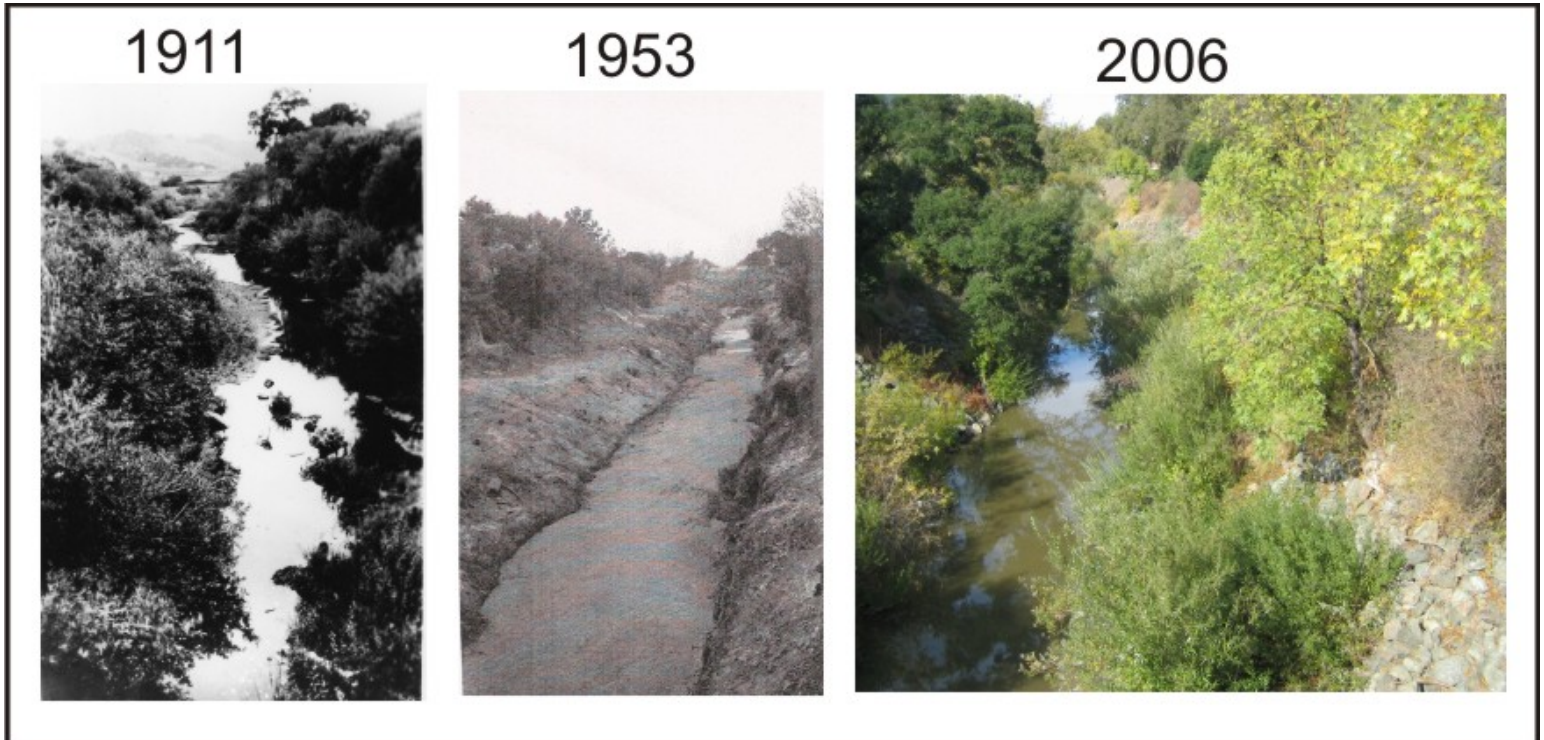
A Sediment Budget for Two Reaches of Alameda Creek

(1900s through 2006)



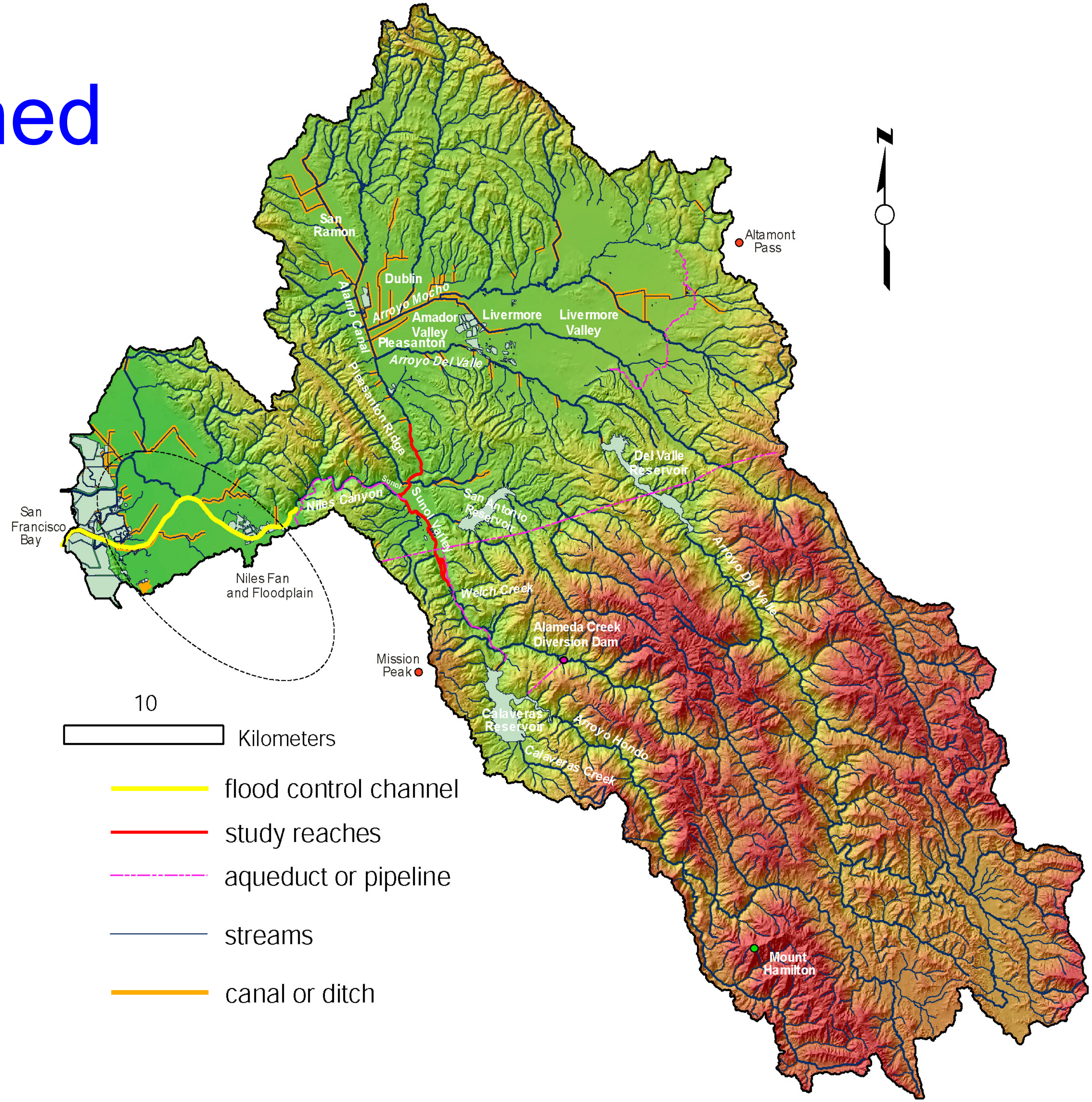
Paul Bigelow, Sarah Pearce, Lester McKee, and Alicia Gilbreath

BIGELOW WATERSHED GEOMORPHOLOGY

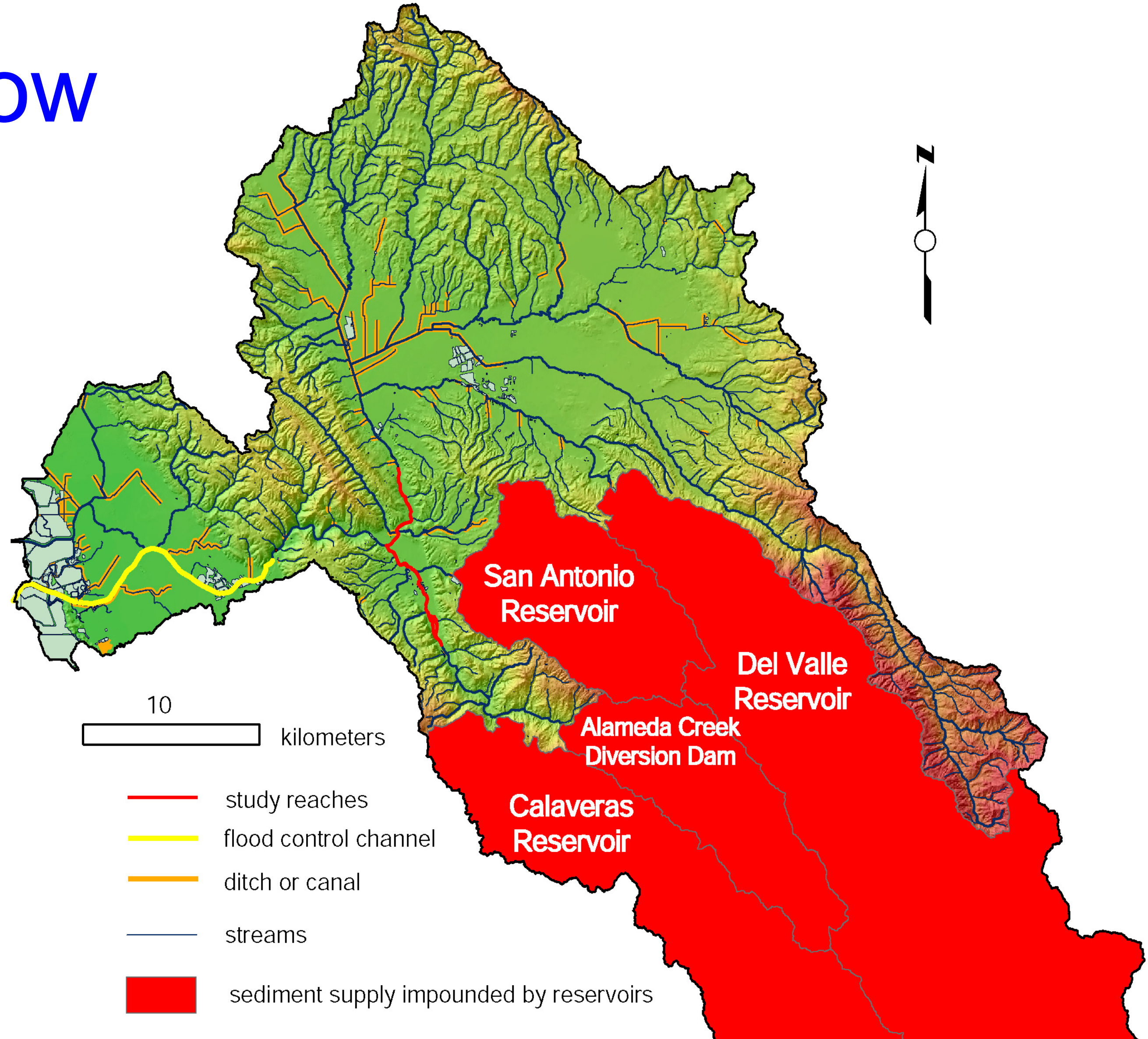
Study Objectives

- Study reaches a major source of sediment to flood control channel ?
- Identify dominant processes and estimate rates of erosion and storage
- Compare reach erosion to watershed
- Evaluate channel evolution

Watershed

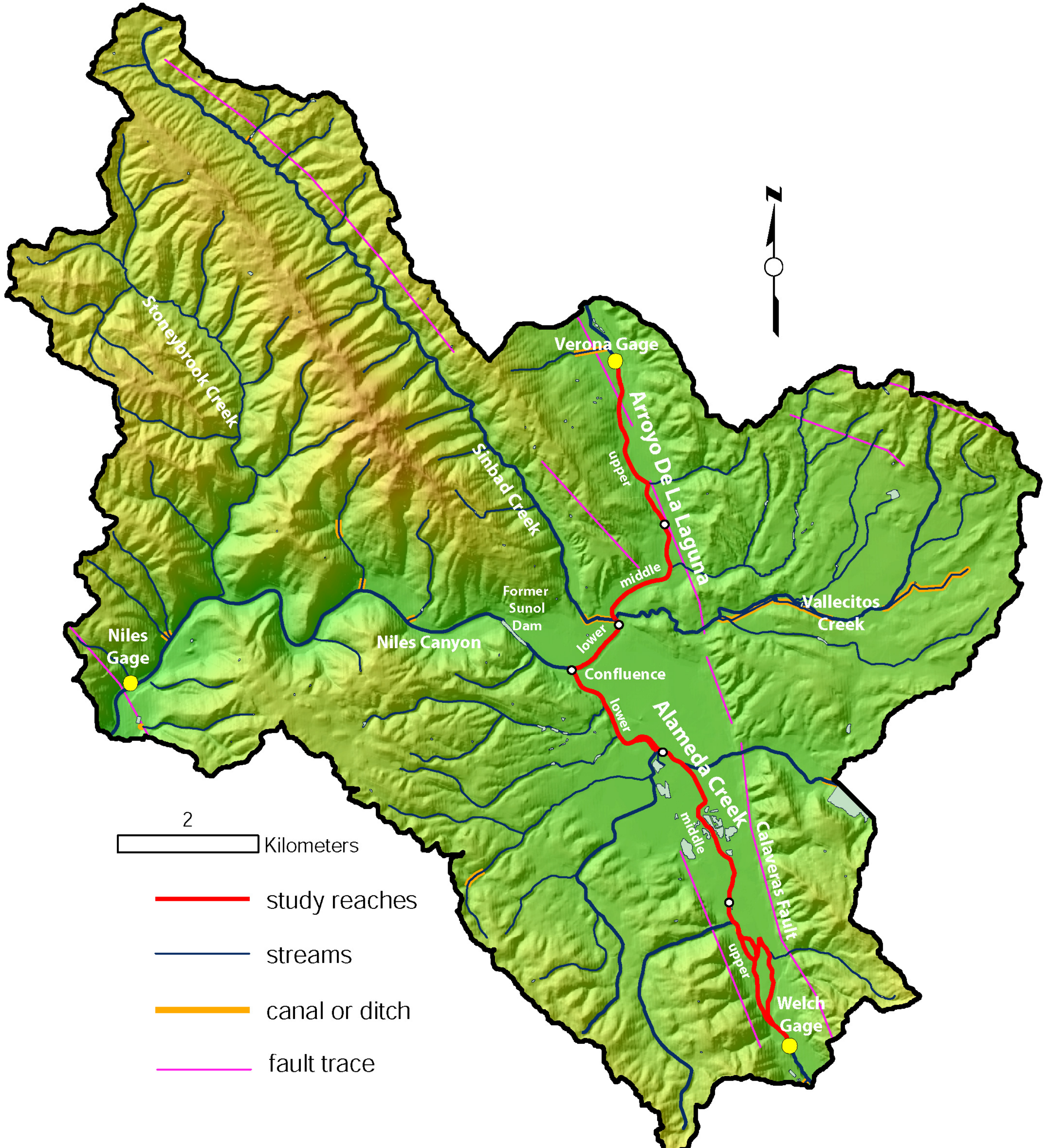

San Ramon
Dublin
Arroyo Mocho
Alamo Canal
Amador Valley
Pleasanton
Livermore
Livermore Valley
Altamont Pass
Arroyo Del Valle
Pleasanton Ridge
Del Valle Reservoir
Niles Canyon
Sunol
Sunol Valley
San Antonio Reservoir
San Francisco Bay
Niles Fan and Floodplain
Welch Creek
Arroyo Del Valle
Alameda Creek Diversion Dam
Mission Peak
Calaveras Reservoir
Arroyo Hondo
Calaveras Creek
Mount Hamilton
N
10
Kilometers
flood control channel
study reaches
aqueduct or pipeline
streams
canal or ditch

Area Below Dams



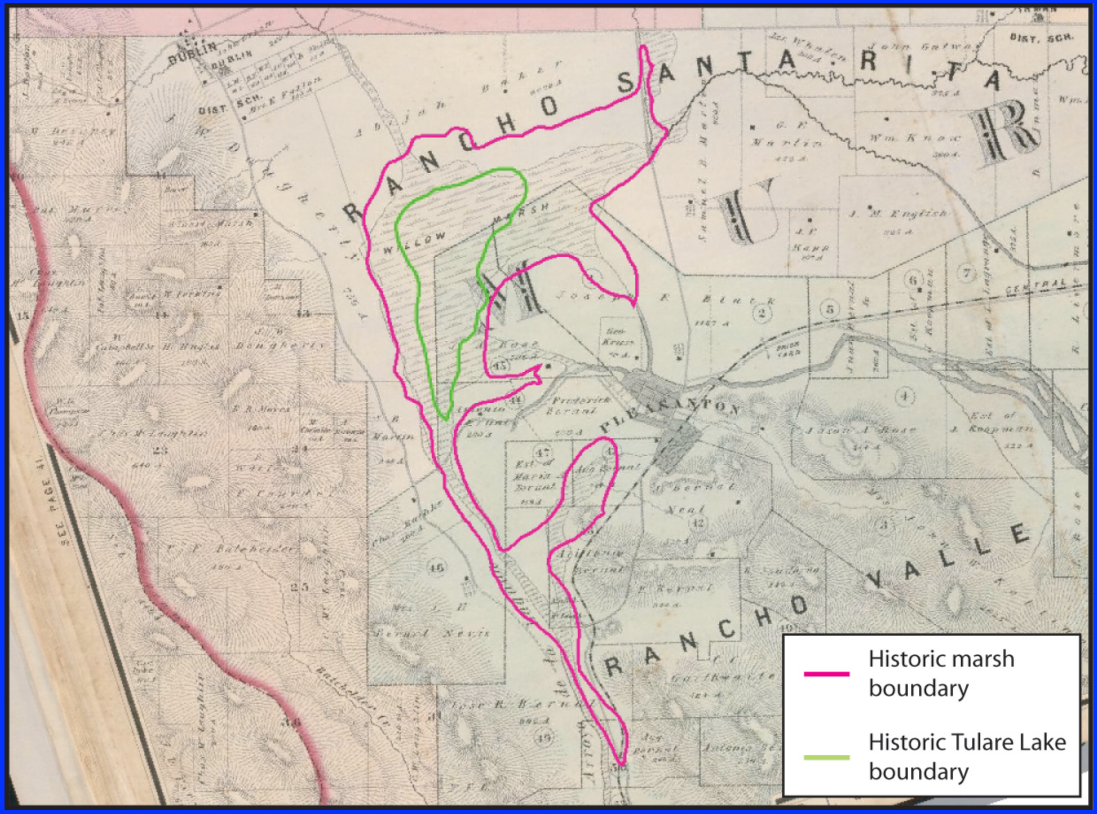
Gage Location	Drainage Area Below Dams (km^2)	Drainage Area total (km^2)	% Area Above Dams
Arroyo de La Laguna at Verona Gage	670	1044	36%
Alameda Creek near Welch Ck Gage	35	376	91%
Alameda Creek at Niles Gage	821	1639	50%

Study Area


N
Stoneybrook Creek
Sinbad Creek
Verona Gage
Arroyo De La Laguna
upper
middle
lower
Former
Sunol
Dam
Niles Canyon
Niles
Gage
Confluence
Vallecitos
Creek
Alameda Creek
lower
middle
upper
Calaveras Fault
Welch
Gage
2
Kilometers
study reaches
streams
canal or ditch
fault trace

Brief Watershed History

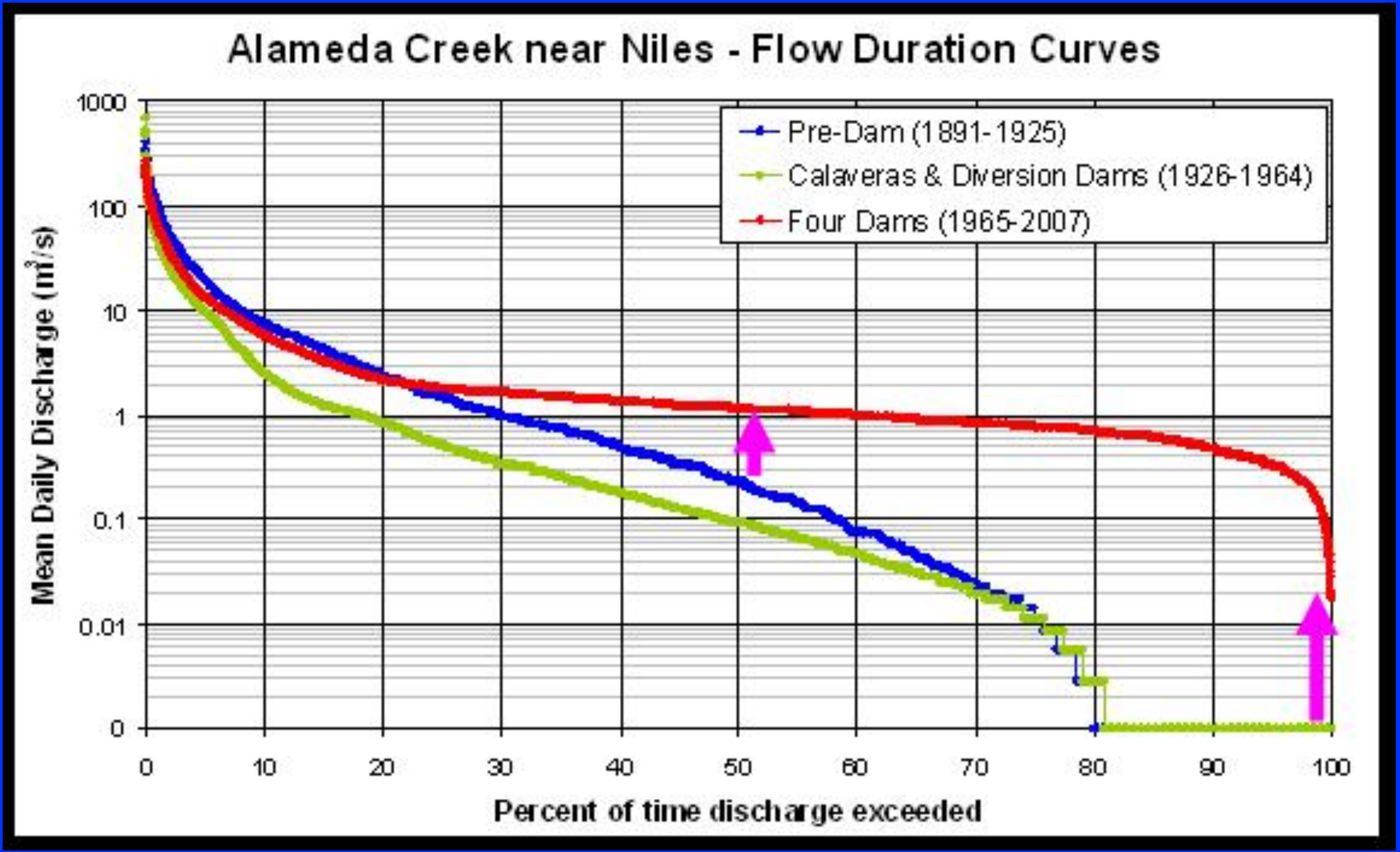
- Pre-1900: channel ditching, groundwater wells, small dams
- 1900: Ditching and draining of Tulare Lake
- 1911: ADLL incision rate of 6 in/yr



1925: Calaveras Dam, gravel mining
1950s: Four largest flood events on record
1964: San Antonio Dam
1968: Del Valle Dam
1970s: Flood Control Channel construction
1980s to 2000s: Flood Control Channel dredging

Oblique view of Pleasanton and Dublin (looking west) during the 1955 flood

Historical Flow Changes



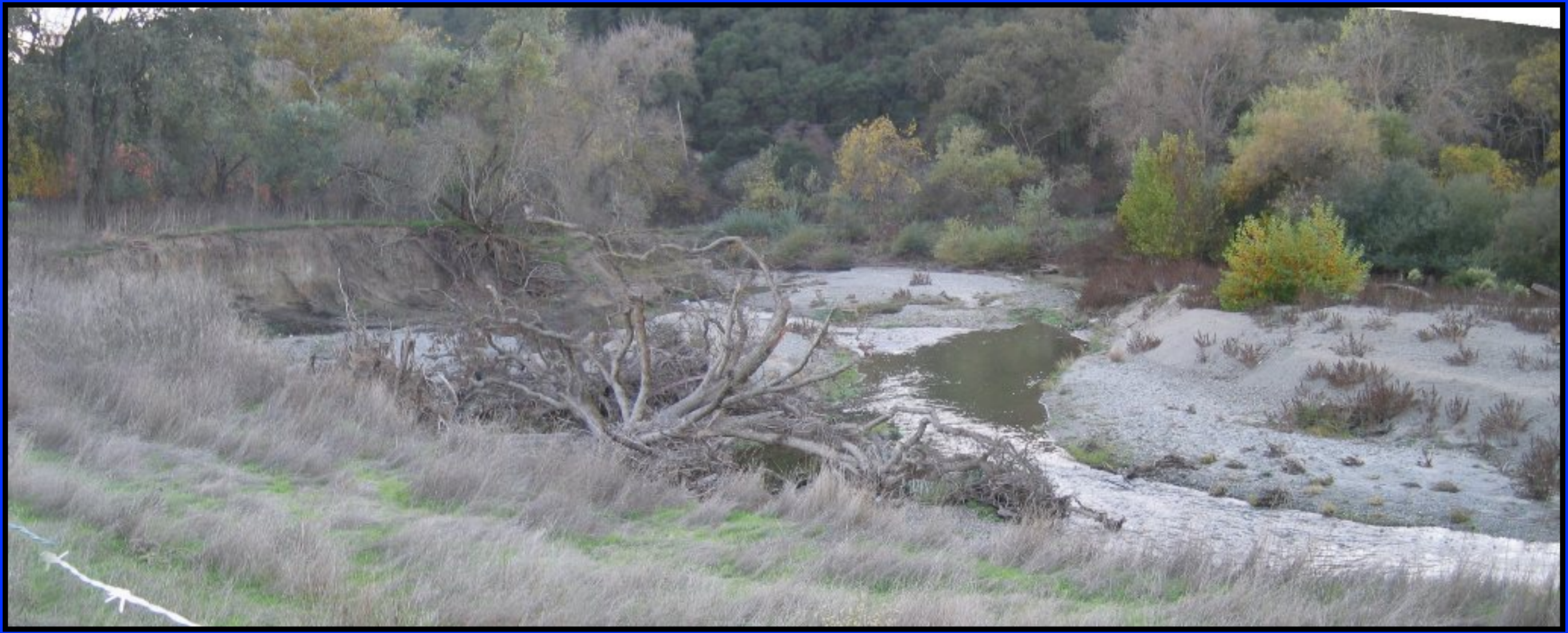
Arroyo De La Laguna

Lower Subreach

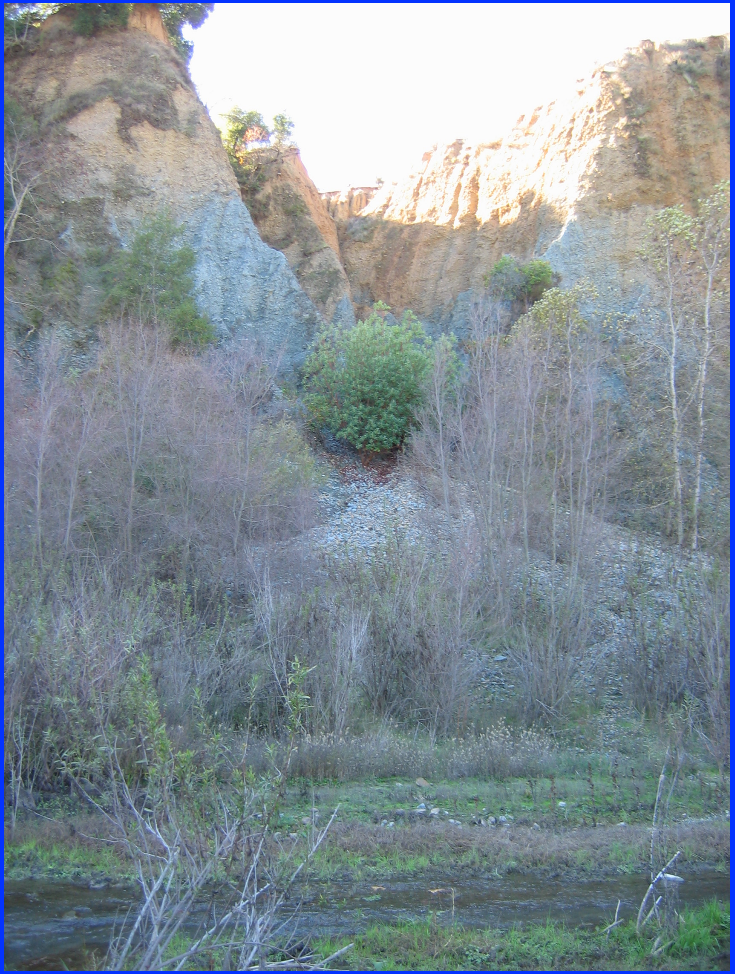
Upper Subreach

Arroyo De La Laguna

Arroyo De La Laguna



Alameda Creek

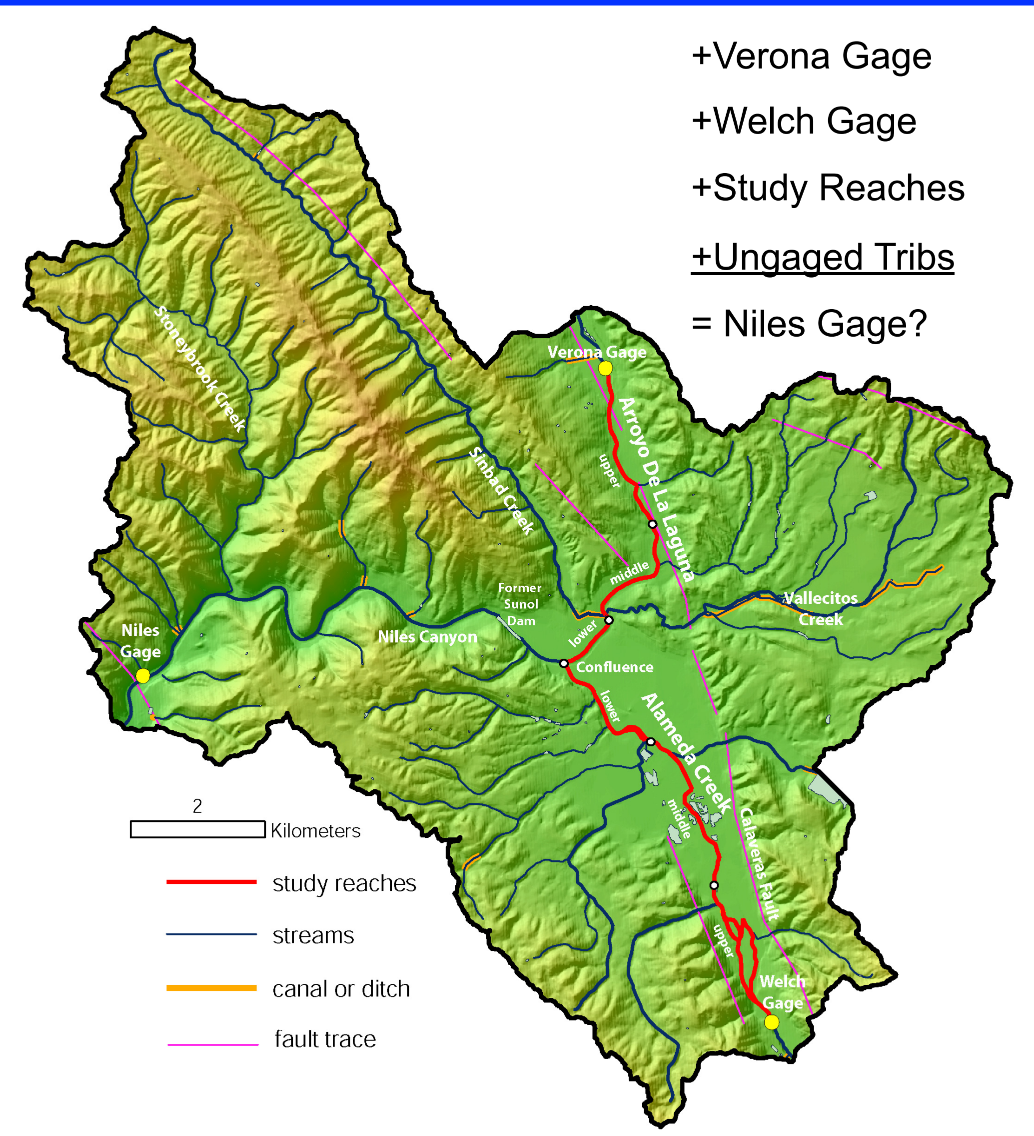


Reach Sediment Budget Methods

- **Incision** – bed elevation surveys 1959, 1971, 2007
- **Bank Erosion & Bar Storage** – field surveys and air photo analysis
- **Cross Section Surveys** – historical and current
- **Flood Plain Storage** – field surveys

- Only subset of data collected for Alameda Creek Reach (little incision, 90% of drainage area above dams)

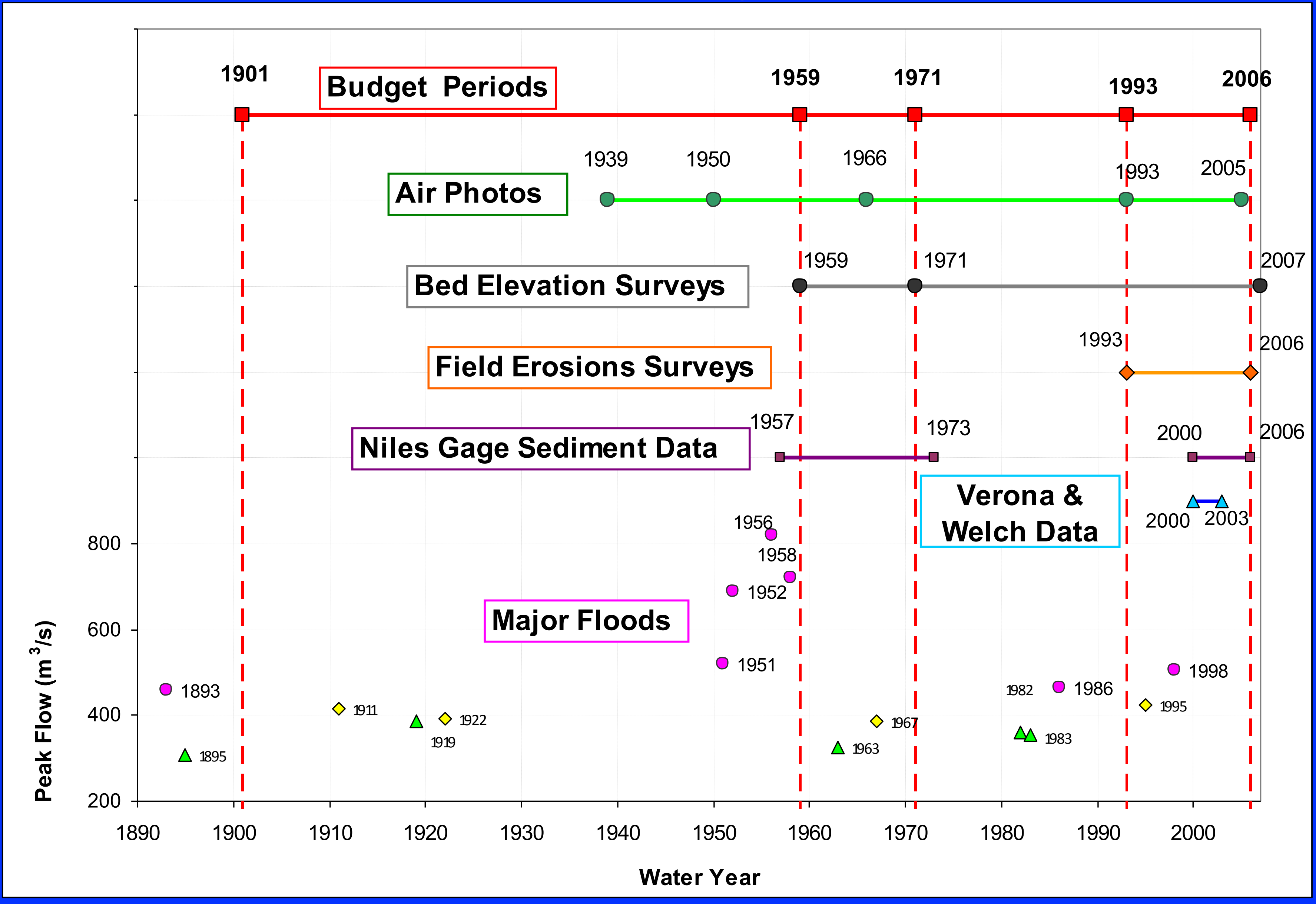
Compare Reaches w/ Watershed



- Balance the Budget
- Estimate Yield at Gages (rating curves)
- Estimate Yield for Ungaged tributaries (reservoir sedimentation rate)
- Compare Reaches w/ Niles Gage

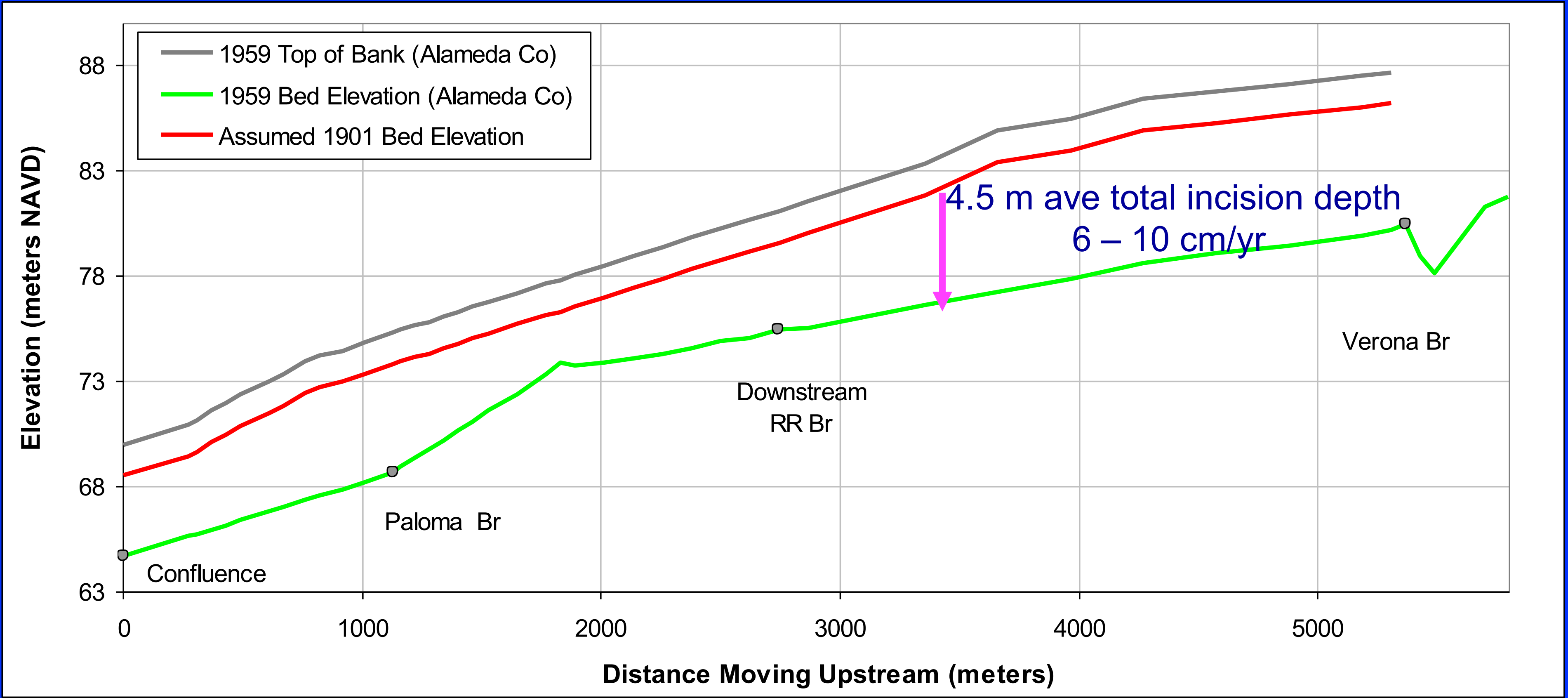
Sedient Budget Periods

and Summary of Data

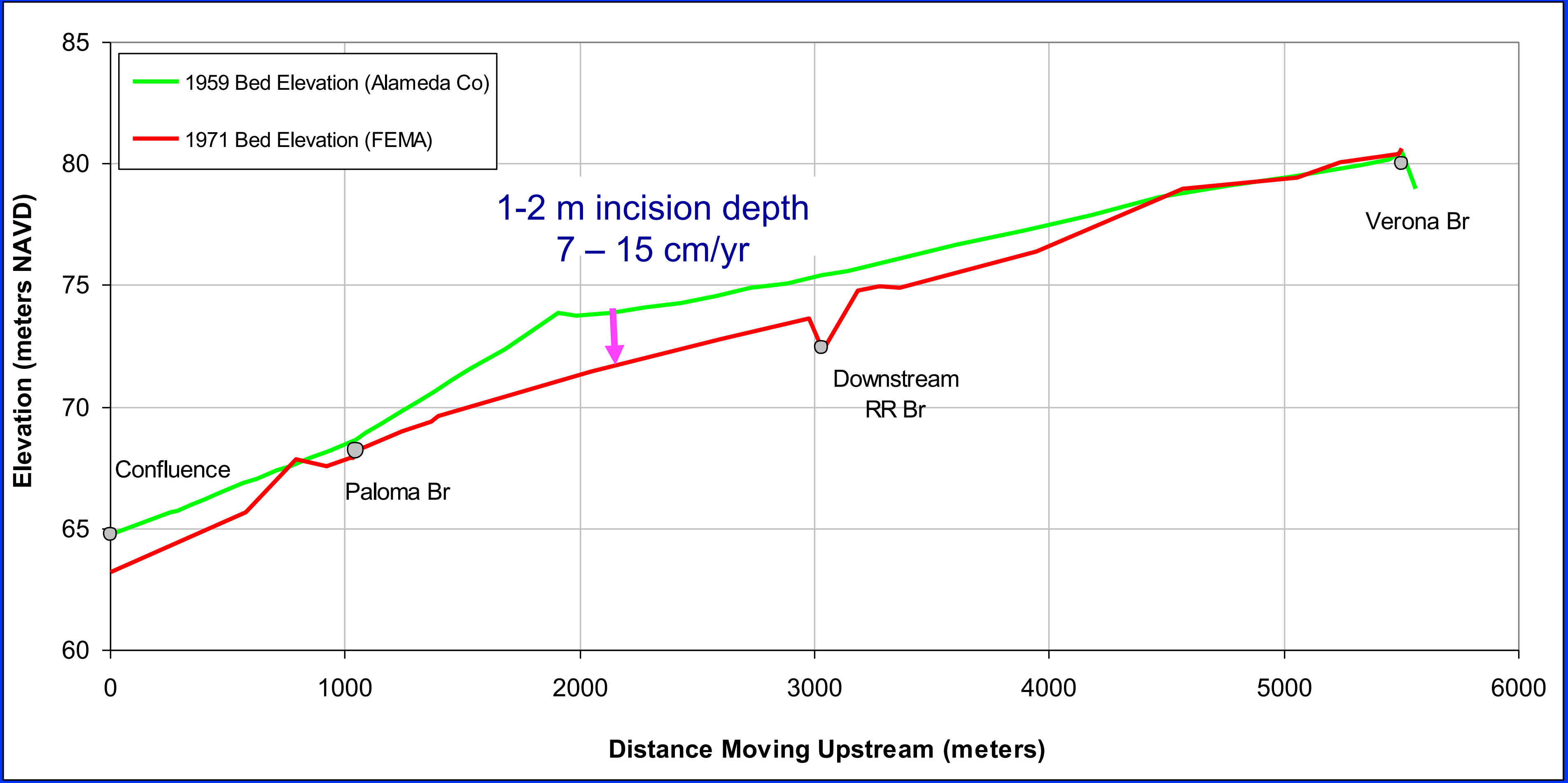


Results
Long Profiles

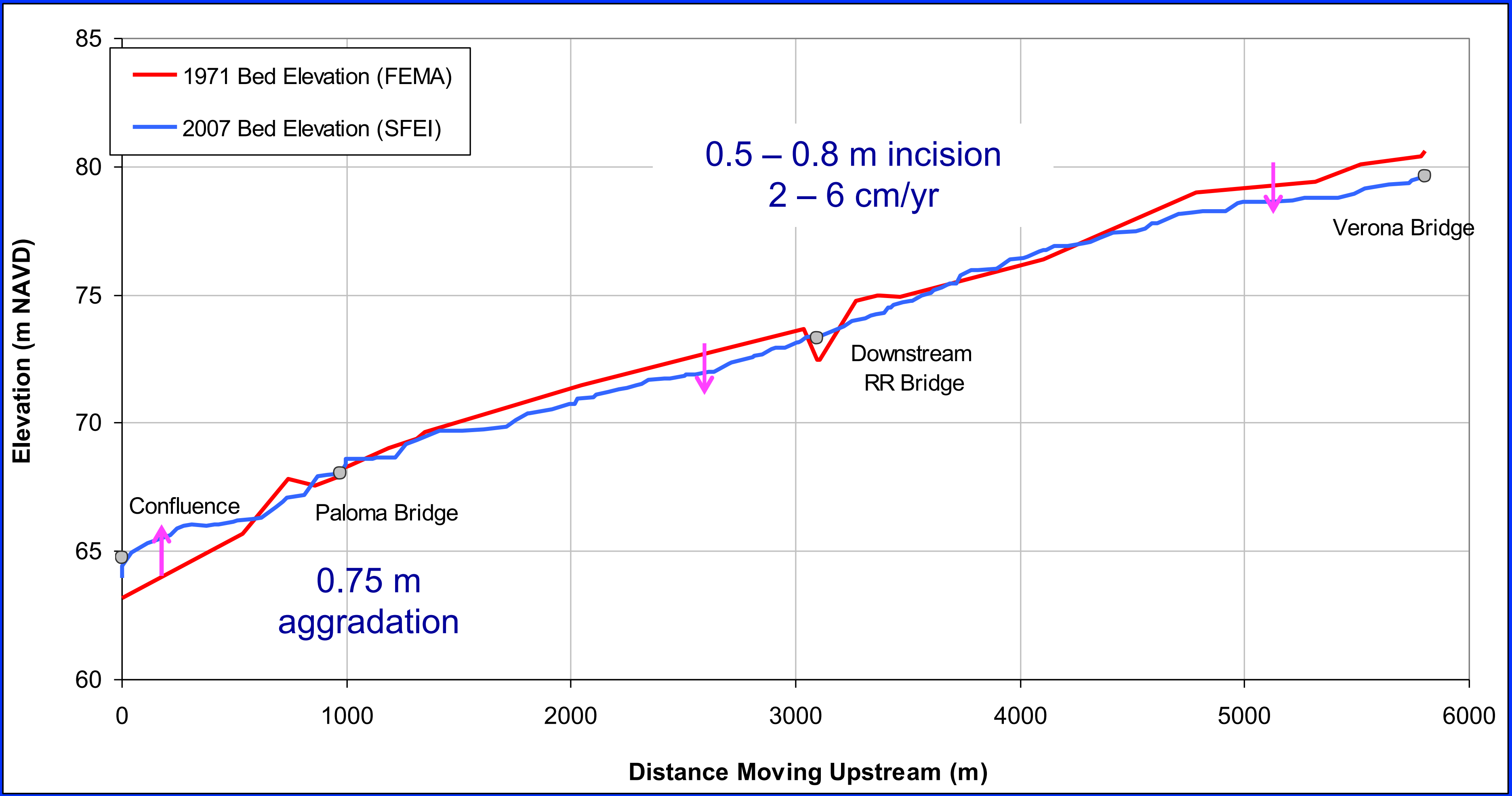
Arroyo De La Laguna
Bed Elevation
~1901 – 1959



1959 to 1971 Bed Elevation

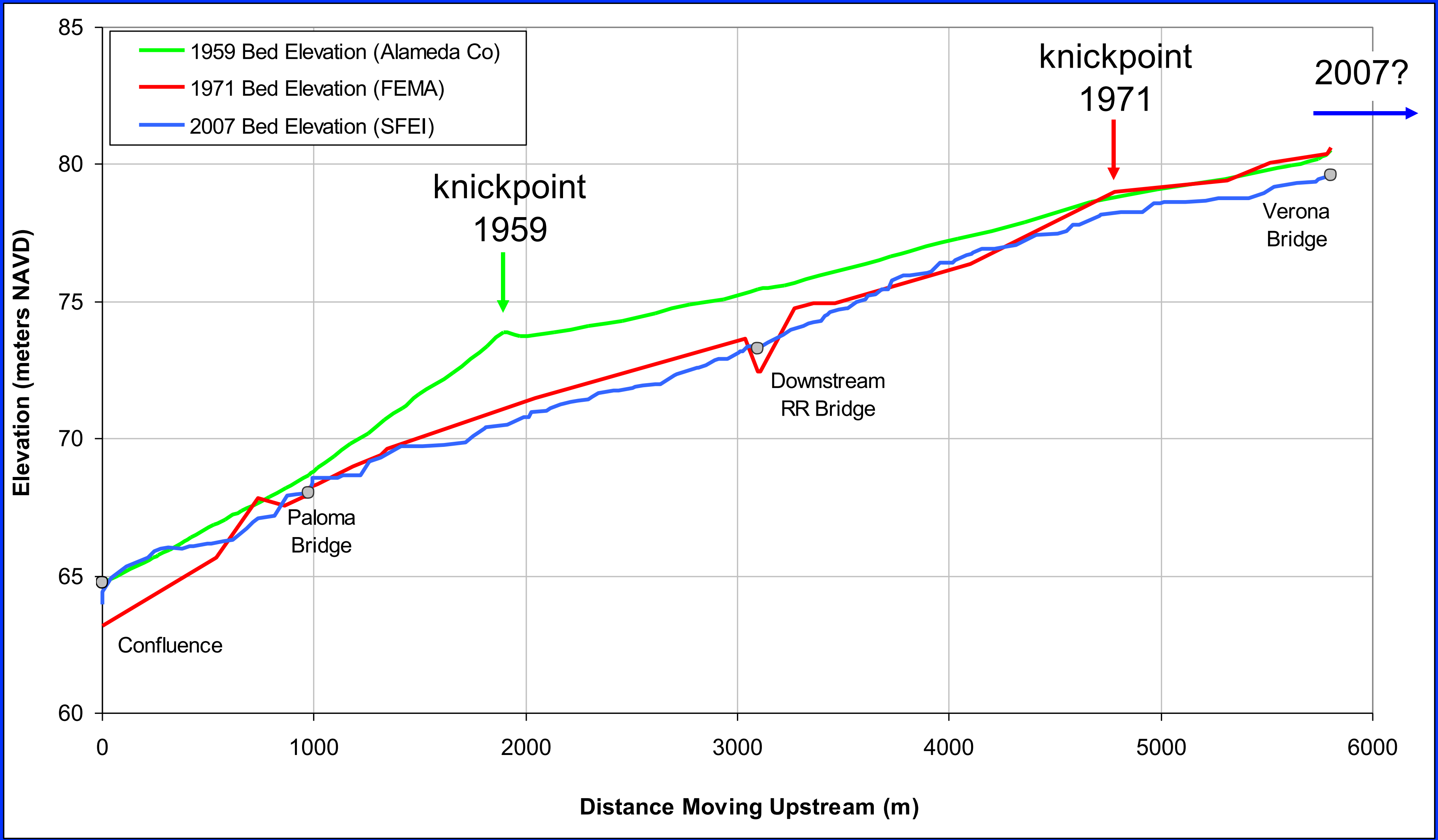


1971 – 2007 Bed Elevation

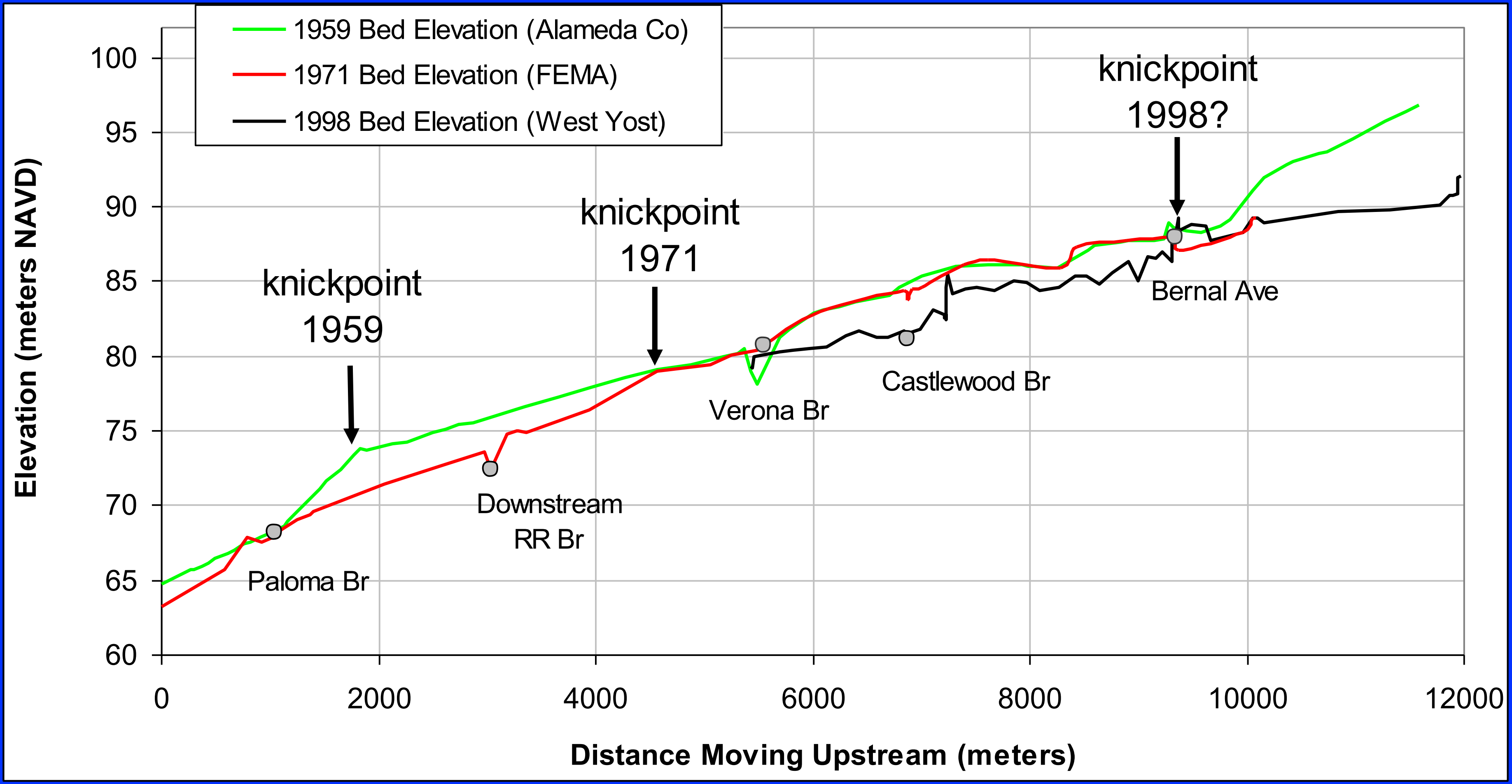


Incision Pattern Over Time

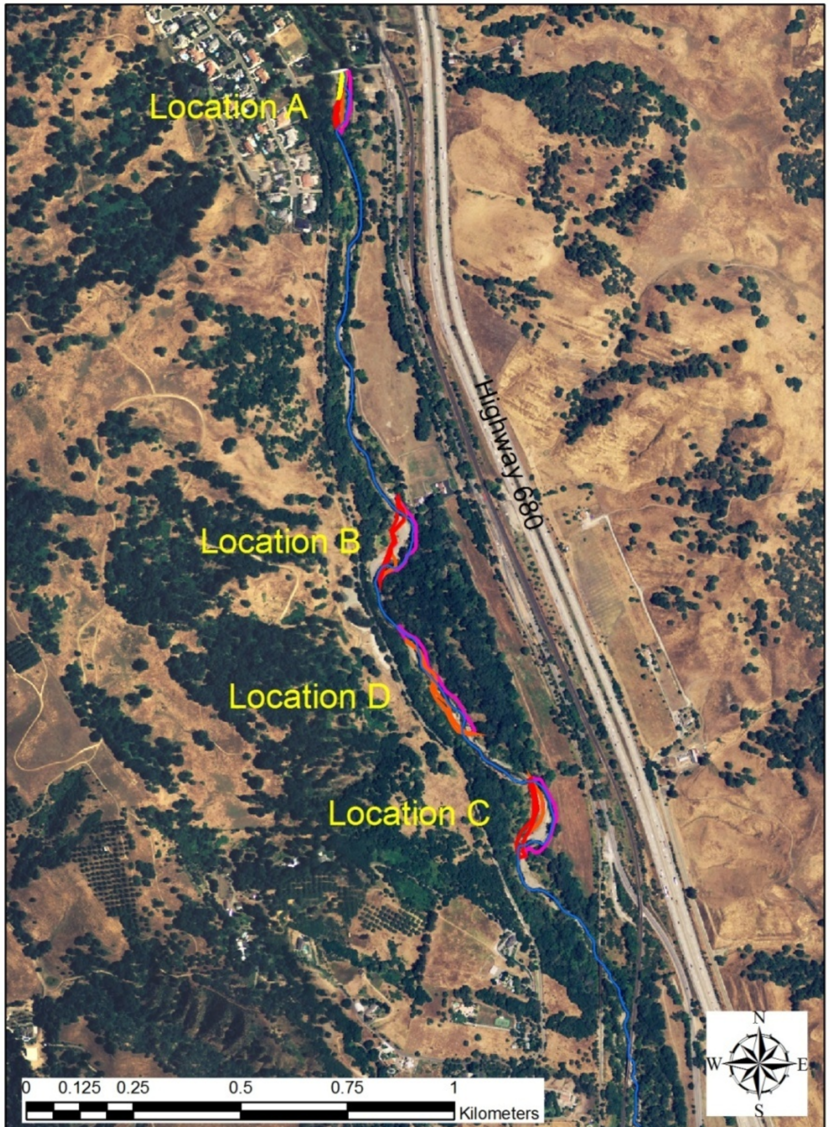
Incision Migrating Upstream



Further Upstream



Bank Erosion & Bar Storage Aerial Photograph Analysis



- Assessed entire study reach
- Focused on four locations
- Four time periods
- Quantified bank erosion and bar storage

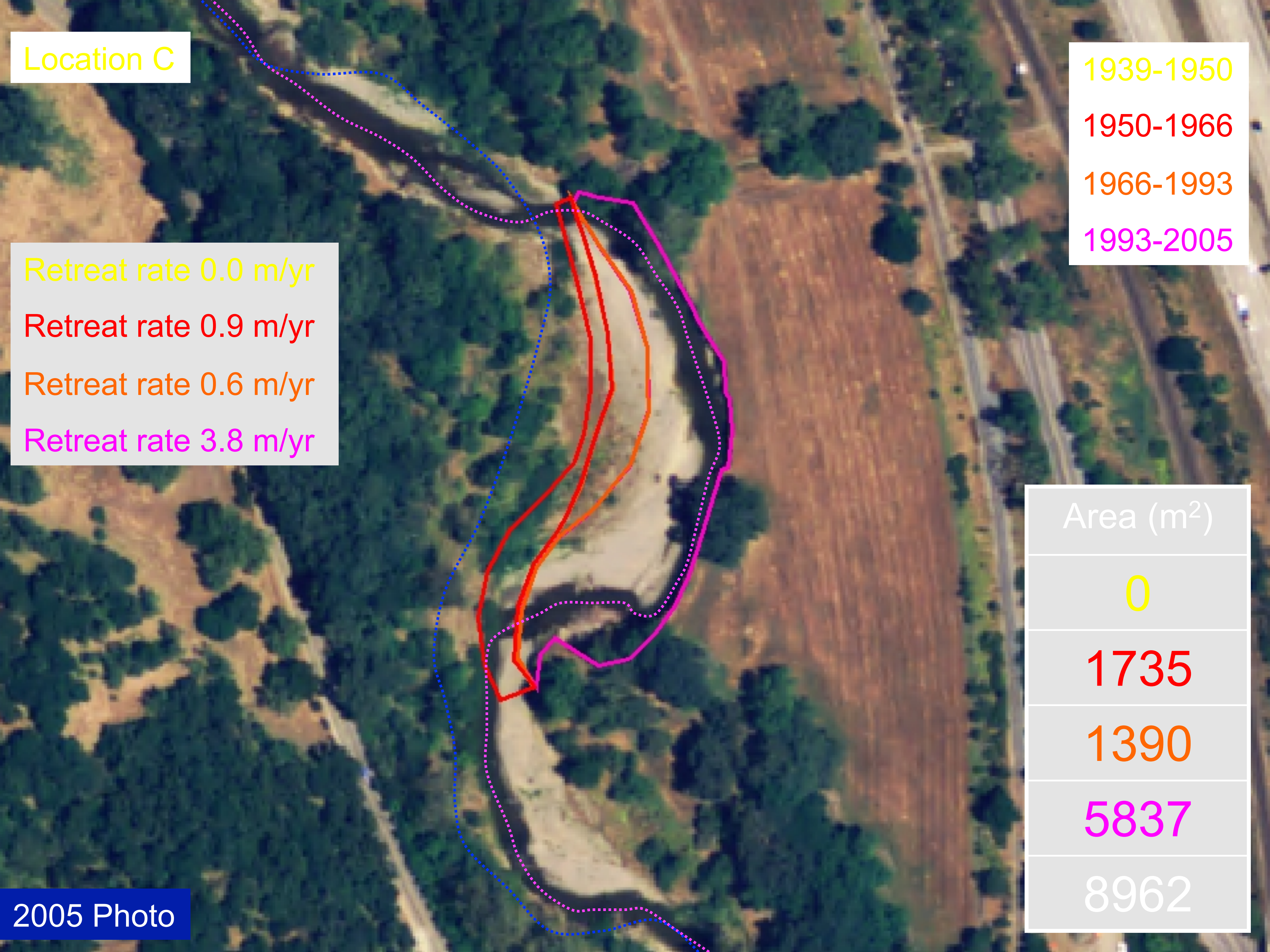

1939 Photo


1950 Photo


1966 Photo


1993 Photo


2005 Photo

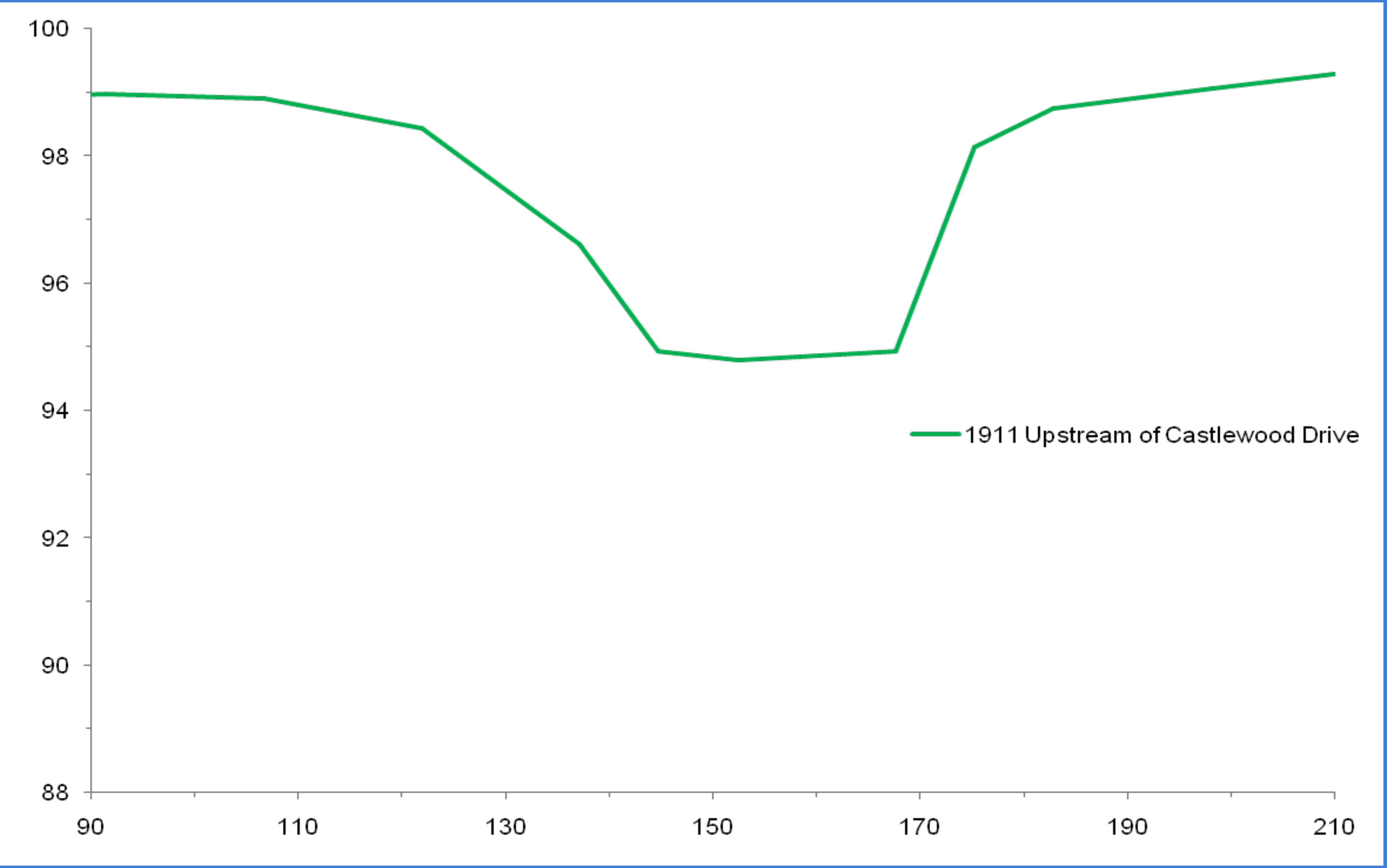


Location C
1939-1950
1950-1966
1966-1993
1993-2005
Retreat rate 0.0 m/yr
Retreat rate 0.9 m/yr
Retreat rate 0.6 m/yr
Retreat rate 3.8 m/yr
Area (m²)
0
1735
1390
5837
8962
2005 Photo

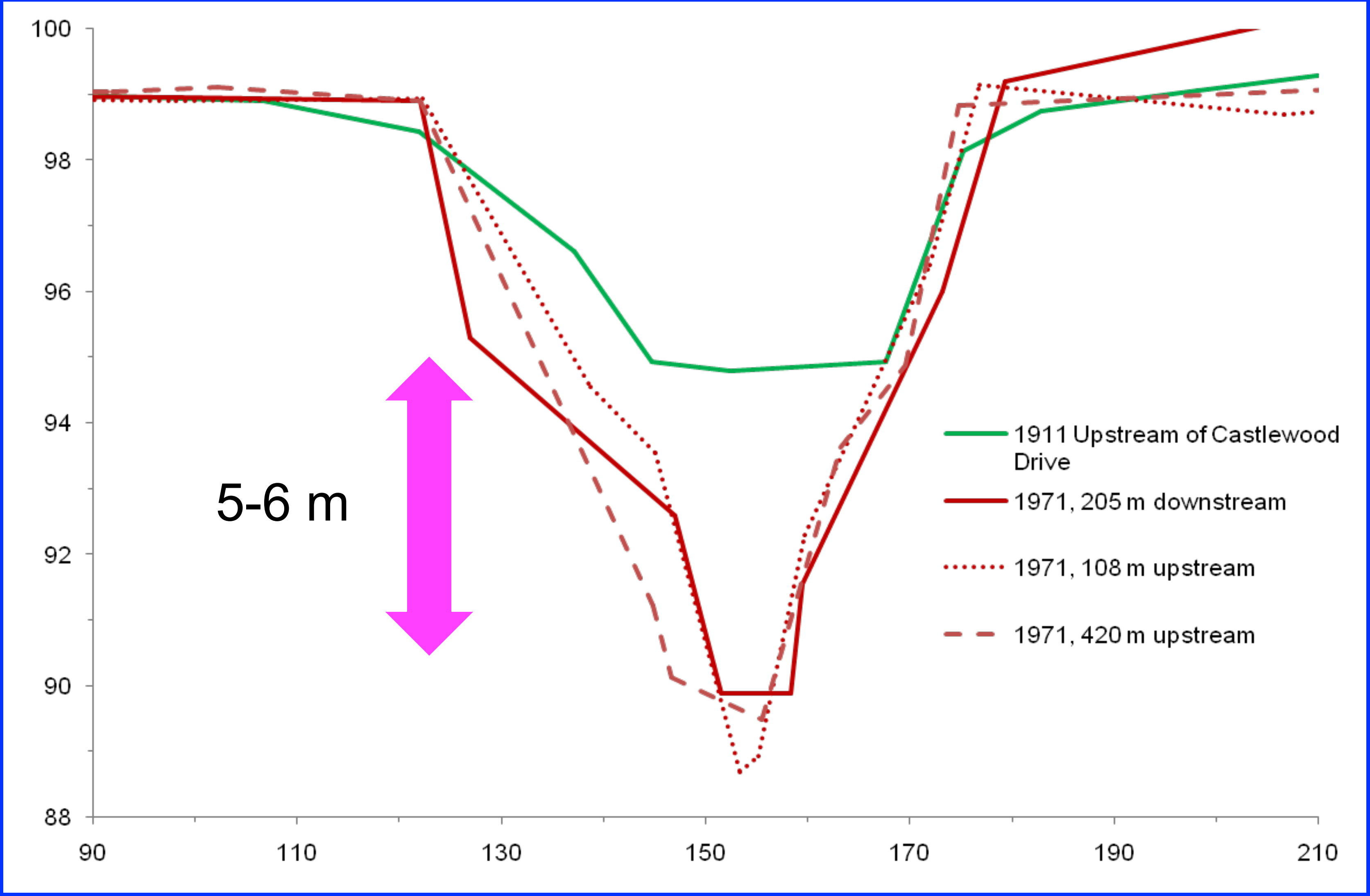
Bank erosion (metric tonnes)

	Erosion Location			
Time Period	A	B	C	D
1939-1950	1,300	0	0	0
1950-1966	5,100	9,900	13,300	0
1966-1993	11,200	8,000	10,700	7,800
1993-2005	22,600	38,200	44,800	21,000
Totals:	40,300	56,200	68,800	28,800

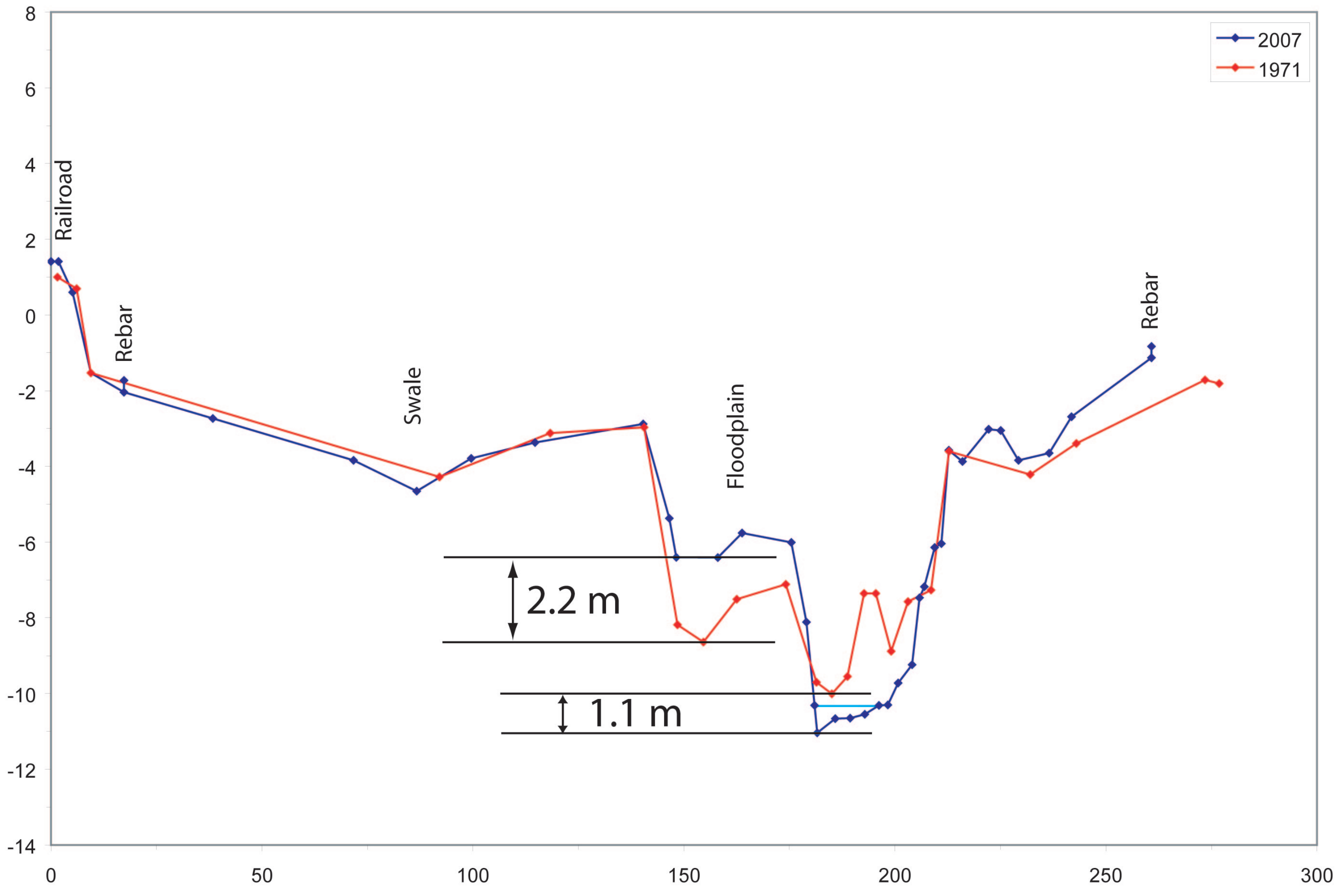
Channel Cross Sections



Channel Cross Sections

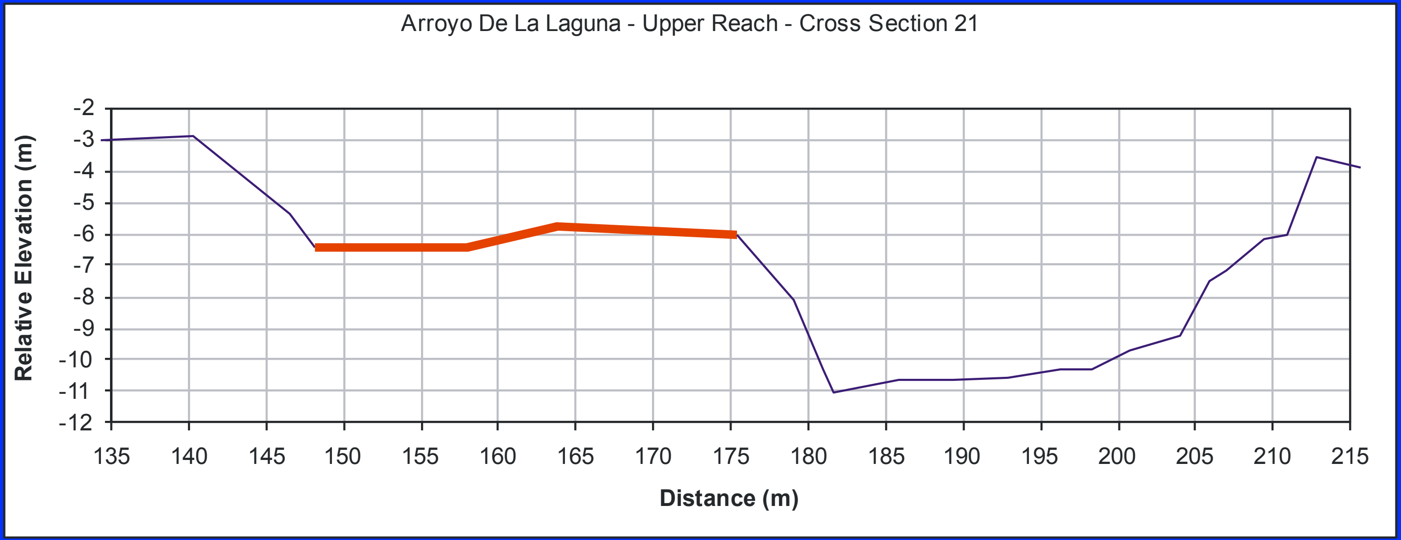



Cross Section 21

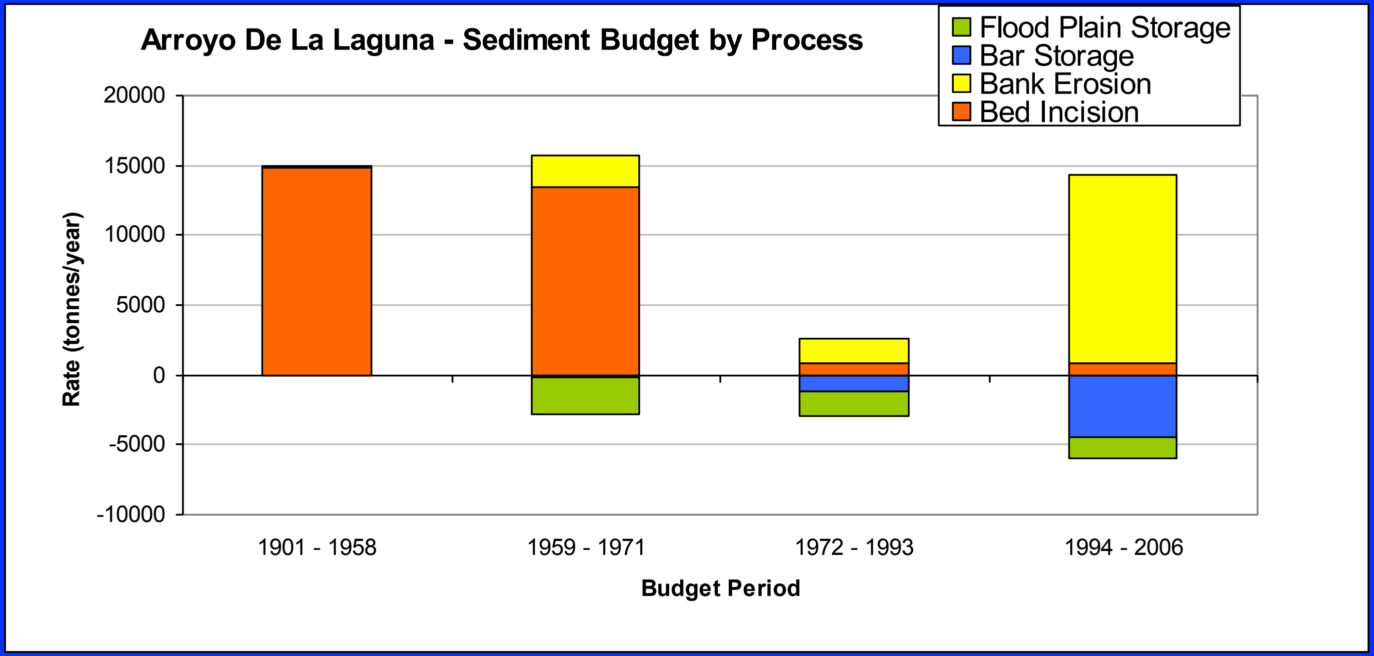

2007
1971
Railroad
Rebar
Swale
Floodplain
Rebar
2.2 m
1.1 m
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
0
50
100
150
200
250
300

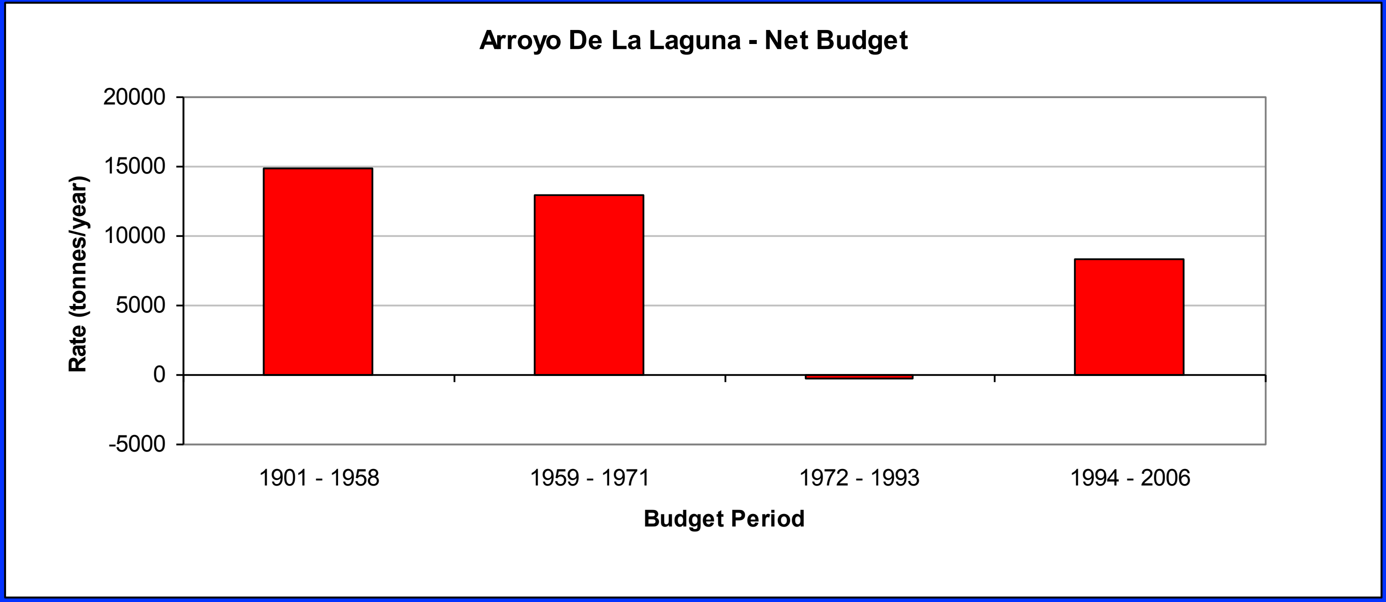

2007
Rebar
Historic ADLL channel
Valley terrace
Swale
Rebar
Railroad
2.5 m
4.5 m
92
88
84
80
76
72
68
-50
0
50
100
150
200
250
300

Flood Plain Storage

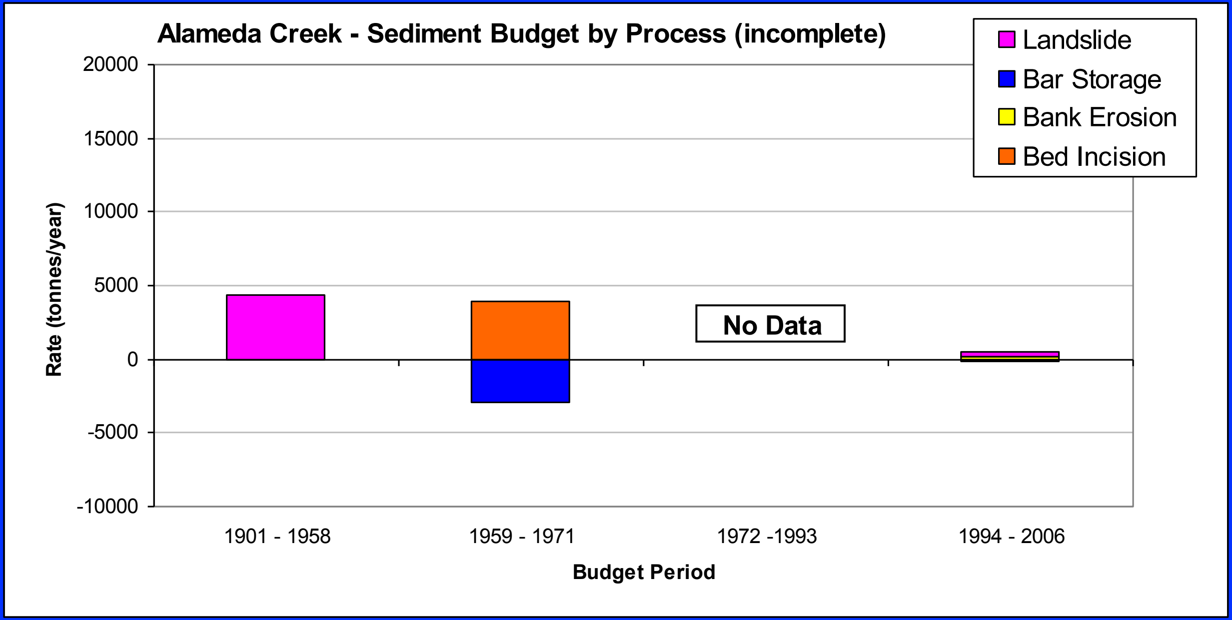


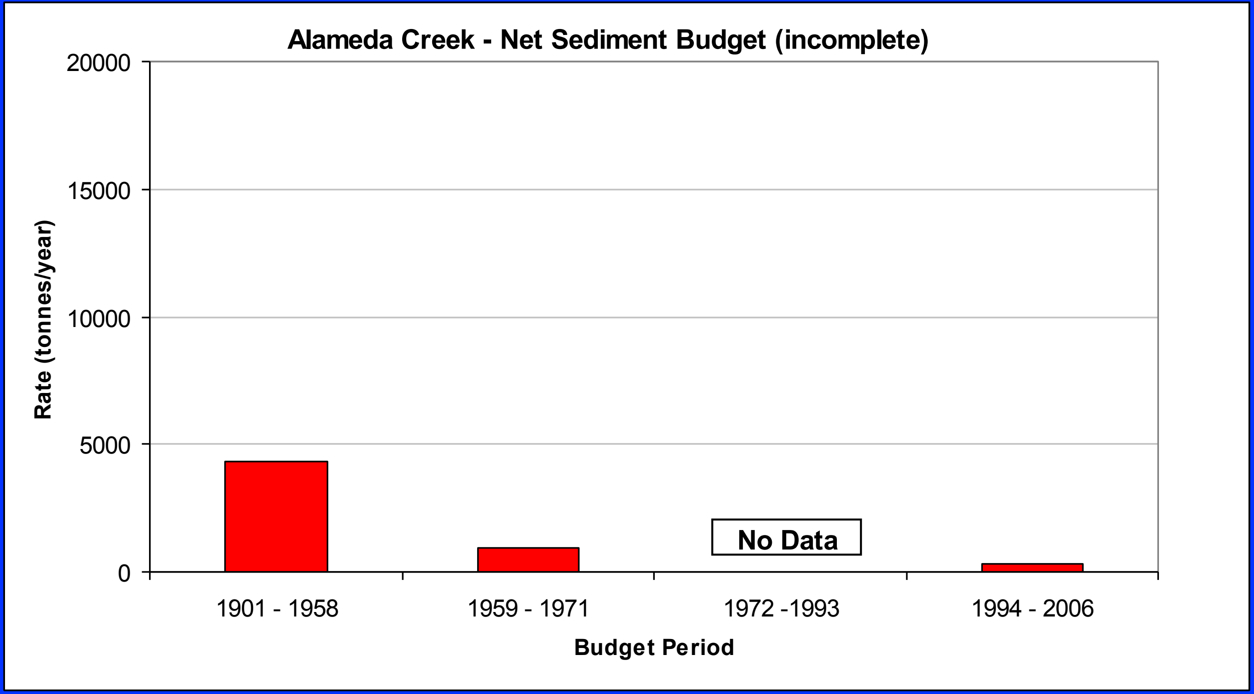
Sediment Budget by Process - ADLL





Alameda Creek Reach





Overall Watershed Comparison for Recent Period (1994 – 2006)

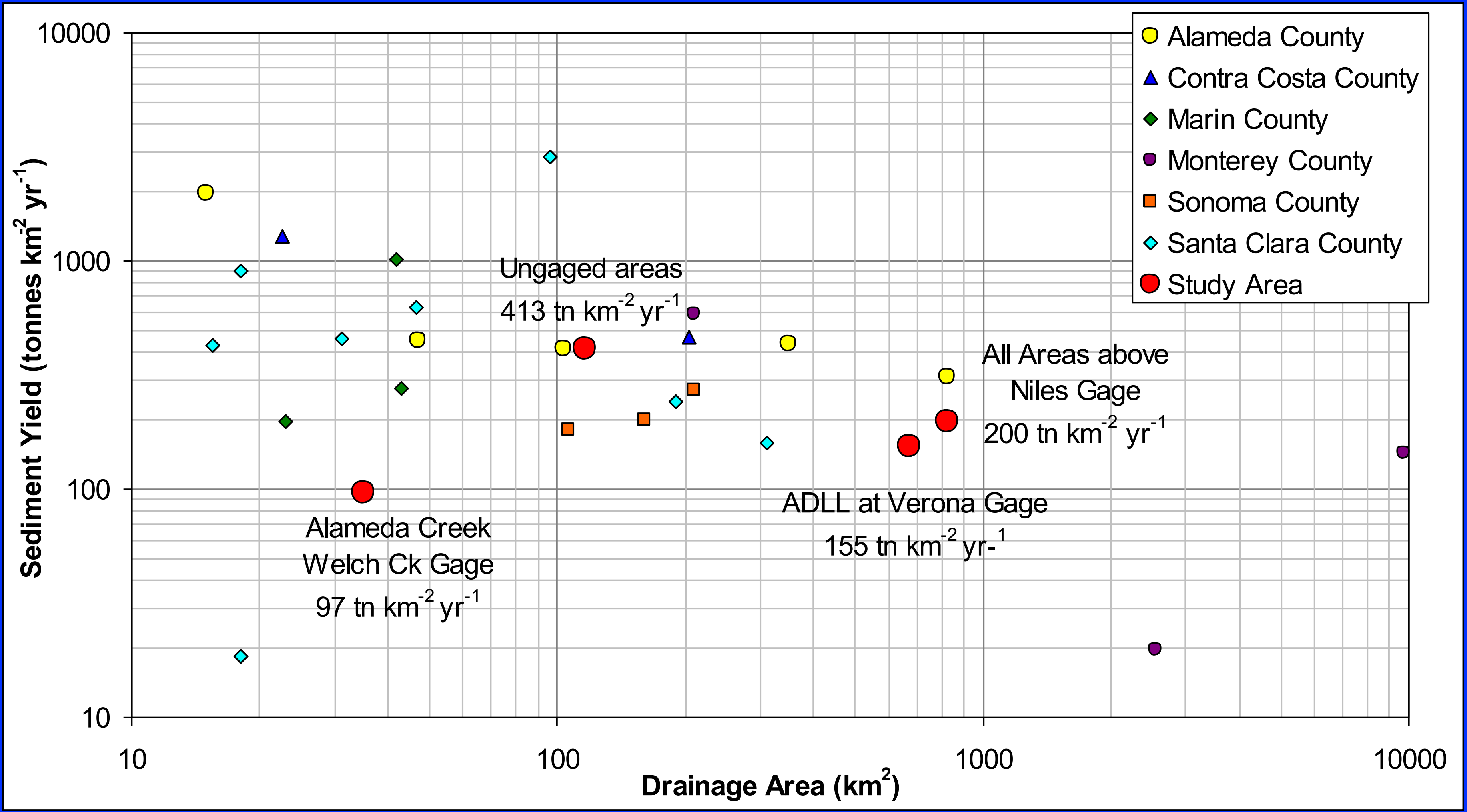
Area	Sediment Yield tonnes/year	% of Total
ADLL at Verona Gage	104,000	63
Alameda Creek near Welch Ck Gage	3,400	2
Arroyo de La Laguna Study Reach	8,400	5
Alameda Creek Study Reach	320	0.2
Ungaged areas	47,908	29
All Areas above Niles Gage	164,000	
Alameda Creek at Niles Gage	156,000	

Within 5%

Study Reaches
Comparison to Niles Gage

Time Period	Niles Gage (tonnes/yr)	Study Reaches Combined (tonnes/yr)	% of Niles
1959-1971	74,000	19,300	26
1972-1993	90,000	320	0.4
1994-2006	156,000	8,700	6

Study Area Sediment Yield Comparison to Regional Values



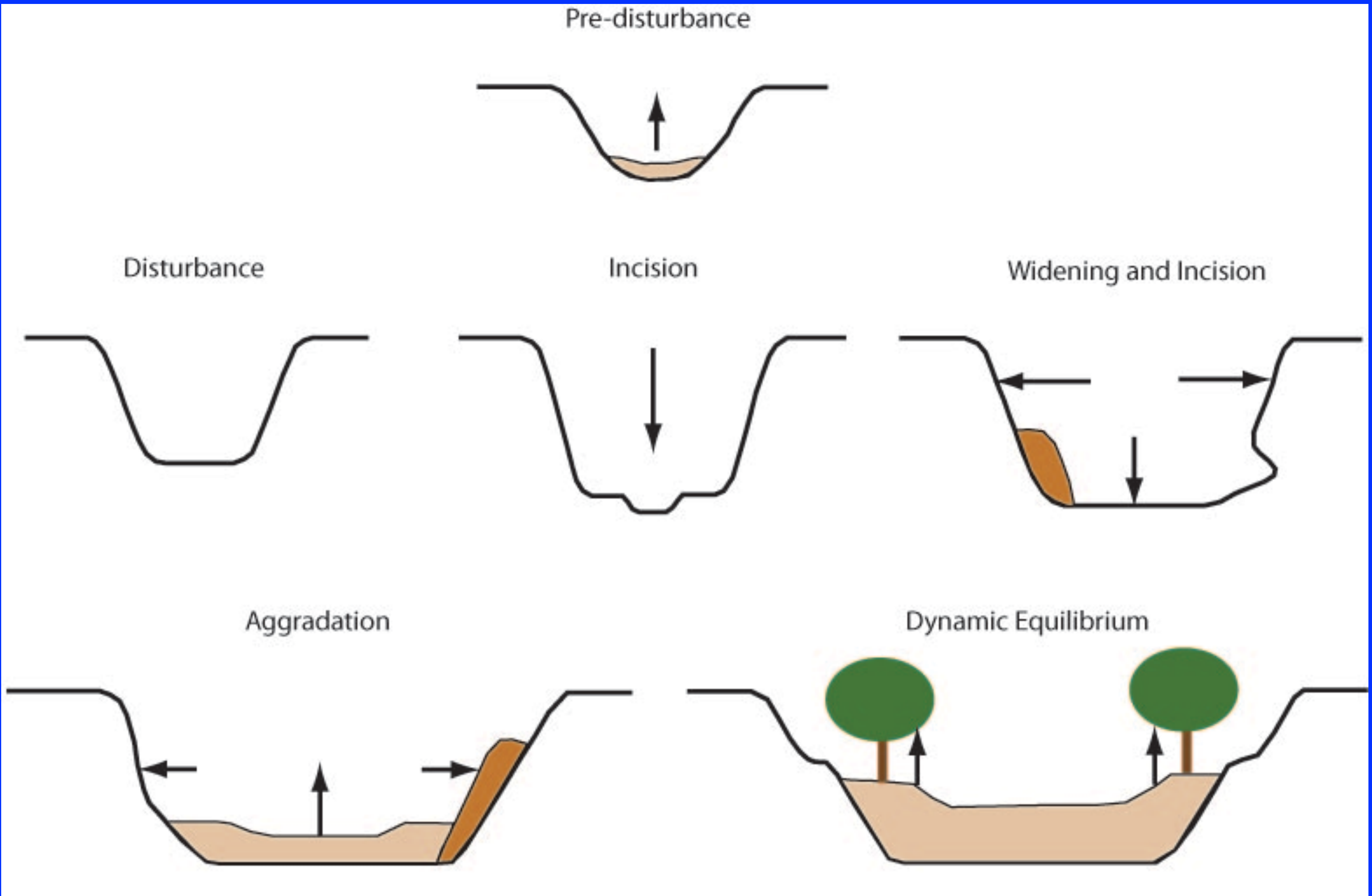
Sediment Budget

Take Home Points

- Sediment budget has adjusted over several periods of land use alteration and disturbance from floods
- Budget dominated by incision in earlier periods, now adjusting through bank erosion
- ADLL sediment yield is high for a short reach (0.25% of total stream network length)
- But comprises a small portion of watershed yield (6% of total yield)

Future Channel Evolution

- Channel Evolution Models
  - Process-based classification
  - Describe channel form as it responds to a disturbance
  - Typical channel adjustments to return a balance of sediment transport capacity
  - Six stages



Modified from Doyle and Shields (2000)

Arroyo De La Laguna
Idealized Hypothetical Channel Evolution

Pre-disturbance Channel
Prior to 1900

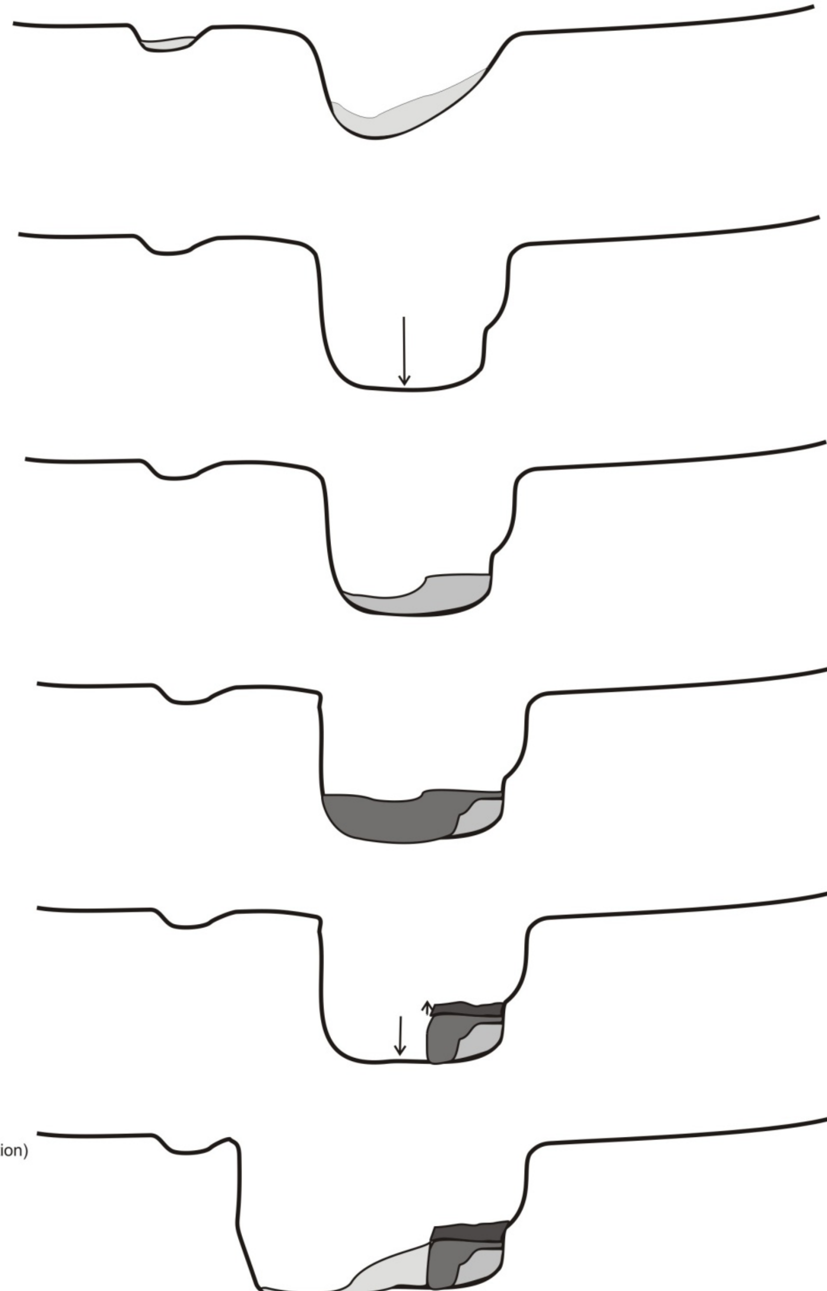
Channel Incision
1900 to1920s(?)

Channel Recovery?
1920s(?) to 1940s

Aggradation
1950s Floods

Incision
(and Flood Plain Accretion)
1959 - 1980s

Widening
(with Bar Deposition and Flood Plain Accretion)
1990s - Present (2007)



Future Response of ADLL

Conceptual Scenarios:

Scenario A (Incision): increased peak discharge, decreased sediment load

- ~ 50% increase in sediment supplied from reach

Scenario B (Aggradation): decreased peak discharge, increased sediment load

- ~ 200% decrease in sediment supplied from reach

Future Response of ADLL

Conceptual Scenarios:

Scenario C (Most Probable): slightly increased peak discharge, upstream channel recovery, changing coarse/fine sediment ratio, increased large woody debris, channel widening

- <10 % increase in sediment supplied from reach

Result:

- Continuing current evolution, increased in-channel sediment storage, continued function as a sediment transport reach

Next Steps - Recommendations

- Conduct upstream sediment budgets to understand sources and dominant processes
- Focus on identifying potentially controllable sources or areas for storage
- This would enable better estimates of sediment routing through the network if desired
- Massive volume eroded from ADLL over the past century represents potential storage area through restoration (?)
- Monitor channel adjustment over time in ADLL