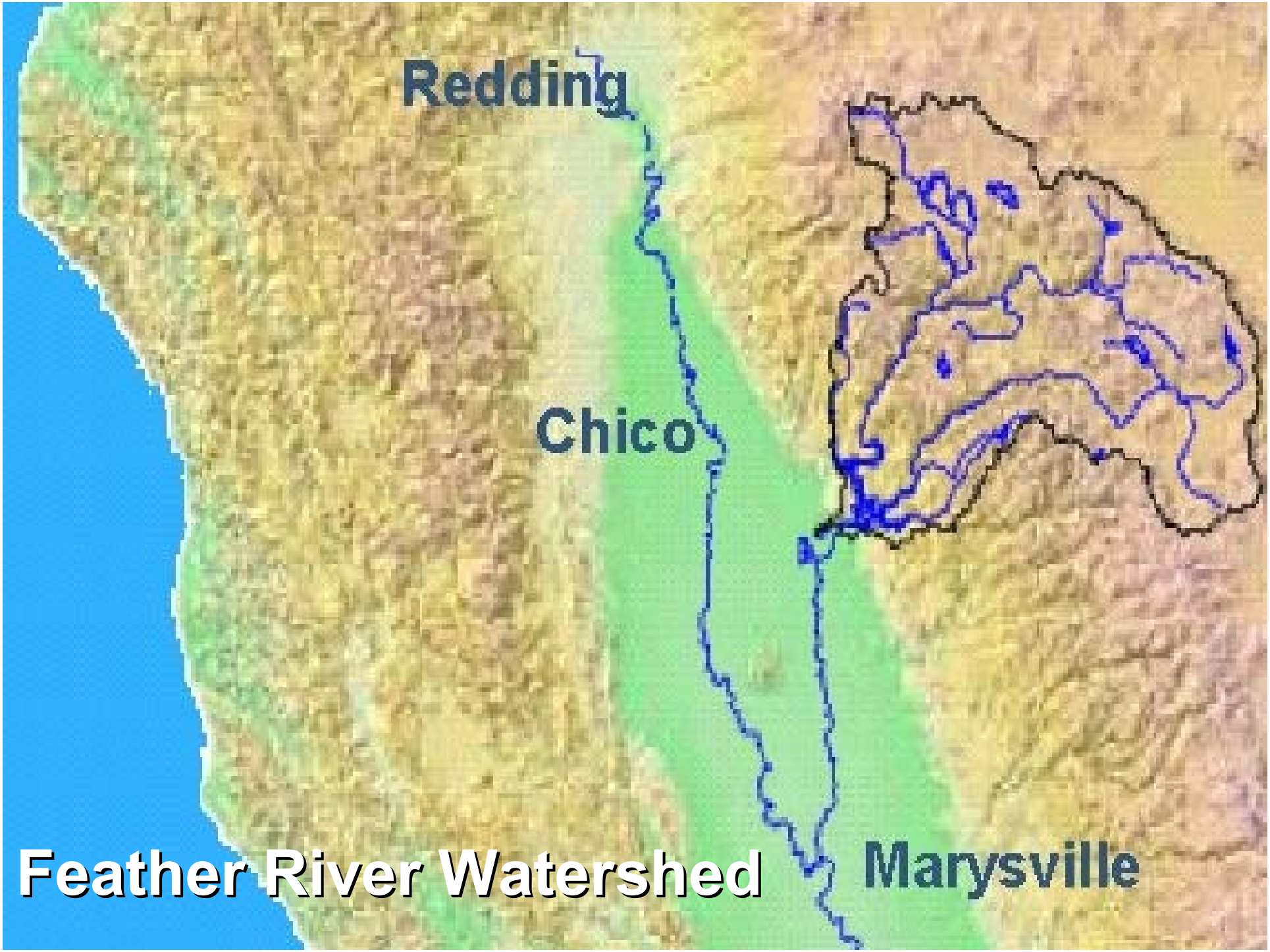
SP-G2: FEATHER RIVER DOWNSTREAM GEOMORPHIC INVESTIGATION (2002 - 2003)

DWR - Northern District Geology

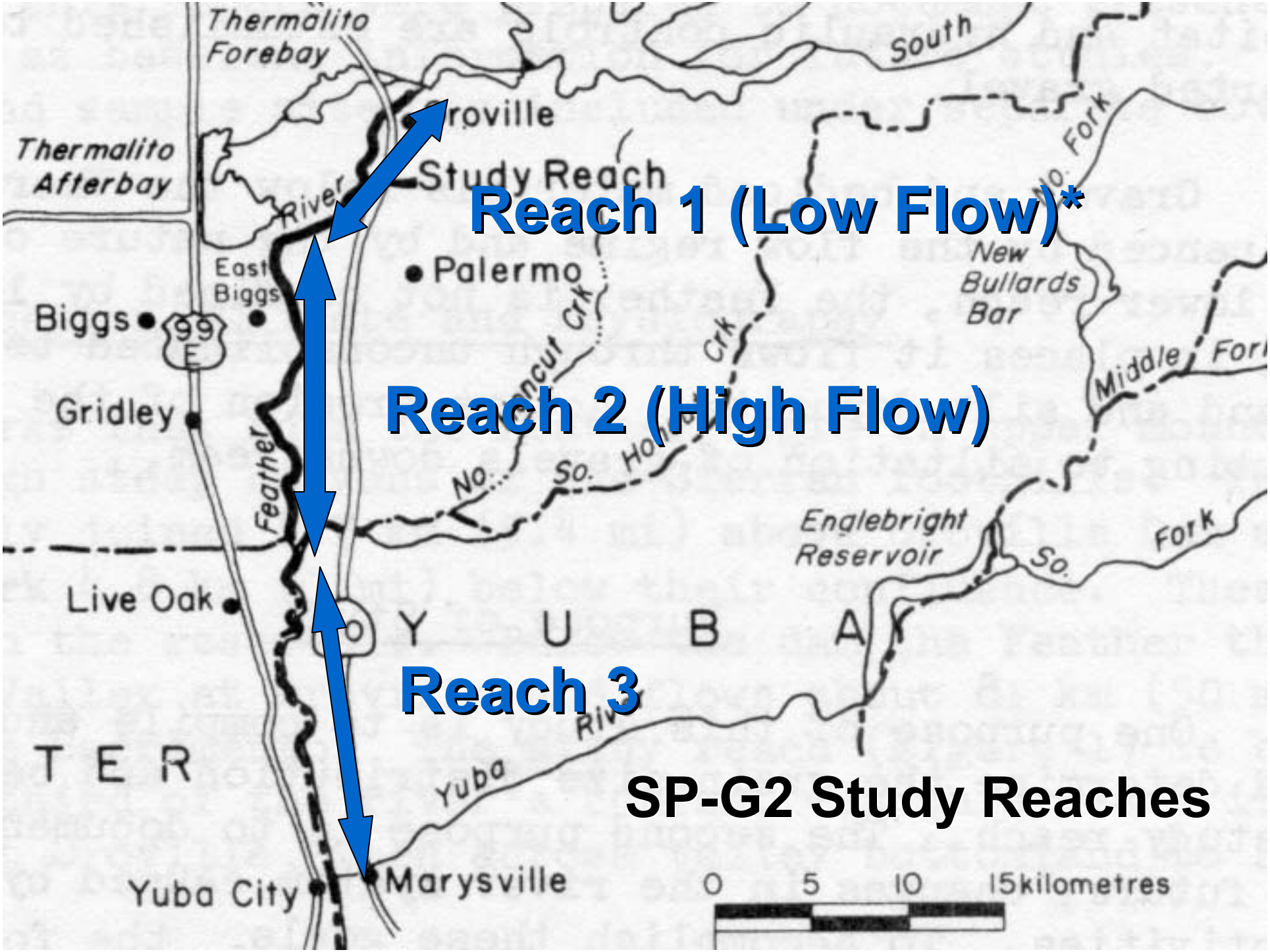
April 22, 2003

INTRODUCTION

- STUDY AREA
- OBJECTIVES
- TASK SUMMARY
  - METHODOLOGY
  - DATA ANALYSIS
  - CONCLUSIONS
- WORK REMAINING



Feather River Watershed



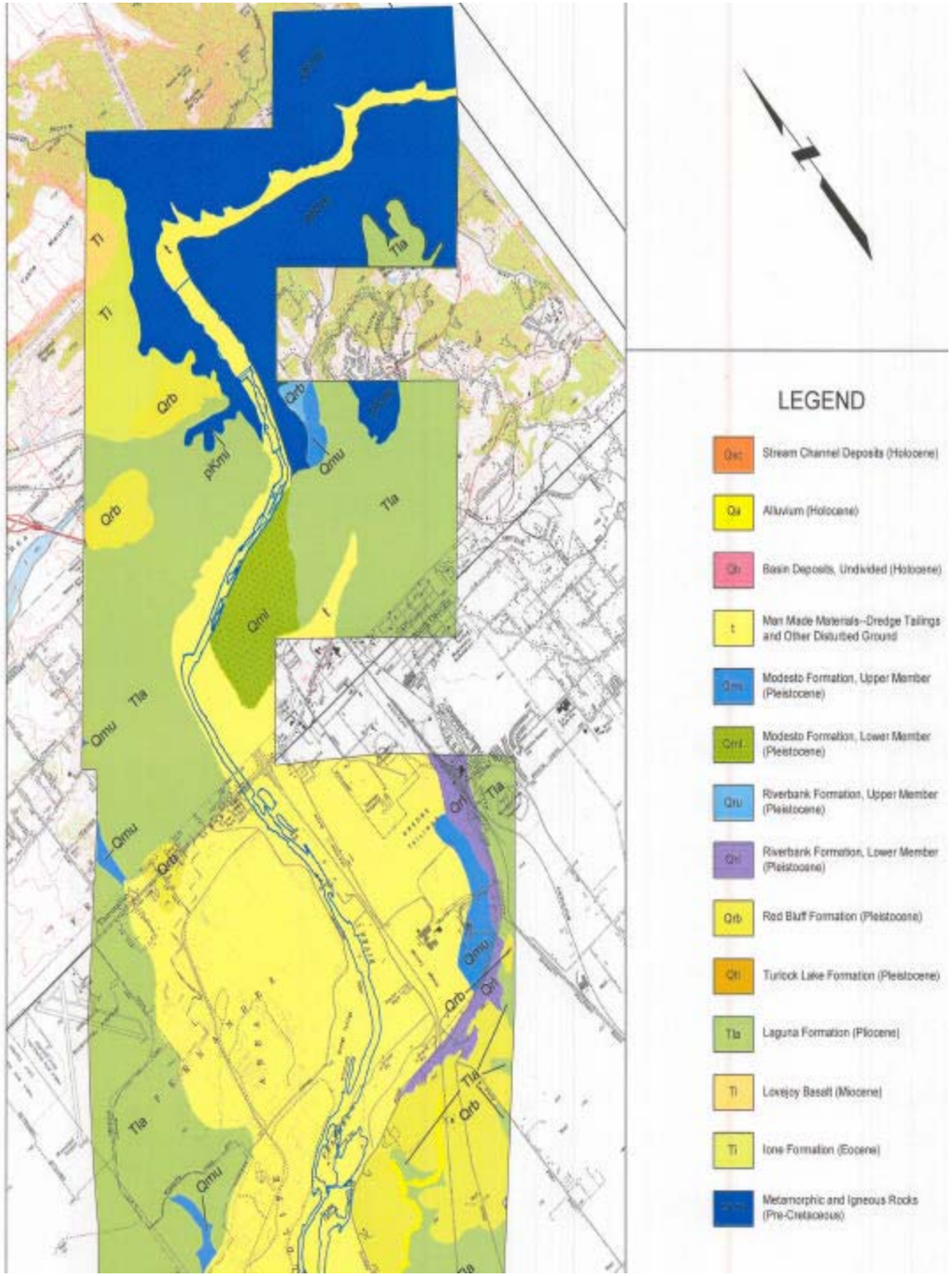
SP-G2 Study Reaches

I. Study Resources

- References
- Aerial Photography
- Maps
- Survey Data
- Hydrologic Data

II. Geologic Mapping

- Harwood and Helley into GIS
- Field Verification



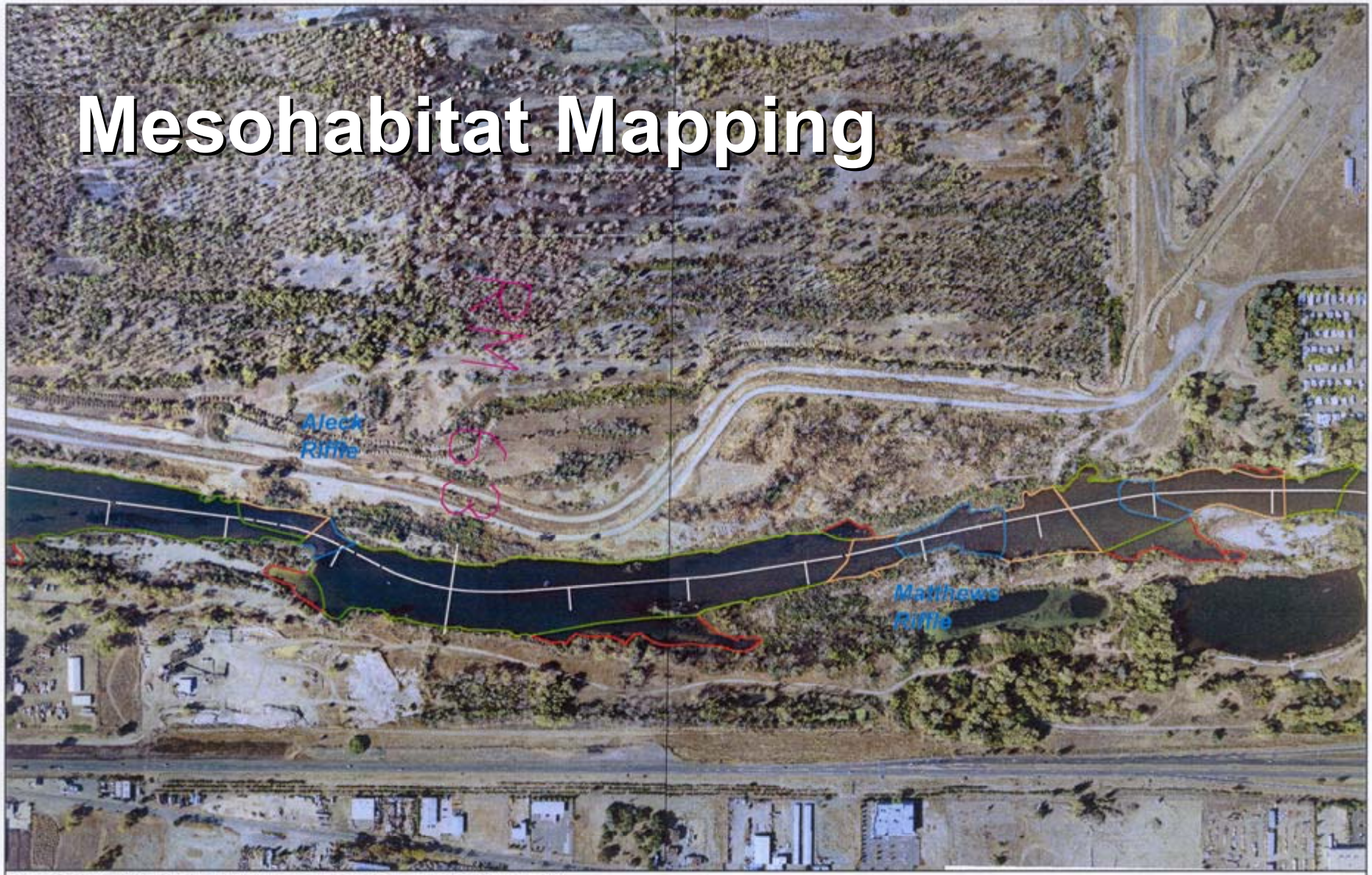
III. River Classification

- Rosgen Level 1 Stream Typing
- Habitat Characterization

Rosgen Level 1 Stream Typing

Cross-section (River Mile)	Bankfull Width (ft)	Bankfull Mean Depth (ft)	Width/Depth Ratio	Maximum Bankfull Depth (ft)	Flood Prone Area Width (ft)	Entrenchment Ratio	Water Surface Elev. (ft)	Valley Length	Sum of Channel Lengths	Channel Length	Sinuosity	Slope	Channel Pattern	Channel Material*	Shape	Stream Type	Date
67	326.3	21.0	15.54	40	465.9	1.4	142			5,279		0.0023			Shallow/Wide	C	Oct. 2002
66	172.9	3.0	57.63	6	402.1	2.3	130			4,752		0.0011			Shallow/Wide	C	Oct. 2002
65	207.8	2.5	83.14	5	258.2	1.2	125			2,110		0.0009			Shallow/Wide	C	Oct. 2002
64*	281.6	5.5	51.19	11	578.1	2.1	123	11944	17422	5,282	1.46	0.0009			Shallow/Wide	C	Oct. 2002
63	272.3	4.5	60.51	9	350.7	1.3	118			5,280		0.0000			Shallow/Wide	F	Oct. 2002
62	744.5	11.5	64.74	23	15557.4	20.9	118			5,278		0.0008			Shallow/Wide	F	Oct. 2002
61	275.5	1.0	275.48	2	291.6	1.1	114			5,279		0.0017			Shallow/Wide	F	Oct. 2002
60	312.4	2.0	156.20	4	361.2	1.2	105			5,279		0.0006			Shallow/Wide	F	Oct. 2002
59	446.8	3.0	148.94	6	477.0	1.1	102			5,280		0.0008			Shallow/Wide	F	Oct. 2002
58	157.4	1.5	104.95	3	173.3	1.1	98			5,280		0.0002			Shallow/Wide	F	Oct. 2002
57	361.6	4.0	90.39	8	898.1	2.5	97			5,277		0.0009			Shallow/Wide	F	Oct. 2002
56	645.4	2.7	239.05	7	703.6	1.1	92			5,279		0.0013			Shallow/Wide	F	Oct. 2002
55	429.7	1.0	429.66	2	477.1	1.1	85			5,281		0.0009			Shallow/Wide	F	Oct. 2002
54	329.6	3.5	94.17	7	379.1	1.1	80			5,280		0.0004			Shallow/Wide	F	Oct. 2002
53	439.1	6.0	73.19	12	740.4	1.7	78			5,278		0.0009			Shallow/Wide	F	Oct. 2002
52	252.6	4.0	63.15	8	741.0	2.9	73			5,280		0.0004			Shallow/Wide	F	Oct. 2002
51	499.6	7.0	71.37	14	694.4	1.4	71			5,279		0.0008			Shallow/Wide	F	Oct. 2002
50	363.9	6.0	60.66	12	521.2	1.4	67			5,279		0.0000			Shallow/Wide	F	Oct. 2002
49	219.0	4.5	48.67	9	1249.9	5.7	67			5,280		0.0004			Shallow/Wide	F	Oct. 2002
48	439.3	5.0	87.86	10	543.0	1.2	65			5,279		0.0009			Shallow/Wide	F	Oct. 2002
47	408.9	4.5	90.87	9	455.0	1.1	60			5,279		0.0006			Shallow/Wide	F	Oct. 2002
46	630.5	3.5	180.13	7	668.8	1.1	57			5,276		0.0006			Shallow/Wide	F	Oct. 2002
45	425.9	4.0	106.47	8	674.9	1.6	54			5,268		0.0006			Shallow/Wide	F	Oct. 2002
44	318.4	5.5	57.88	11	415.1	1.3	51			5,277		0.0002			Shallow/Wide	F	Oct. 2002
43	292.1	6.5	44.94	13	382.9	1.3	50			5,277		0.0004			Shallow/Wide	F	Oct. 2002
42	357.1	3.0	119.02	6	398.9	1.1	48			5,275		0.0002			Shallow/Wide	F	Oct. 2002
41	262.8	4.0	65.70	8	318.8	1.2	47			5,274		0.0002			Shallow/Wide	F	Oct. 2002
40	387.5	7.0	55.36	14	1435.3	3.7	46			5,278		0.0000			Shallow/Wide	F	Oct. 2002
39	208.0	4.5	46.22	9	235.4	1.1	46			5,278		0.0000			Shallow/Wide	F	Oct. 2002
38	246.4	2.5	98.56	5	269.2	1.1	46			5,274		0.0002			Shallow/Wide	F	Oct. 2002
37	340.0	8.5	40.00	17	4636.5	13.6	45			5,278		0.0011			Shallow/Wide	F	Oct. 2002
36	349.2	2.5	139.66	5	365.5	1.0	39			5,026		0.0002			Shallow/Wide	F	Oct. 2002
35	351.5	3.0	117.15	6	431.7	1.2	38			5,281		0.0006			Shallow/Wide	F	Oct. 2002
34	197.0	10.0	19.70	20	5498.4	27.9	35			5,277		0.0000			Shallow/Wide	F	Oct. 2002
33	236.7	4.0	59.18	8	269.2	1.1	35			5,278		0.0000			Shallow/Wide	F	Oct. 2002
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]			Shallow/Wide	F	Oct. 2002
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]			Shallow/Wide	F	Oct. 2002
30	335.5	[illegible]	27.96	24	3378.6	10.1	33			5,278		[illegible]			Shallow/Wide	F	Oct. 2002
29	281.9	4.5	62.65	9	311.6	1.1	32			5,279		0.0004			Shallow/Wide	F	Oct. 2002
28	231.0	6.0	38.50	12	205.2	0.9	30			5,280		0.0000			Shallow/Wide	F	Oct. 2002
27	711.9	2.0	355.95	4	746.8	1.0	30			3,192		0.0000			Shallow/Wide	F	Oct. 2002
27**	543.6	5.5	98.84	11	553.8	1.0	30			4,878		0.0000			Shallow/Wide	F	Oct. 2002
26	647.2	8.0	80.90	16	1765.5	2.7	30			5,310		0.0000			Shallow/Wide	F	Oct. 2002
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]			[illegible]	[illegible]	[illegible]

Mesohabitat Mapping



SP-G2 FEATHER RIVER GEOMORPHIC STUDY

MESOHABITAT TYPING

LOWER FEATHER RIVER, ALECK AND MATHEWS RIFFLES

Backwater
Pool
Riffle
Glide

100 0 500
Feet

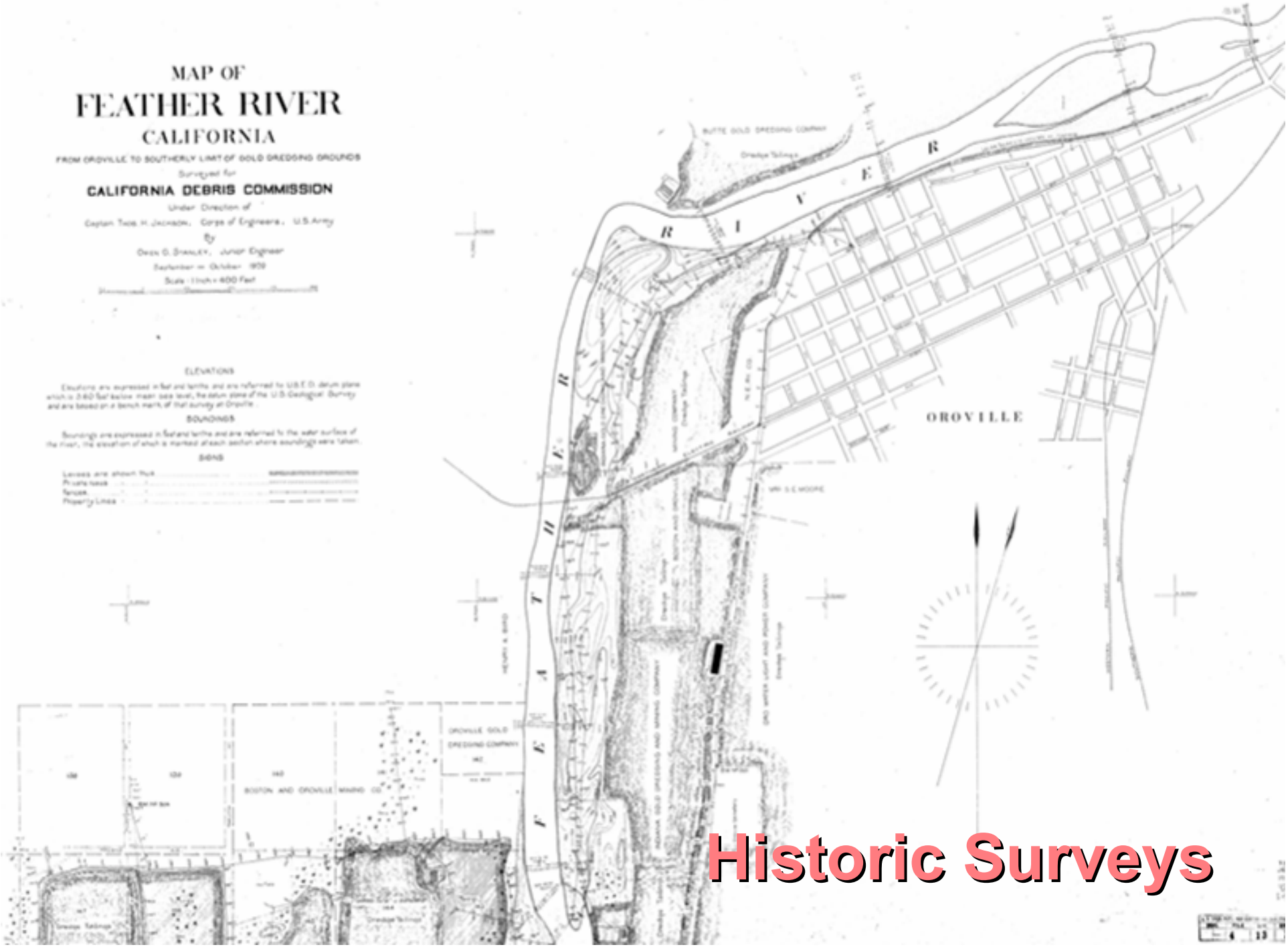
Oroville FERC Relicensing
(Project No. 2100)

IV. Spawning Riffle Mapping

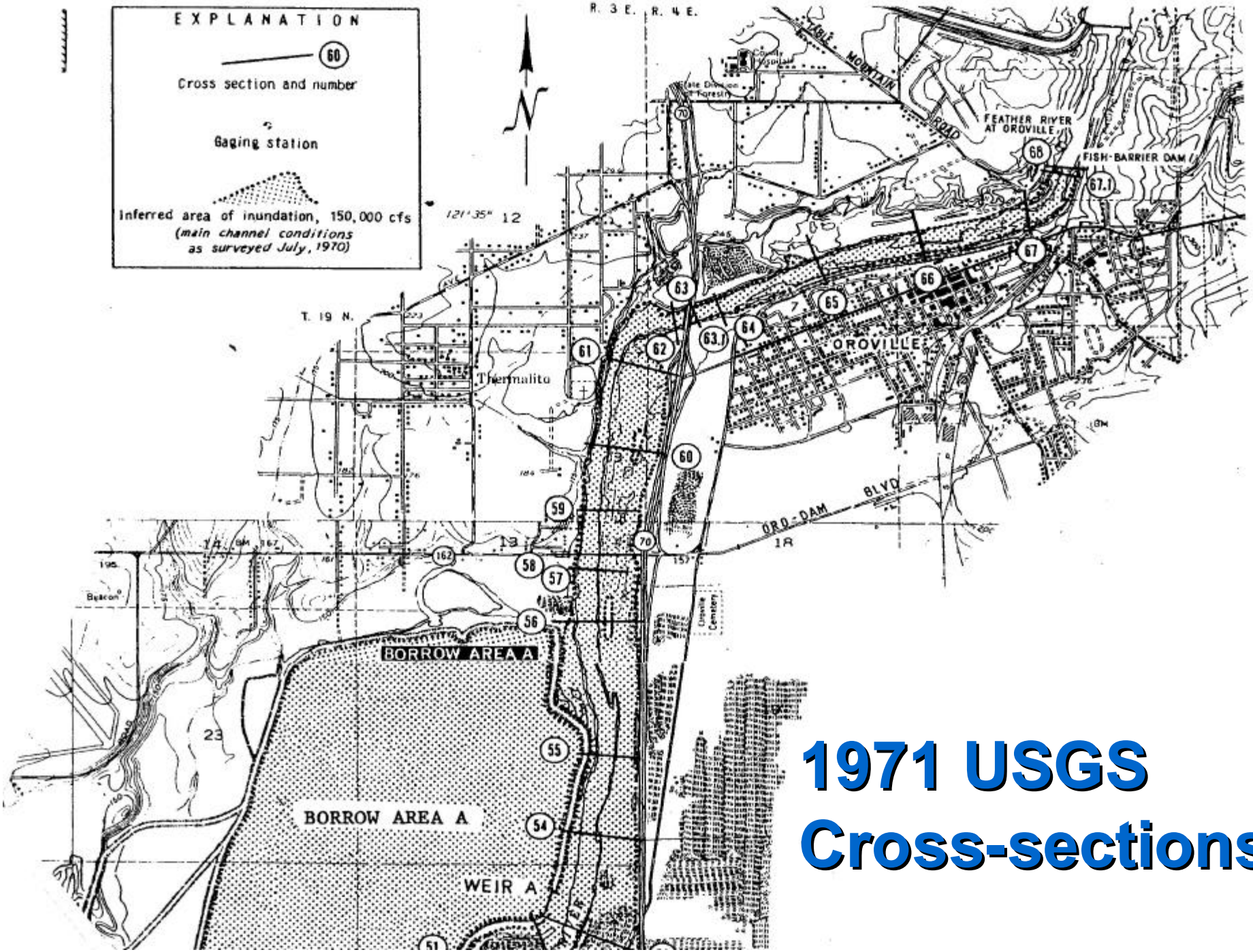
- 1982 in GIS
- 1996 in rough draft
- 2001 off aerials

V. Historic Cross-sections

- 1909 Army Debris Commission
- 1965 DWR – scattered soundings
- 1971 USGS – 71 x/s between Oroville and Honcut Creek
- 1982 DWR Spawning Gravel Study – x/s at all major riffles
- 1996 IFIM Study – 34 x/s

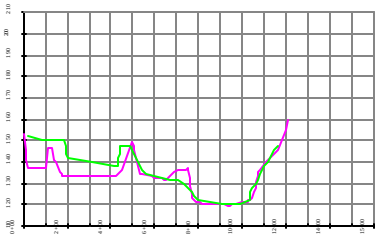


Historic Surveys



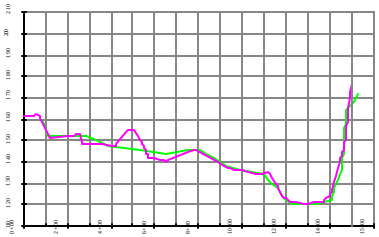
1971 USGS Cross-sections

USGS Cross-section Changes; 1971 - 2003



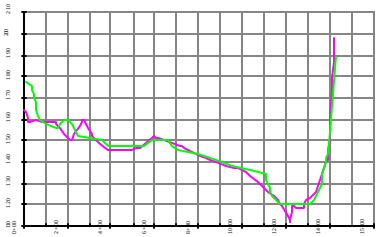
64.04 (Blodgett XS 59)

Blodgett 1972
COE 1997



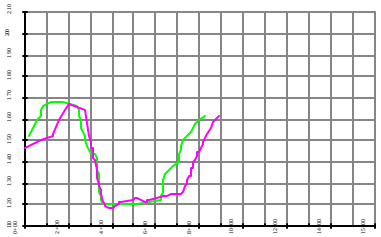
64.31 (Blodgett XS 60)

Blodgett 1972
COE1997



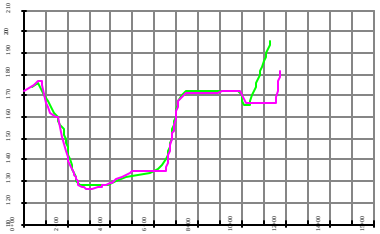
64.65 (Blodgett XS 61)

Blodgett 1972
COE 1997



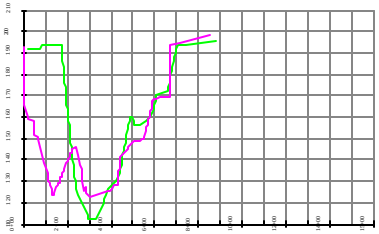
64.94 (Blodgett XS 62)

Blodgett 1972
COE 1997



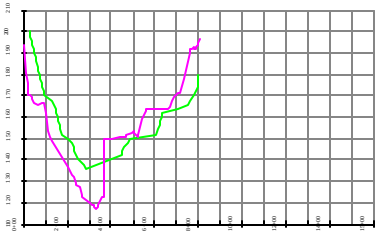
65.88 (Blodgett XS 66)

Blodgett 1972
COE 1997



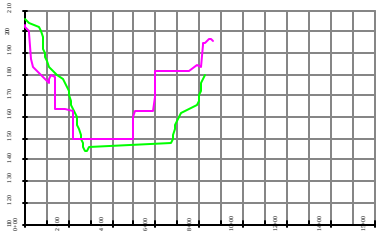
66.29 (Blodgett XS 67)

Blodgett 1972
COE1997



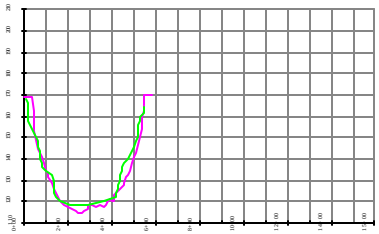
66.51 (Blodgett XS 67.1)

Blodgett 1972
COE 1997



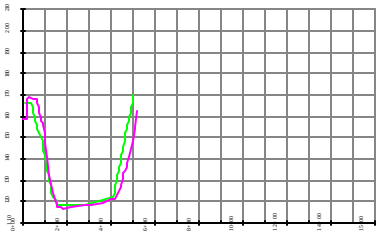
66.54 (Blodgett XS 68)

Blodgett 1972
COE 1997



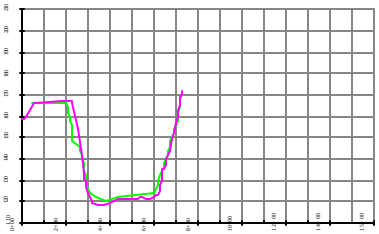
64.98 (Blodgett XS 63)

Blodgett 1972
COE 1997



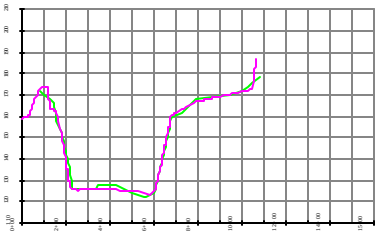
65.02 (Blodgett XS 63.1)

Blodgett 1972
COE 1997



65.12 (Blodgett XS 64)

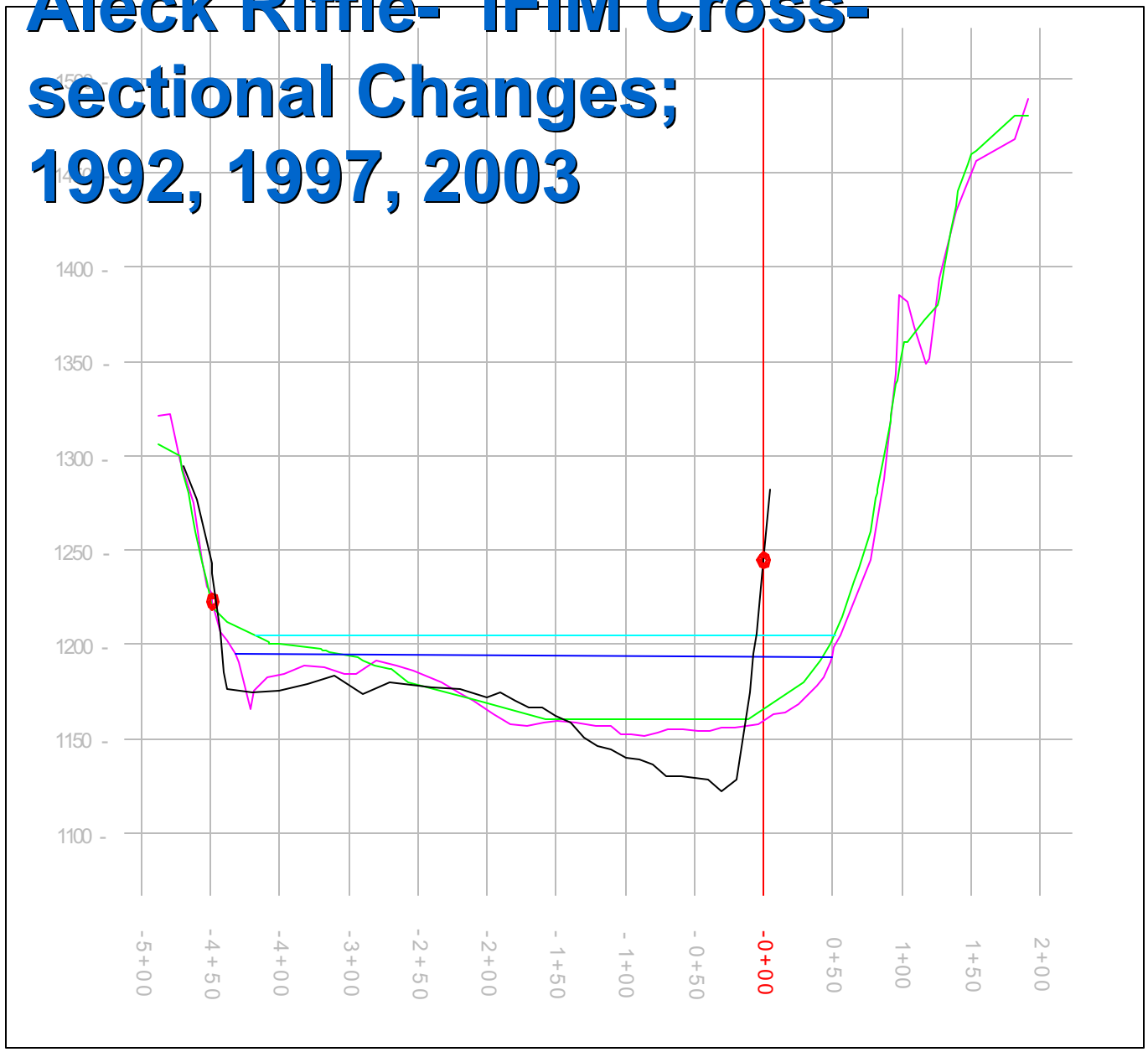
Blodgett 1972
COE 1997



65.50 (Blodgett XS 65)

Blodgett 1972
COE 1997

Aleck Riffle- IFIM Cross-sectional Changes; 1992, 1997, 2003



LEGEND

- Drill Hole Location
- Proposed Diversion Alignment
- Seismic Line and Geophone Numbers
- Cross-section Line
- Trees
- 5 ft. Contour Lines
- 1 ft. Contour Lines

Notes:

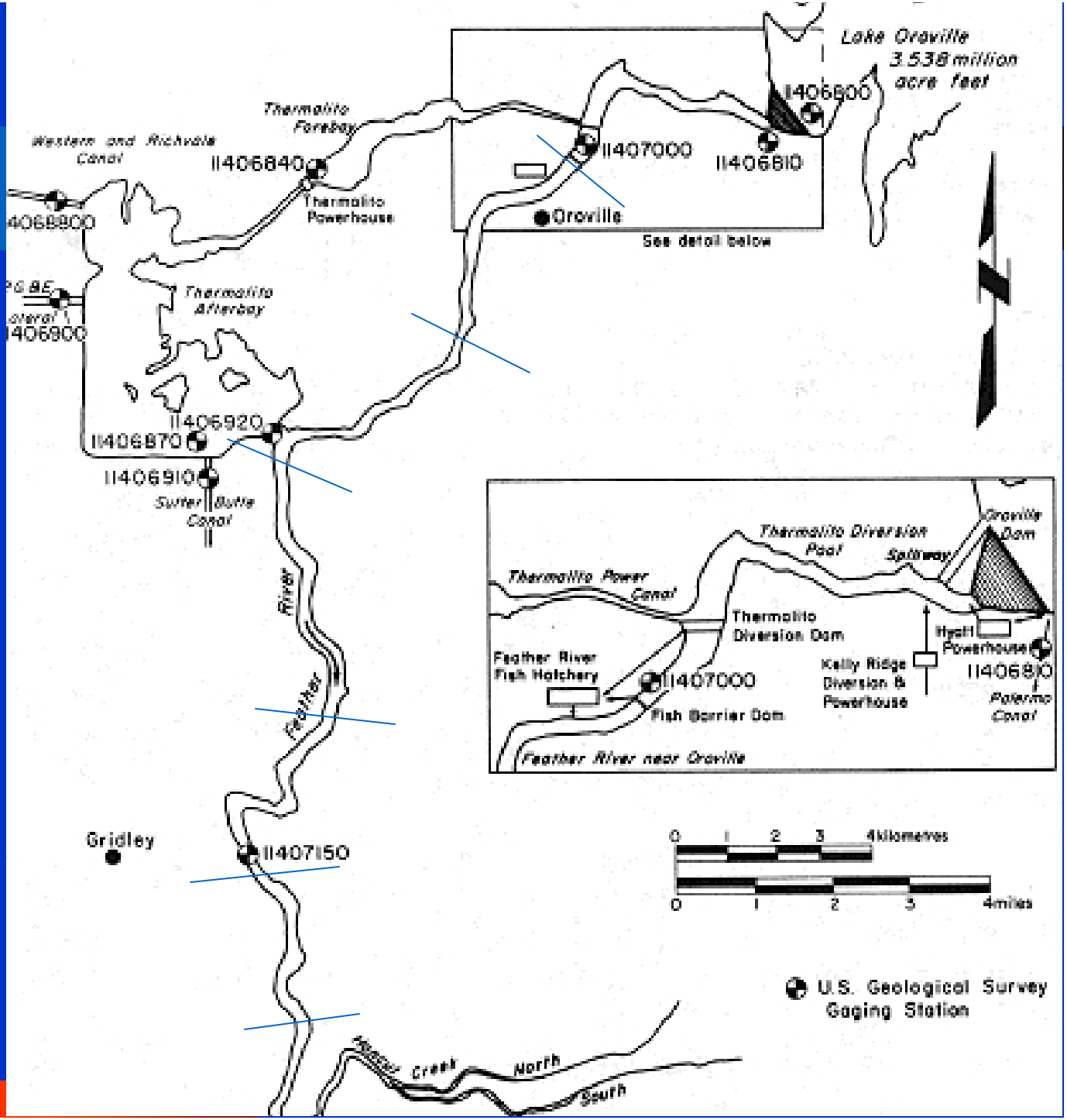
1. Cross-section and seismic lines placed by DWR-ND Geology section.
2. Drill holes placed by DWR-ND Geology and Engineering sections.
3. Proposed Diversion Alignments placed by DWR-ND Engineering section.
4. Survey data provided by DWR-ND Engineering section, with topography generated from Softdesk software.
5. Elevations based on 100 ft. benchmark.

VI. Monitor Cross-sections

- 3 proposed in Low Flow; 3 in High Flow
- Gaging station locations
- also coordinate with environmental no specific monitoring because low flows
- radio-tagged rocks

Lower Feather River –

Gaging Station Locations and Proposed Monitoring Cross-sections



Radio-tagging of Rocks

VII. Sample Sediments

- general observations with habitat typing
- also 20 locations bulk sampled in 1982, 1996, 2003
- 130 Wolman counts in 1982 – many currently being resampled

Auditorium Riffle - Bulk Gravel Sampling and Sieving

Further Sieving of Bulk Sample Aliquots

Wolman Sampling Field Data Sheet

DATE:	10/18/02, 1:00 pm	RM:	66.7	REACH: Low-flow	SAMPLE CODE: WS - 102
PROJECT:	FERC Feather River SP-G2	LOCATION:	Hatchery Riffle		
SAMPLING CREW:	Dave Forwalter, Glen Gordon, Clint Andreason				
COMMENTS:	Adjacent to WS1-2 sampling location				

GRID SIZE:	HORIZ:	5.0 feet	GPS Coords:	Northing:	2314404.9
(cell dimensions)	VERT:	5.0 feet	(Zone 2, NAD 83)	Easting:	6687372.4

north arrow

streamflow

Wolman Sampling Raw Data (millimeters)

	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
5																					
10																					
15																					
20																					
25																					
30																					
35																					
40												69	156								
45					214	112	85	132	204	150	45	156	232	94	149	80					
50					145	108	28	255	113	202	75	195	89	60	78	124					
55					195	173	51	182	101	201	14	49	180	178	60	177					
60					28	157	79	193	260	265	223	220	48	143	59	56					
65					225	215	112	70	193	215	80	145	73	260	215	54					
70					296	250	32	13	85	152	163	140	73	128	162	92					
75					178	51	178	123	235	101	55	190			67	109					
80					48	167	236	180	263	70	100	160	49	178	33	68					
85					182	82															
90					120	204															
95																					
100																					
105																					
110																					
115																					
120																					
125																					
130																					
135																					
140																					
145																					
150																					

= not sampled

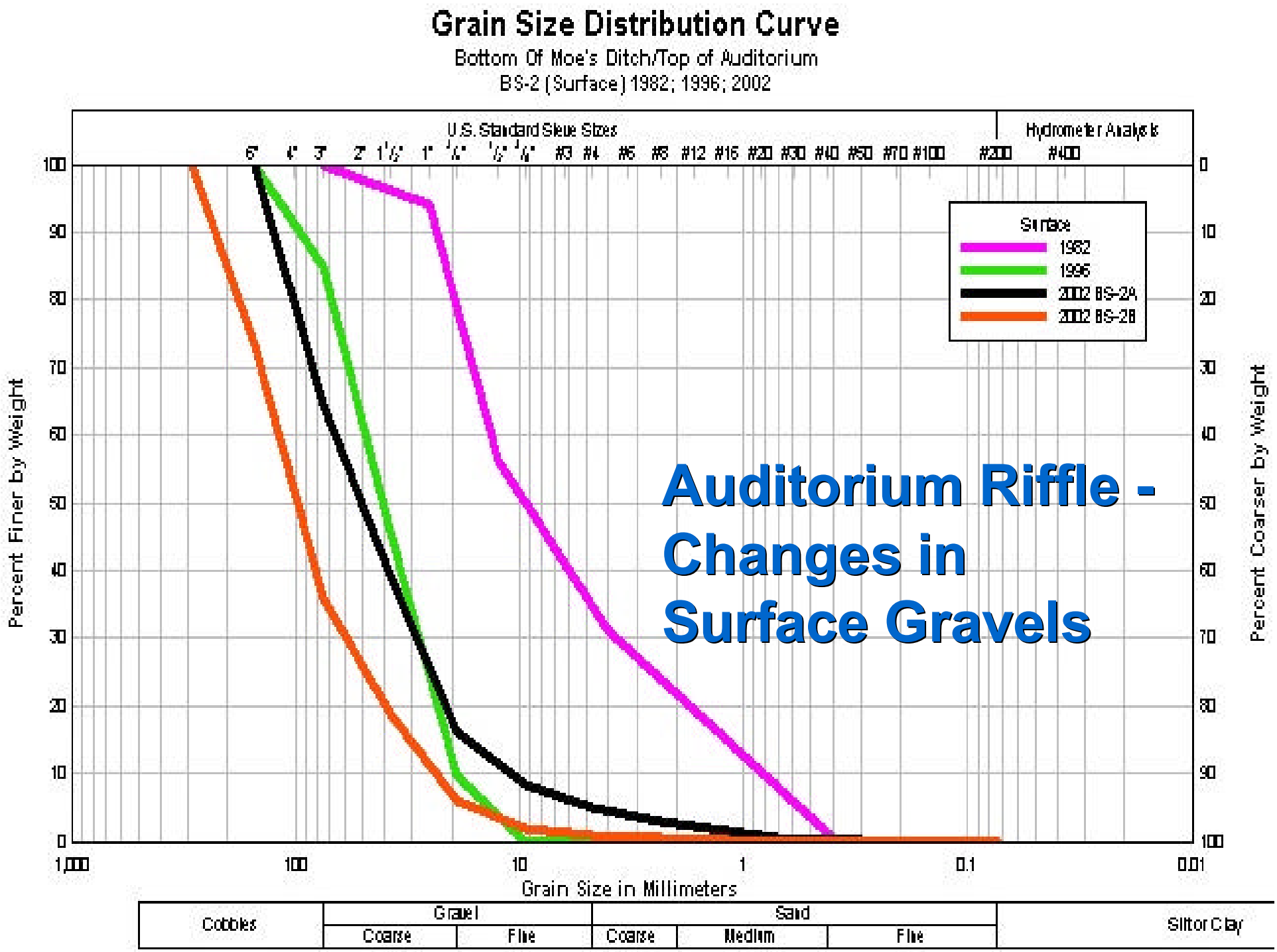
112 = surface sample

39 = underwater sample (or sitting in water)

= bedrock

= GPS reference point

= tape baseline(s)


Grain Size Distribution Curve
Bottom Of Moe's Ditch/Top of Auditorium
BS-2 (Surface) 1982; 1996; 2002
U.S. Standard Sieve Sizes
Hydrometer Analysis
6" 4" 3" 2" 1½" 1" ¾" ½" ⅜" #3 #4 #6 #8 #12 #16 #20 #30 #40 #50 #70 #100 #200 #400
Surface
1982
1996
2002 BS-2A
2002 BS-2B
Percent Finer by Weight
Percent Coarser by Weight
Grain Size in Millimeters
1,000
100
10
1
0.1
0.01
Cobbles
Gravel
Coarse
Fine
Sand
Coarse
Medium
Fine
Silt or Clay
Auditorium Riffle - Changes in Surface Gravels

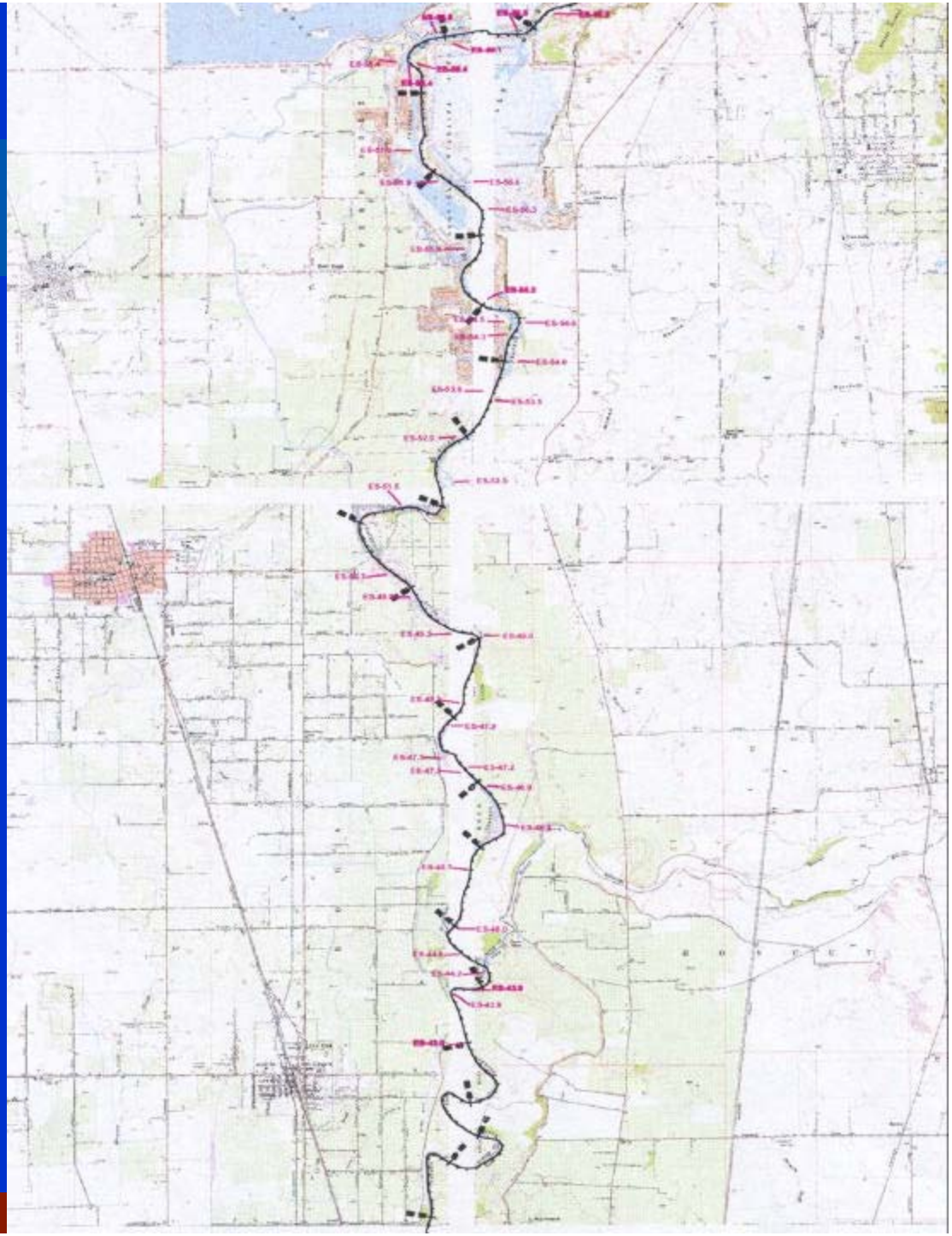
VIII. Project Effects

- IHA analysis in progress to quantify hydraulic effects
- 1982, 1996 DWR studies concluded armouring and coarsening of sediments downstream of dam
- Current study verifying this

IX. Bank Erosion Monitoring

- River meander history from aerials shows general erosion patterns
- WET listed 40 potential erosion sites from RM 44.2 to RM 60.3
- Will monitor about 10 of these
- Three sites at Herringer Riffle surveyed last Fall

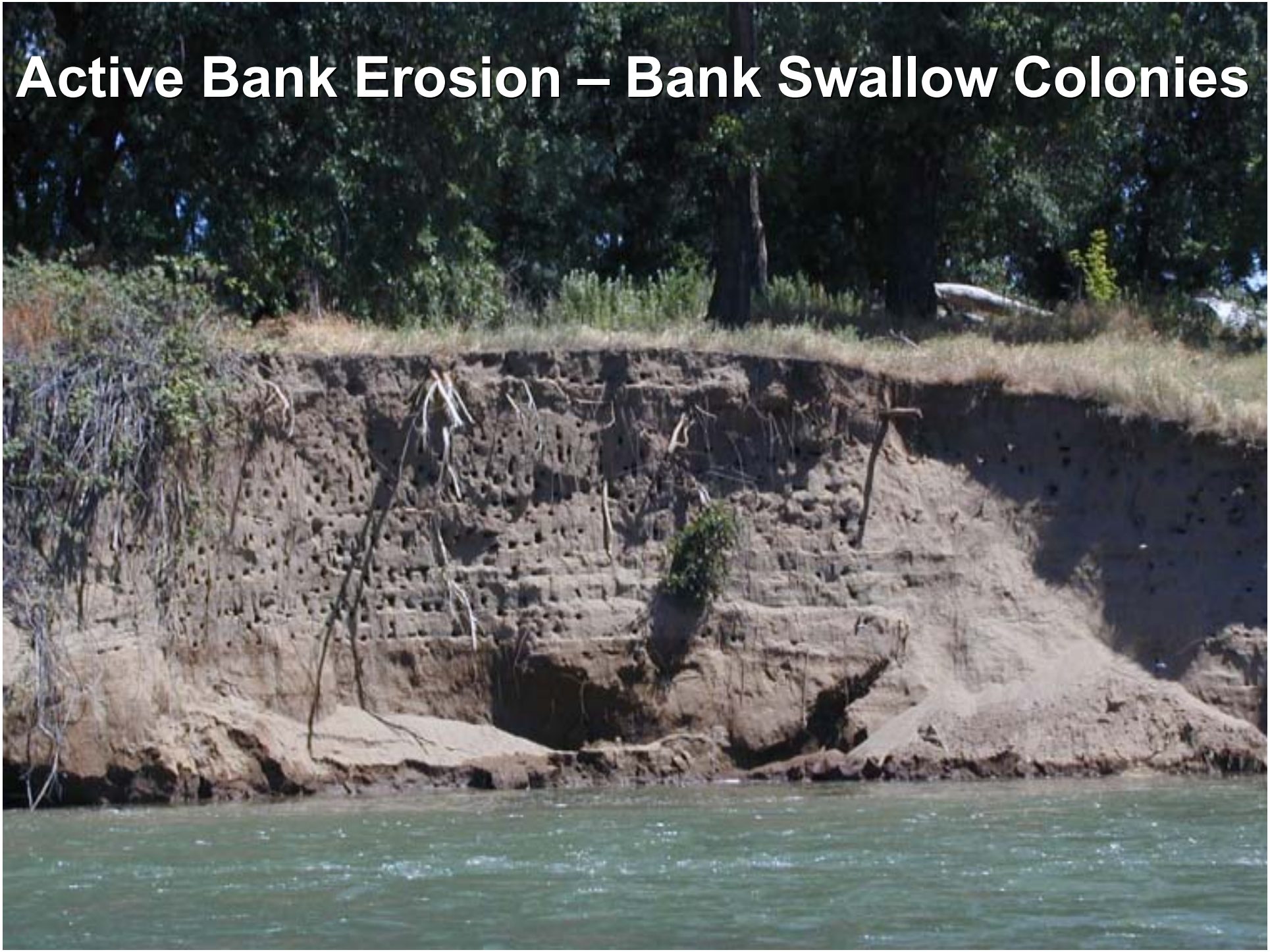
Lower Feather River Bank Erosion Sites, Thermalito Afterbay to Yuba City



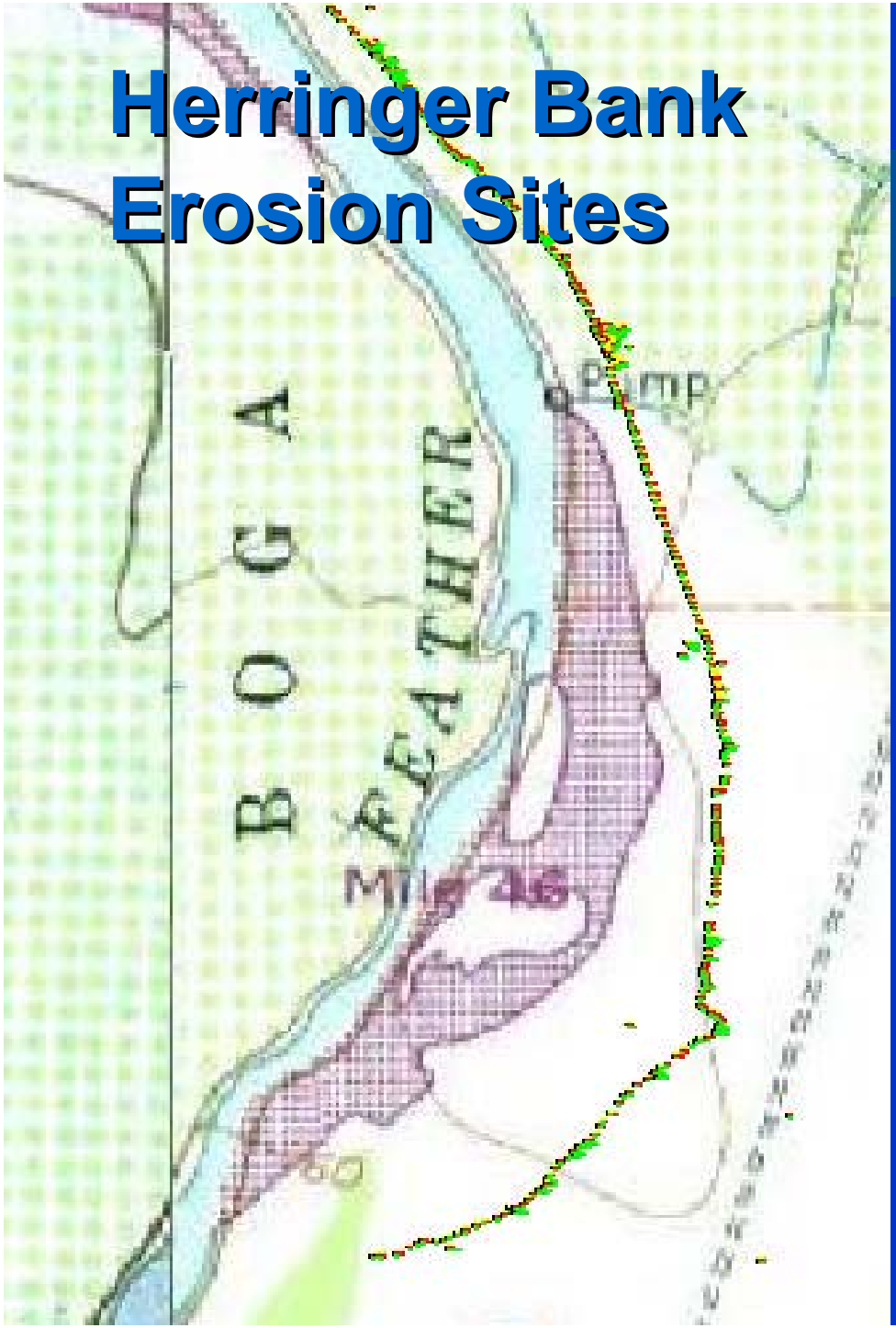
Oroville Wildlife Area Dredging Piles

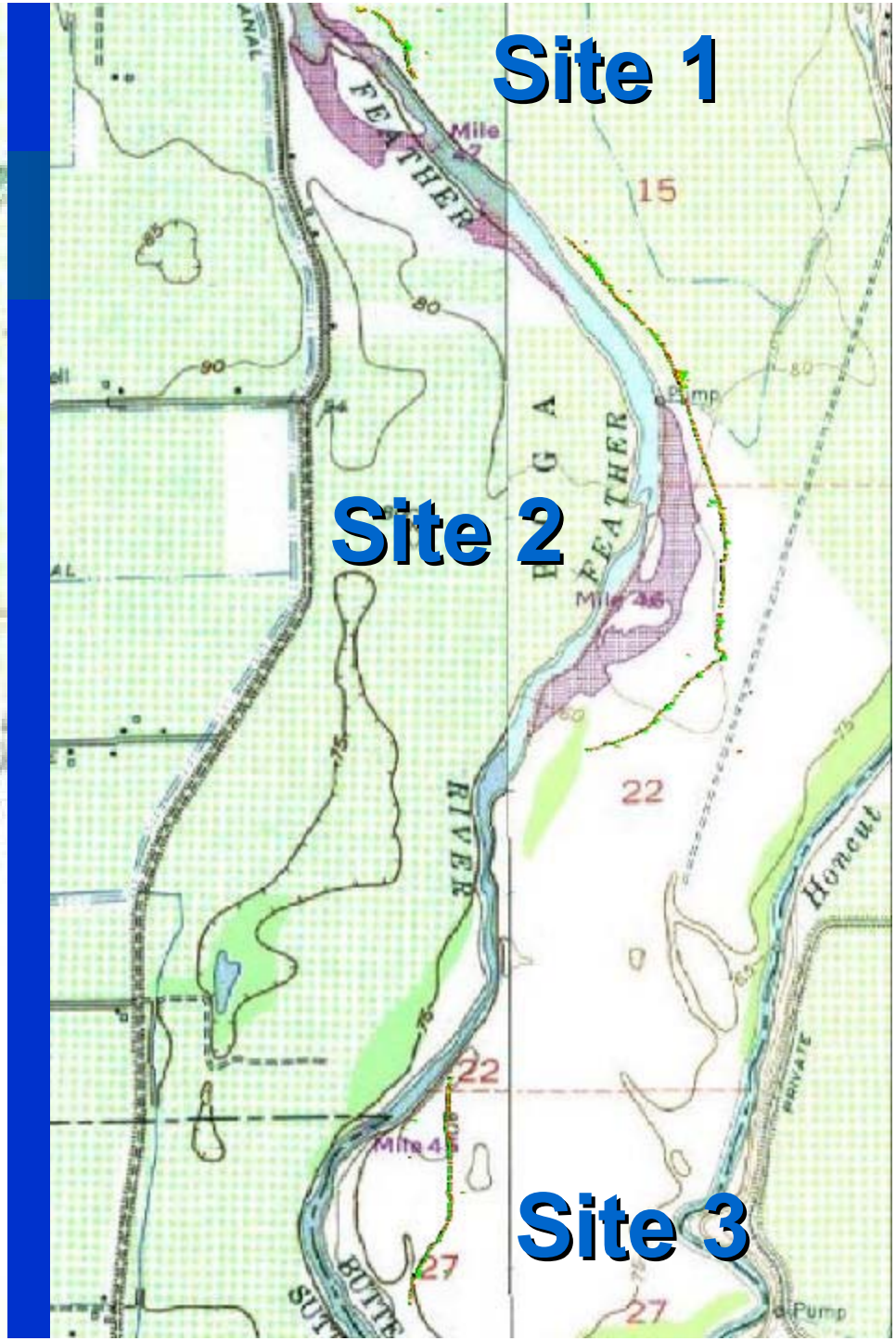
Feather River- High Flow Reach - Bank Erosion Site

Active Bank Erosion – Bank Swallow Colonies



Herringer Bank Erosion Sites





X. Sediment Transport Modeling

- FLUVIAL-12
- Data Inputs
- Data Outputs

10-21-02: Data Input Requirements for the Fluvial-12 Sediment Transport Model

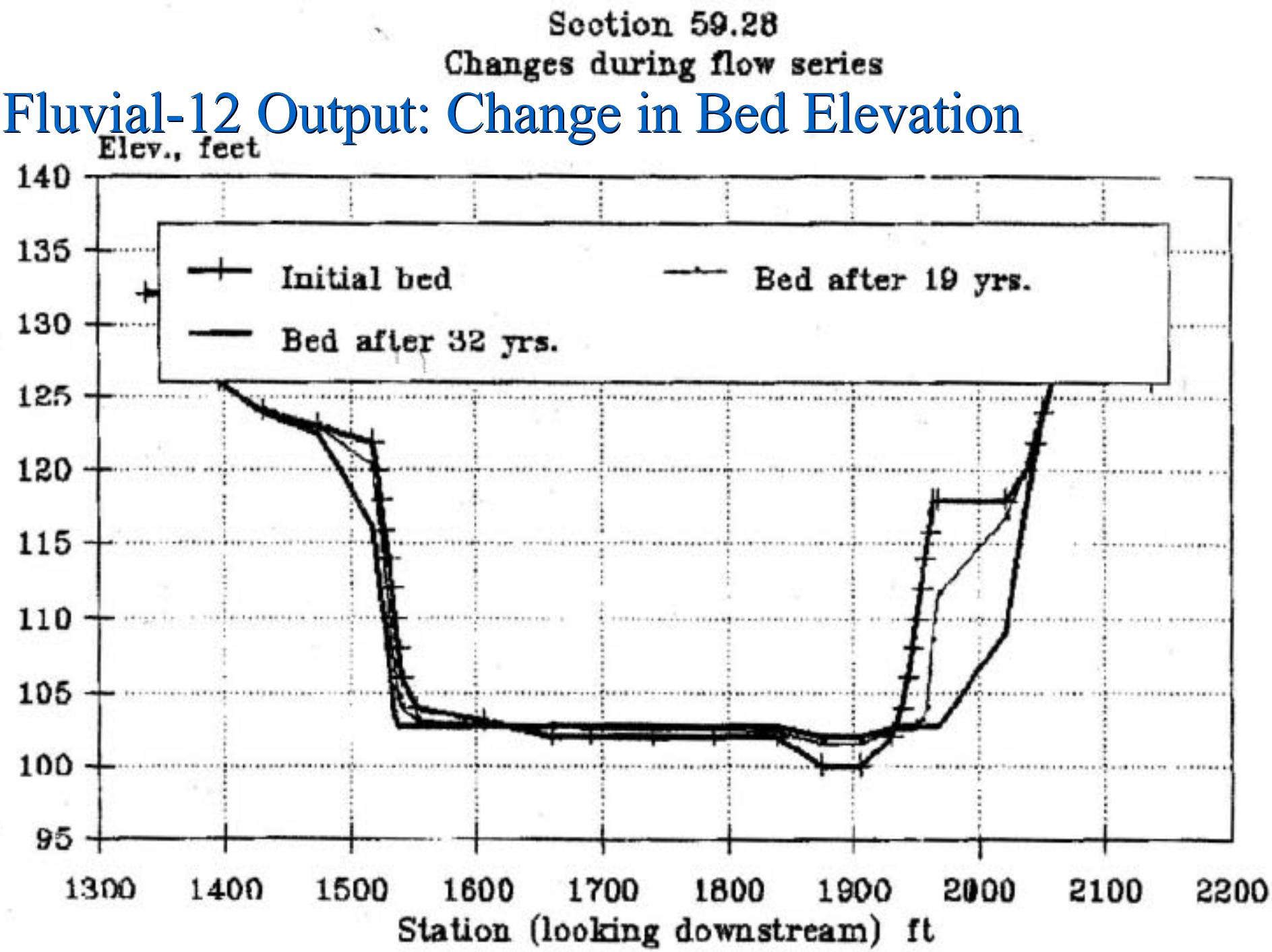
MODEL INPUTS	1901 - 1965 DATA SETS		1965 - 1996 DATA SETS		1997 - 2002 DATA SETS		
	Low Flow Reach, RM 67 (Hatchery) to RM 59 (Thermalito)	High Flow Reach, RM 45 (Honcut Creek) to RM 59 (Thermalito)	Low Flow (Hatchery to Thermalito)	High Flow (Thermalito to Honcut Creek)	Low Flow (Hatchery to Thermalito)	High Flow (Thermalito to Honcut Creek)	
DISCHARGE RECORDS							
Daily Flow Records	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1901-1965	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1901-1965 (both reaches have same flow)	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1966-1996	CDEC hourly flow data for gaging station #11407160 (at Gridley Bridge) 1964-1996	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1997-2002	CDEC hourly flow data for gaging station #11407160 (at Gridley Bridge) 1997-1998;	
Stage records	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1901-1965	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1901-1965 (both reaches have same stage)	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1966-1996	CDEC hourly stage data for gaging station #11407160 (at Gridley Bridge) 1964-1996	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1997-2002	CDEC hourly stage data for gaging station #11407160 (at Gridley Bridge) 1997-1998;	
Flood Hydrograph Records	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC 2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	Da
Water Temperature	ND-Water Quality data?	ND-Water Quality data?	DWR 1970 report "Lower Feather River Water Quality"; also DFG's 1979 report - "Temperatures on the Feather River at Oroville"	DWR 1970 report "Lower Feather River Water Quality"	ND-Water Quality data (sampling stations #'s 21-27)	ND-Water Quality data (sampling stations #'s 27-32, 42)	
CROSS-SECTIONS AND PROFILES							
Topography of channel and floodplain (cross-sections)	Army Debris Commission 1909 2-foot contour map. 23 cross-sections across flood-plain (soundings in channel).	Army Debris Commission 1909 2-foot contour map. 16 cross-sections across flood-plain (soundings in channel).	DWR 1965 5-foot contour map (EXCEPT for underwater!!). 16 cross-sections across floodplain (with soundings in channel) replicate 1909 work. Also 1971 USGS cross-sections (71); 1982 DWR cross-sections (about 100?)	DWR 1965 5-foot contour map (EXCEPT for underwater!!). 16 cross-sections across floodplain (with soundings in channel) replicate 1909 work. Also 1971 USGS cross-sections (71); 1982 DWR cross-sections (about 100?)	USACE 1997 2-foot contour map. 46 LINET cross-sections across floodplain (bathymetry in channel).	USACE 1997 2-foot contour map. 125 LINET cross-sections across floodplain (bathymetry in channel).	
Profile and slope of the channel	1909 longitudinal thalweg profile; historic USGS topos (at State Library)	1909 longitudinal thalweg profile; historic USGS topos (at State Library)	1965 longitudinal thalweg profile; USGS topos	1965 longitudinal thalweg profile; USGS topos	USACE 1997 2-foot contour map.	USACE 1997 2-foot contour map.	
BED MATERIAL DATA							
Bulk sample data (size fractions)	Gravel operations? Dredging piles? Upriver samples?	Gravel operations? Dredging piles? Upriver samples?	DWR: 1982 = 10 samples; 1996 = 10 samples; also USGS sampling	DWR: 1982 = 10 samples; 1996 = 10 samples; also USGS sampling	In progress.	In progress.	ND b sar
GEOMORPHIC DATA							
Bank Erodibility	geologic map; changes in historic channel center-lines	geologic map; changes in historic channel center-lines	geologic map; changes in historic channel center-lines	geologic map; changes in historic channel center-lines	geologic map; field evaluation	geologic map; field evaluation	Ava
Bank Protection	Army Debris Commission 1909 2-foot contour map.	Army Debris Commission 1909 2-foot contour map.	DWR 1965 5-foot contour map.	DWR 1965 5-foot contour map.	USACE 1997 aerial photography	USACE 1997 aerial photography	
Immobile Bed Areas	geologic map	geologic map	geologic map	geologic map	geologic map	geologic map	
Bed Surface Composition	??	??	DWR: 1982 = 42 samples; 1996 = 10 samples	DWR: 1982 = 106 samples; 1996 = 10 samples	In progress.	In progress.	ND Wo sar
Thickness of Erodible Bed Layer	DWR well and auger data; 1909 longitudinal profile of thalweg	DWR well and auger data; 1909 longitudinal profile of thalweg	DWR well and auger data; 1965 longitudinal profile of thalweg	DWR well and auger data; 1965 longitudinal profile of thalweg	DWR well and auger data; 1997 longitudinal profile of thalweg	DWR well and auger data; 1997 longitudinal profile of thalweg	
Specific Gravity	samples	samples	samples	samples	samples	samples	
Radius of Curvature of Bends	Army Debris Commission 1909 2-foot contour map.	Army Debris Commission 1909 2-foot contour map.	DWR 1965 5-foot contour map.	DWR 1965 5-foot contour map.	USACE 1997 2-foot contour map.	USACE 1997 2-foot contour map.	
CHANNEL AND FLOODPLAIN ROUGHNESS							
Manning's Coefficient of Roughness	aerial photos	aerial photos	aerial photos; gravel sample analysis	aerial photos; gravel sample analysis	aerial photos; gravel sample analysis; site review	aerial photos; gravel sample analysis; site review	

Fluvial-12 Data Inputs

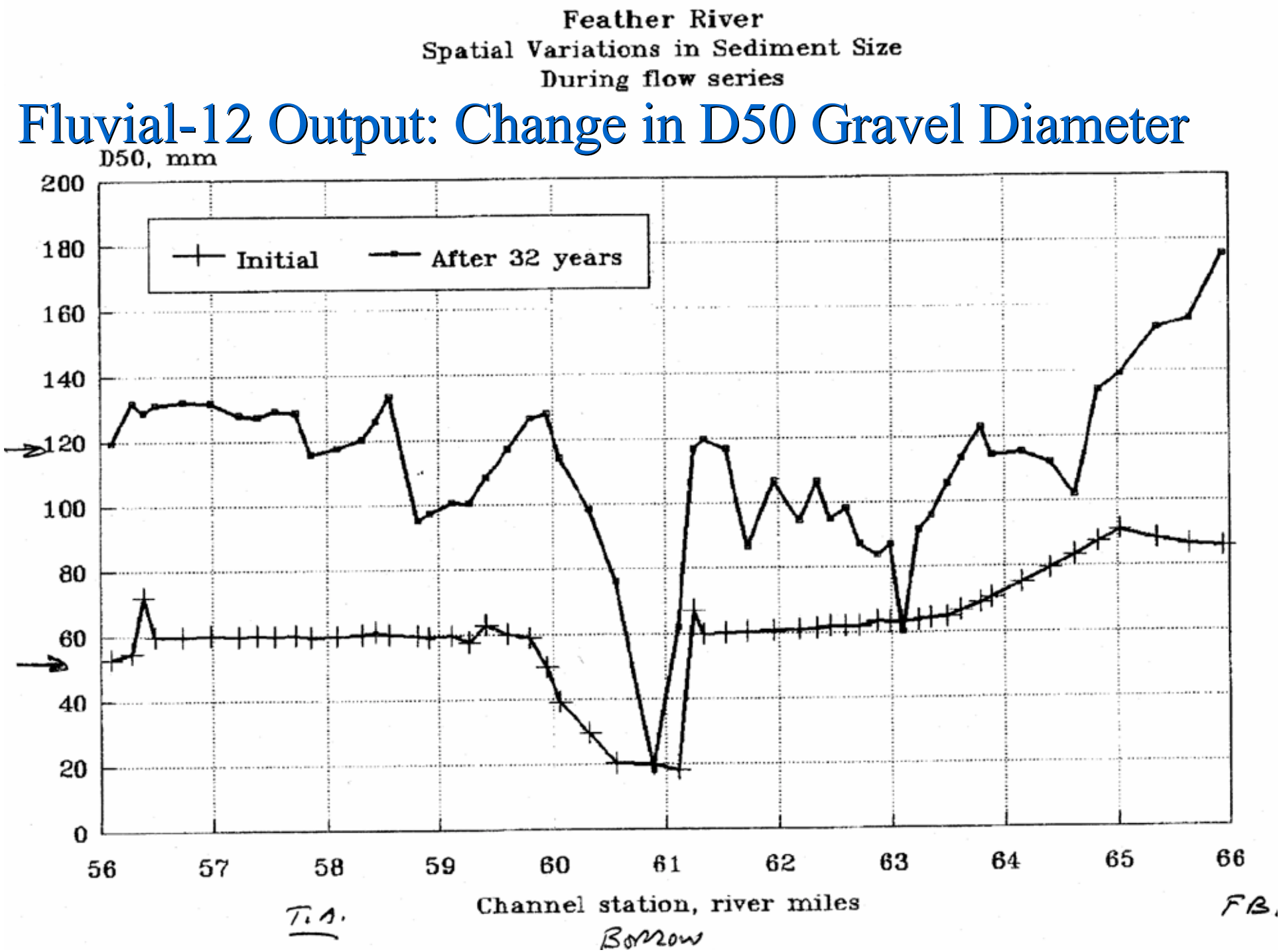
Fluvial-12 Calibration

- tried Level 3 but inadequate initial condition data
- now Level 1 instead (common approach) for Low Flow Reach
- uses current channel configuration, compare with USGS, IFIM x/s
- post-Dam hydrographs
- sediment characterized with sampling
- bank erodibility with historic meanders and specific bank erosion monitoring
- ie. = data from <u>rest</u> of SP-G2!

Fluvial-12 Output: Change in Bed Elevation



Fluvial-12 Output: Change in D50 Gravel Diameter



SUMMARY

- main emphasis is on Fluvial-12 calibration – completion in Fall
- bulk and surface sediment sampling continues to Yuba City
- monitoring of cross-section characteristics, radio-tagged rocks planned at higher flows
- verify armouring and coarsening conclusions of 1982, 1996 studies

SUMMARY

- bank erosion monitoring continuing – will monument and survey another 8-10 this summer
- additional habitat mapping planned
- will produce atlas(es) that combine cross-section surveys, gravel sampling, habitat mapping
- also GIS integration