



Woodson Bridge SRA

Fluvial Geomorphology

Explore Issues
Define Processes
Develop Framework
Find Solution

0 750 1,500 3,000 Feet



RIVER CLASSIFICATION

- MOSTLY ALLUVIAL
- GEOLOGIC CONTROL IN PLACES
- MEANDERING AND ANABRANCHING
- CHARACTERISTIC REACHES



RIVER CLASSIFICATION, cont.

- ROSGEN C3, LOW GRADIENT,
MEANDERING GRAVEL-BED CHANNEL



RIVER CLASSIFICATION, cont.

- **SLIGHTLY CONFINED-** low gradient channel with erodible streambanks and low amount of stream power to transport sediments. Deposition is the driving force for lateral migration. The river moves across its relatively wide floodplain, eroding the banks on one side and depositing sediment on the other.
- **LOW TO MODERATE SINUOSITY-** measured by dividing the length of the river and dividing by the length of the valley



RIVER REACHES



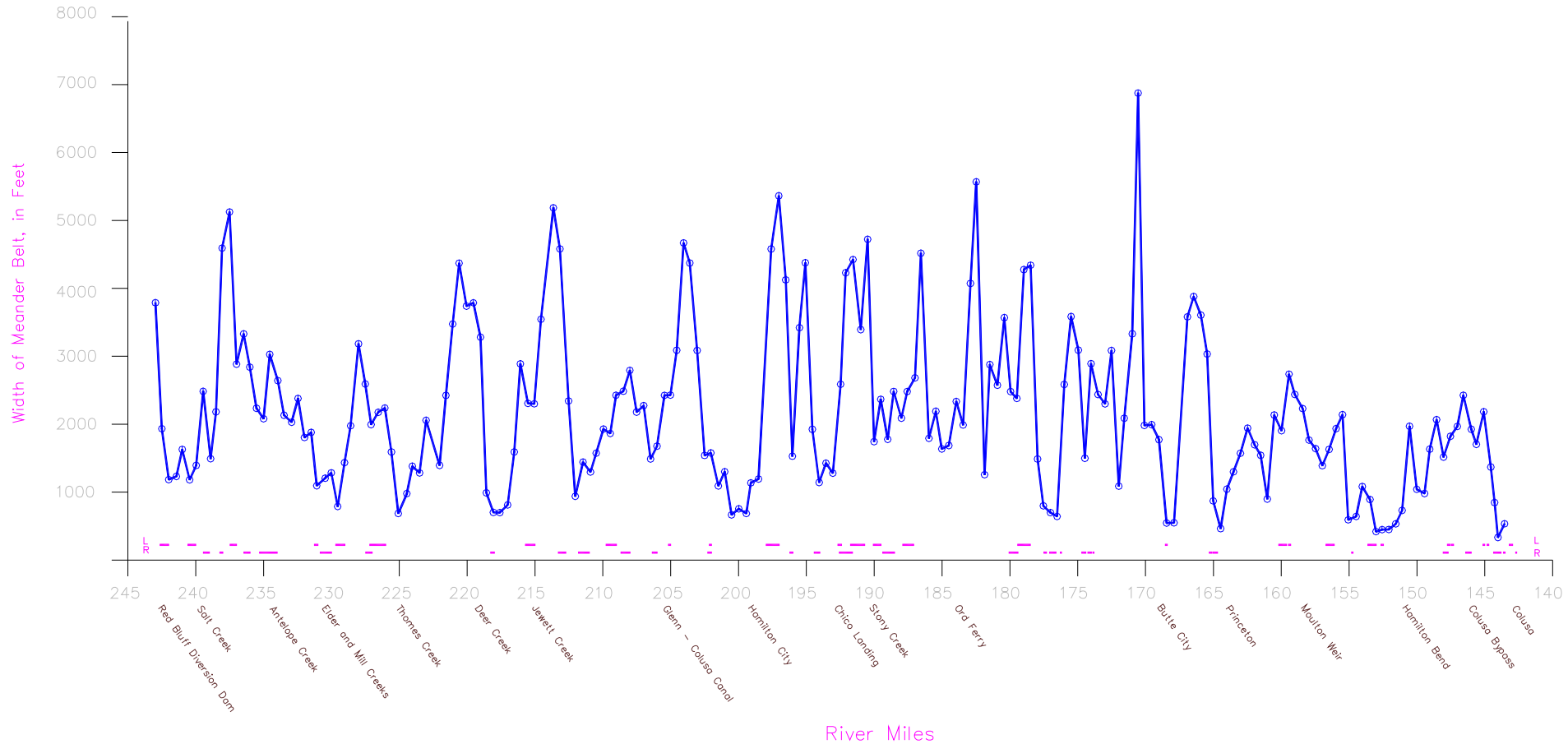


RIVER REACHES

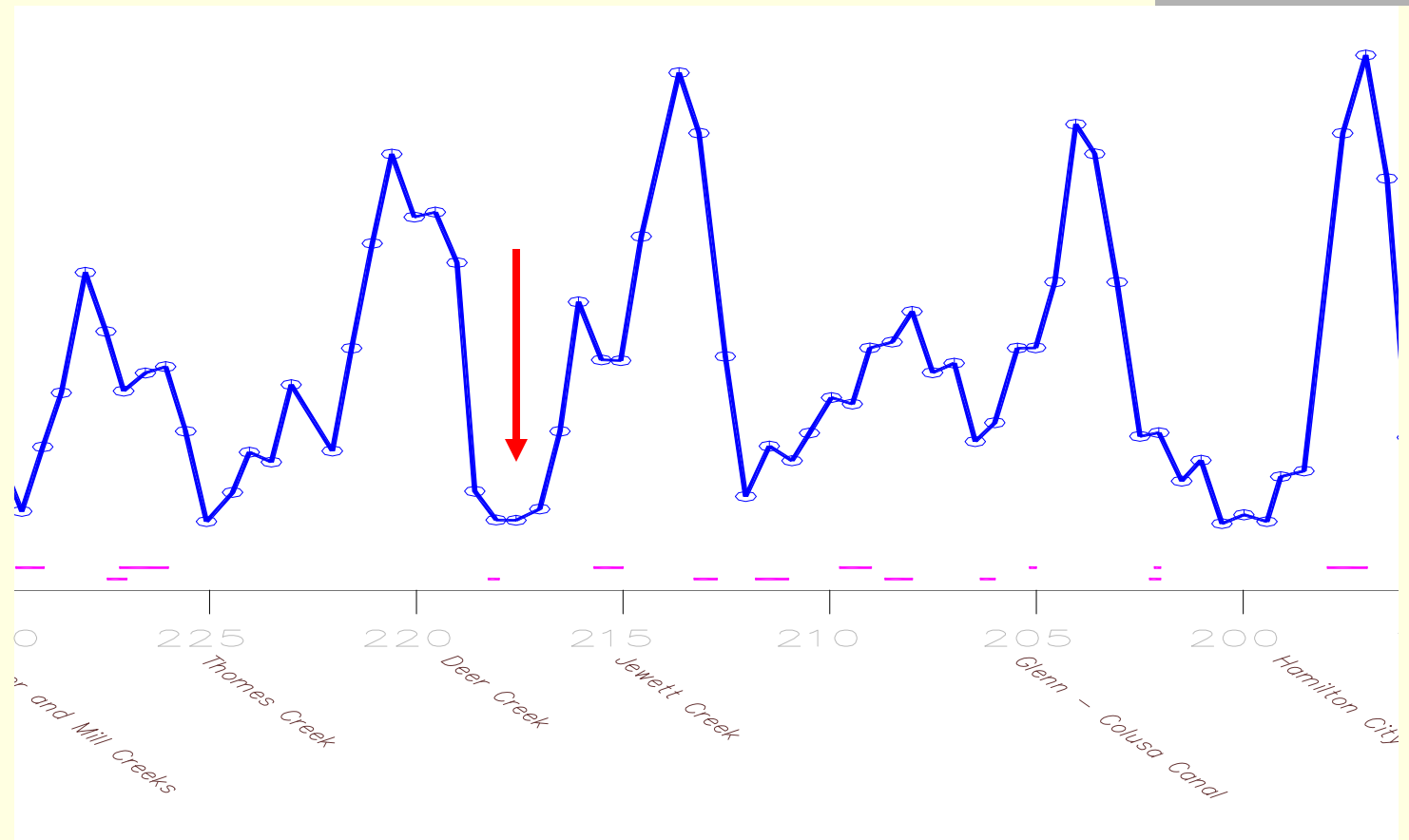
- REACHES 1 TO 5 – REDDING TO RED BLUFF
- REACH 6 – RED BLUFF TO CHICO LANDING, 6A TO 6H
- REACH 7 – CHICO LANDING TO BUTTE CITY, 7A TO 7C
- REACH 8- BUTTE CITY TO COLUSA, 8A TO 8C



100-YEAR MEANDER BELT WIDTH



Woodson Bridge

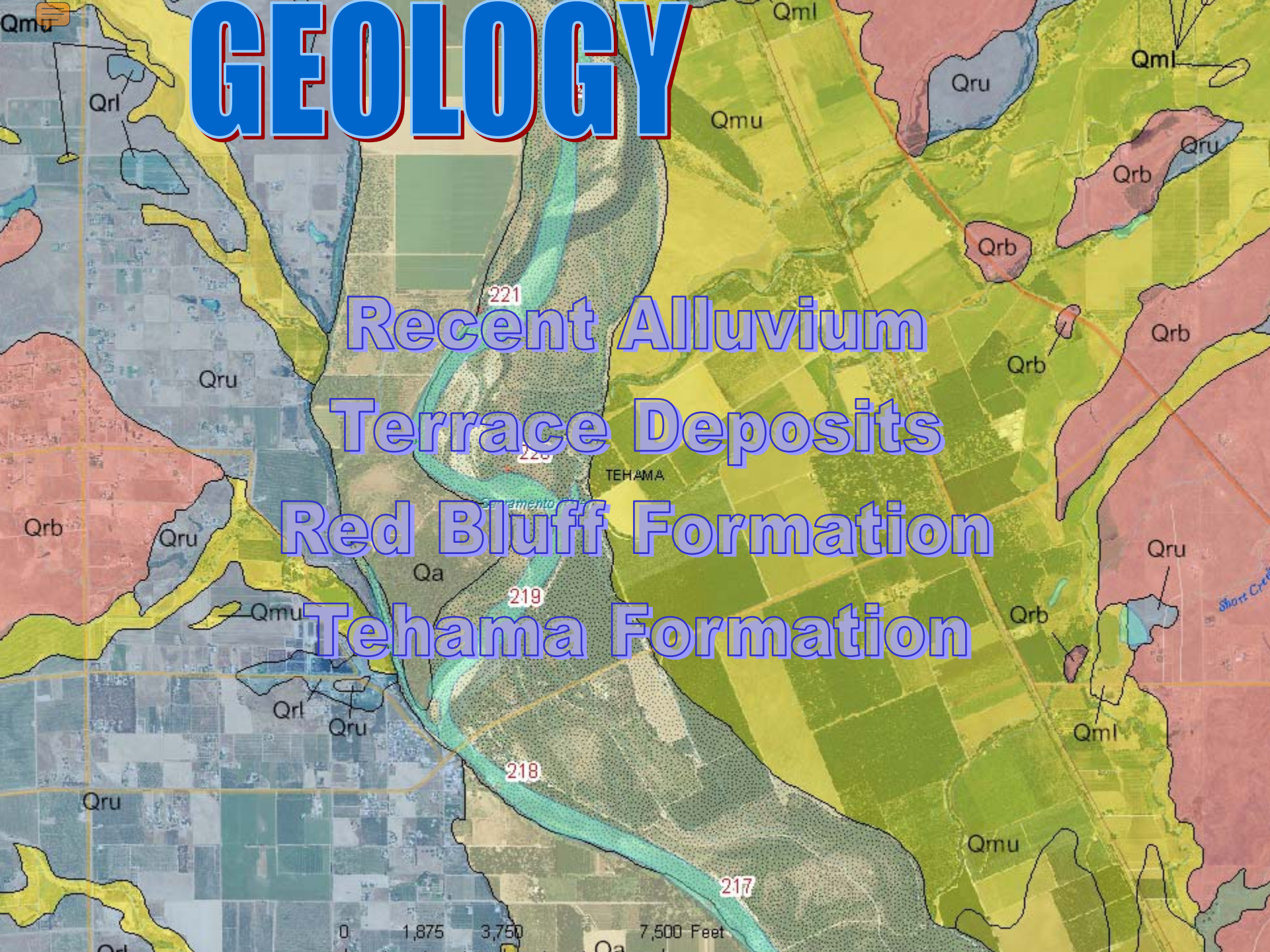


REACH 6D AND 6E

- 6D IS SINUOUS WITH HIGH BANK EROSION AND .00054 GRADIENT
- 6E IS STRAIGHT WITH LOW BANK EROSION, .00030 GRADIENT AND GEOLOGIC CONTROL
- 6F IS SINUOUS WITH HIGH BANK EROSION AND .00054 GRADIENT

GEOLOGY

Recent Alluvium
Terrace Deposits
Red Bluff Formation
Tehama Formation



TEHAMA FORMATION

- 1 TO 3.6 MILLION YEARS OLD
- FLUVIAL DEPOSITS VARYING IN THICKNESS UP TO OVER 1,000 FT
- YELLOW TAN TO LIGHT GREEN
- UNDERLIES ENTIRE VALLEY
- COMPACTED CLAYEY DEPOSIT IS GEOLOGIC CONTROL

RED BLUFF FORMATION

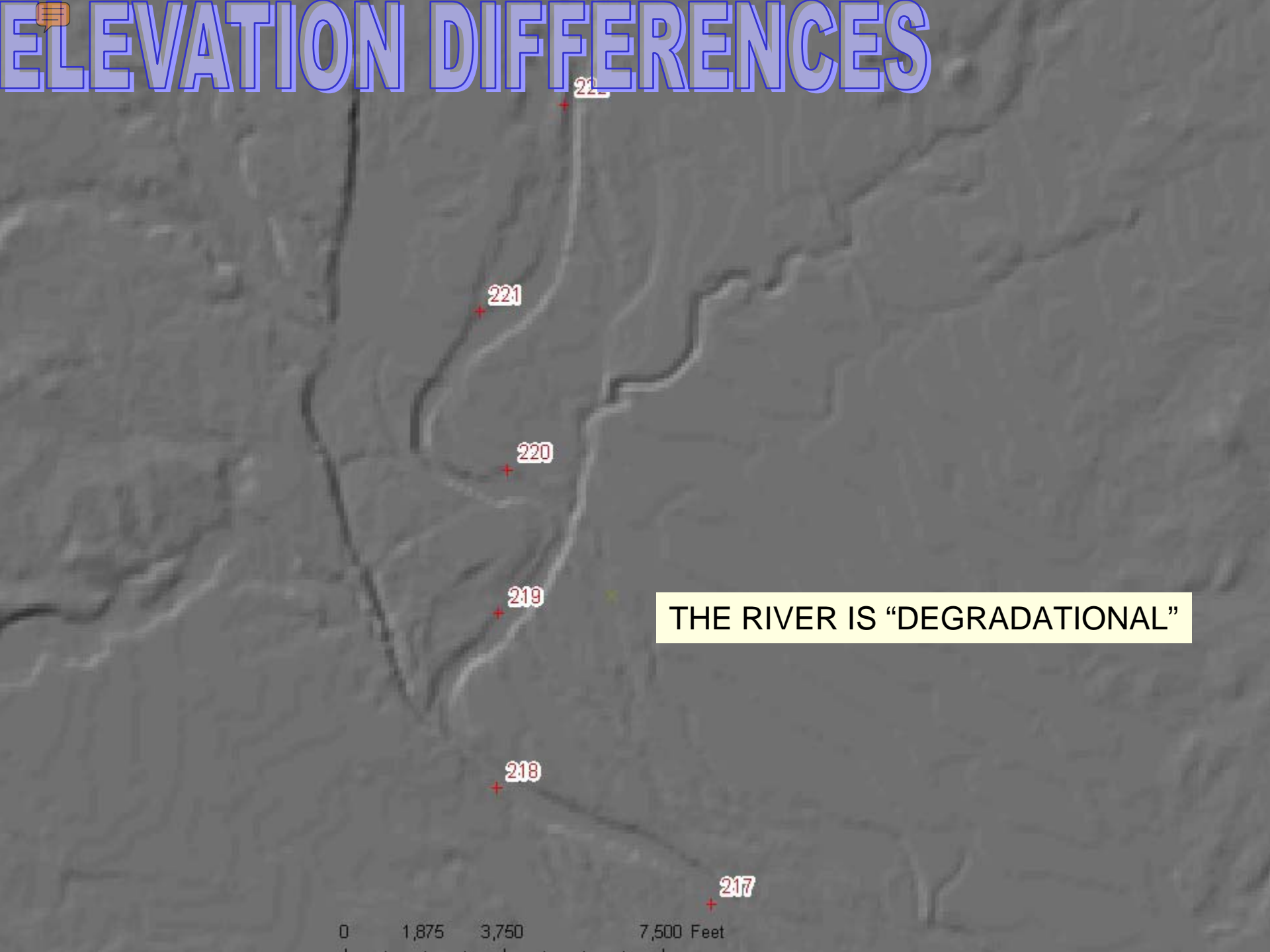
- BRICK RED CLAYEY GRAVEL
- 0.5 TO 1.0 MILLION YEARS OLD
- PEDIMENT FORMED FROM GLACIAL
OUTWASH
- NEXT OLDEST UNIT IN THE AREA

TERRACE DEPOSITS

Modesto- upper and lower
Riverbank- upper and lower



ELEVATION DIFFERENCES



THE RIVER IS “DEGRADATIONAL”

0 1,875 3,750 7,500 Feet

RIVERBANK AND TEHAMA

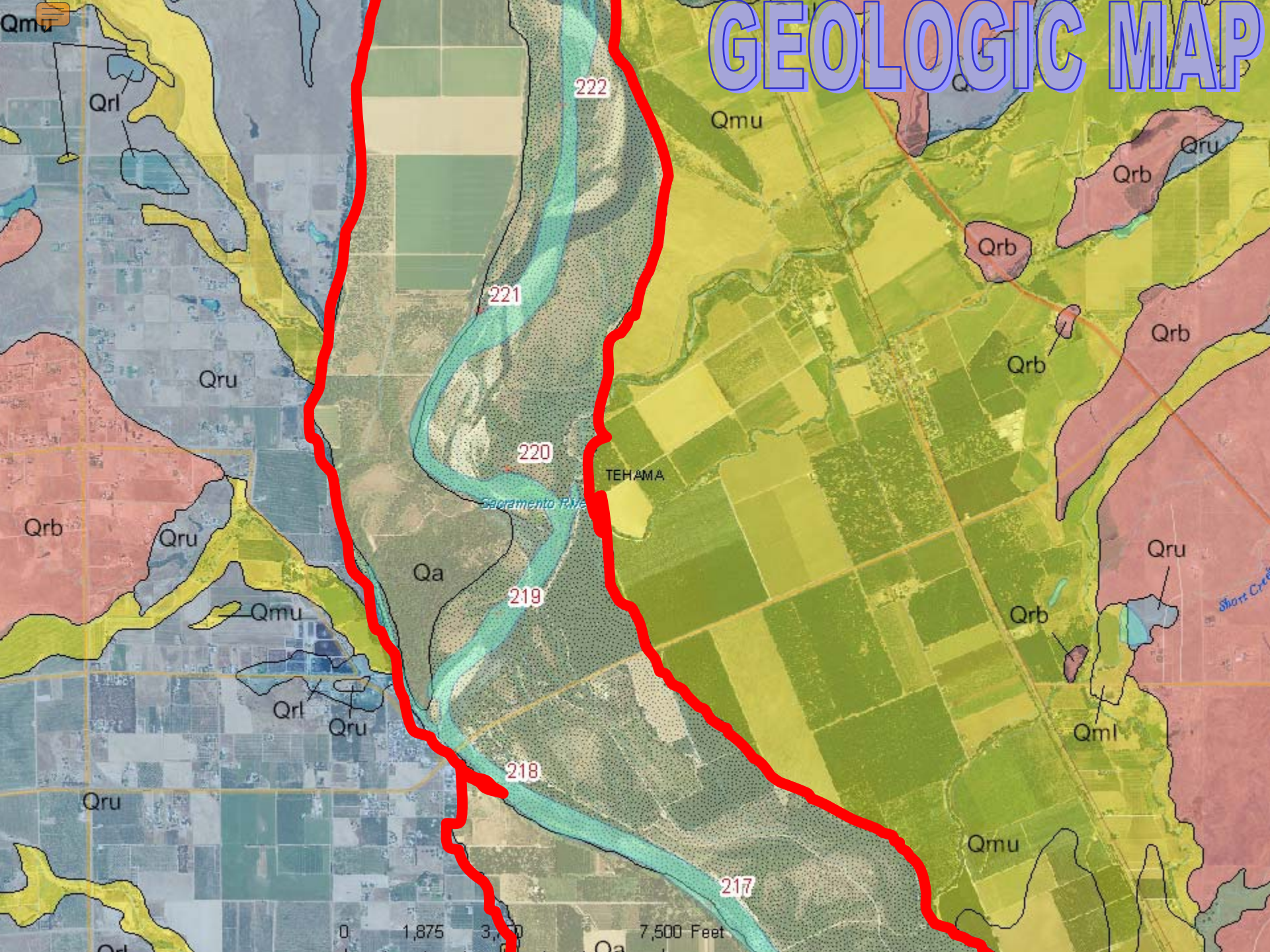




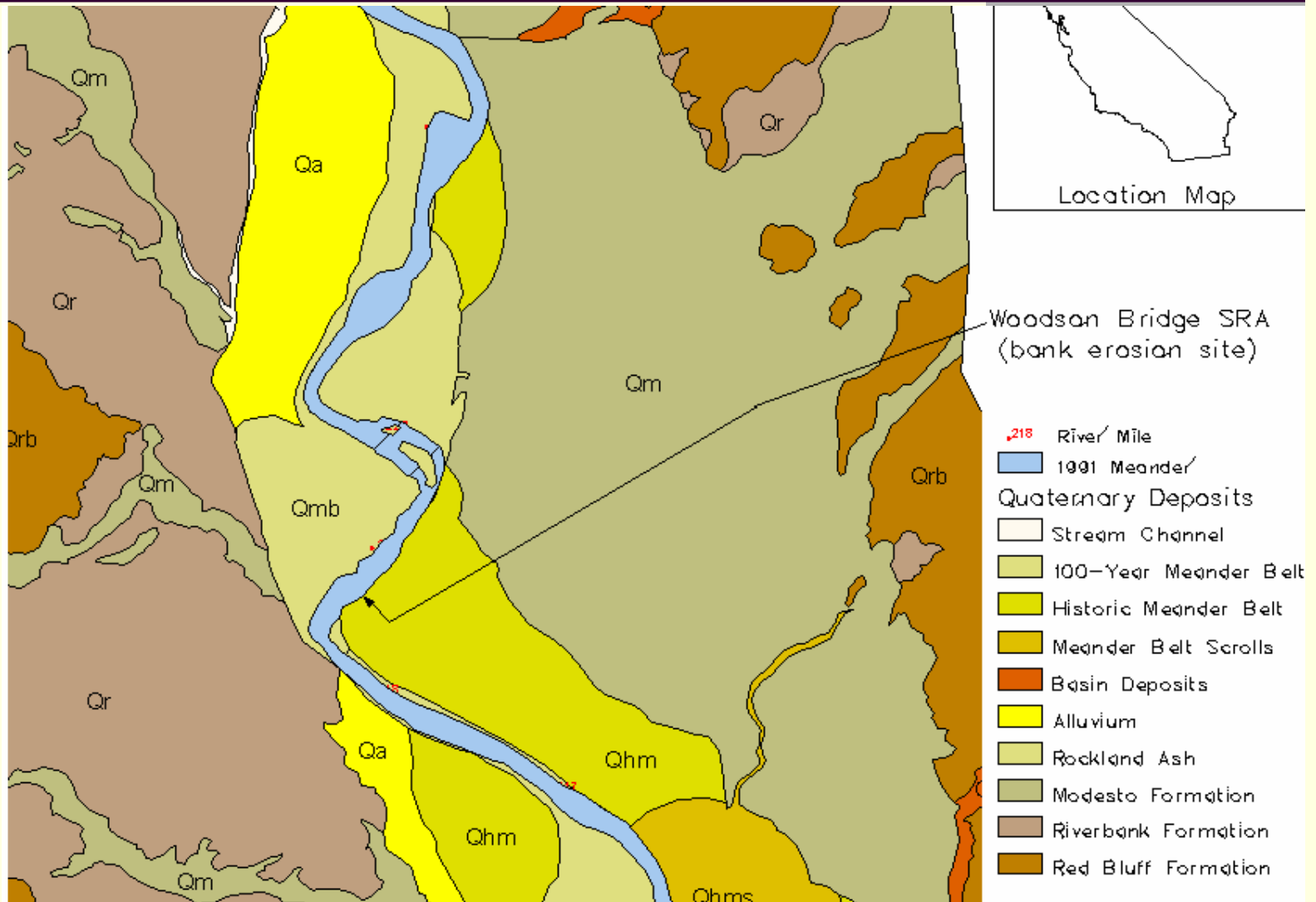
“GEOLOGIC CONTROL”

- OLDER, EROSION RESISTANT UNITS
- GENERALLY UNDERLAIN BY THE TEHAMA FORMATION
- VERY LOW BANK EROSION RATES

GEOLOGIC MAP



HISTORIC AND 100-YEAR MEANDER BELTS





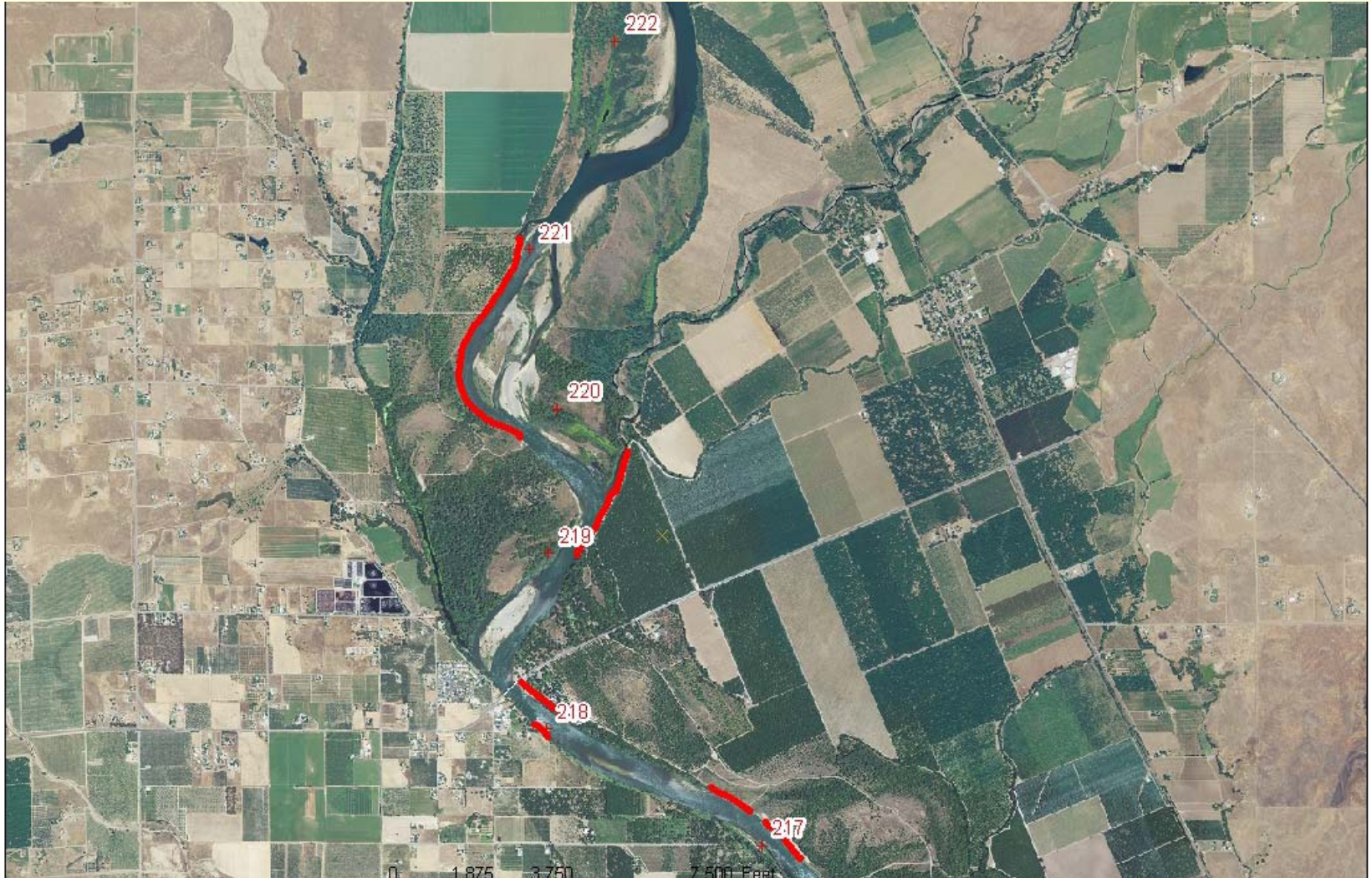
BANK MATERIAL

- GEOLOGIC CONTROL AND RIPRAP
- CLAY AND SILT- OXBOW LAKE DEPOSIT
- SILT AND SAND- FLOODPLAIN DEPOSIT
- SAND AND GRAVEL- POINT BAR DEPOSIT

GEOLOGIC CONTROL AND BANK PROTECTION

- SLOWS OR STOPS BANK EROSION AND MEANDERING
- ERODES CHANNEL THALWEG
- DEPOSITION ON FAR SIDE
- CHANNEL NARROWS
- BED MATERIAL BECOMES COARSER

BANK PROTECTION INSTALLED IN 1963



CLAY AND SILT BANKS

- BANK EROSION RATES LOW
- “COHESION”
- OXBOW LAKE DEPOSITS OR “CLAY PLUGS”
- MORE CLAY MEANS LESS EROSION
- MORE SILT MEANS MORE EROSION

CLAY PLUG



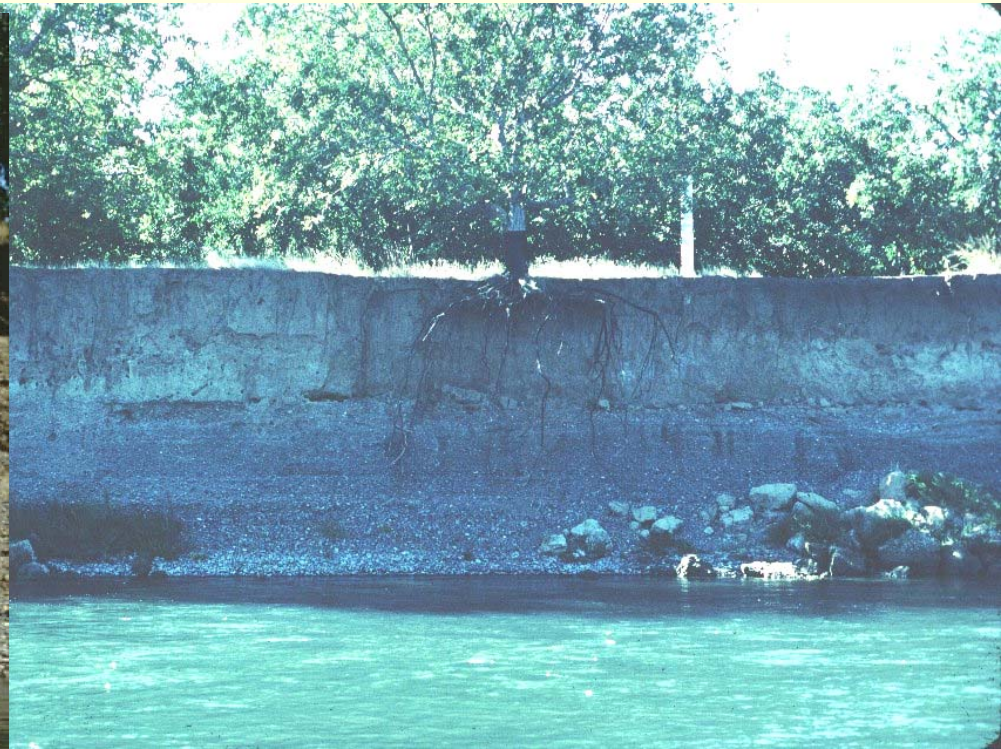
SILT AND SAND BANKS

- BANK EROSION RATES HIGH
- NO COHESION
- FLOODPLAIN DEPOSITS
- LOW STRENGTH WHEN WET
- SUBJECT TO COLLAPSE DURING RAPID DRAWDOWN

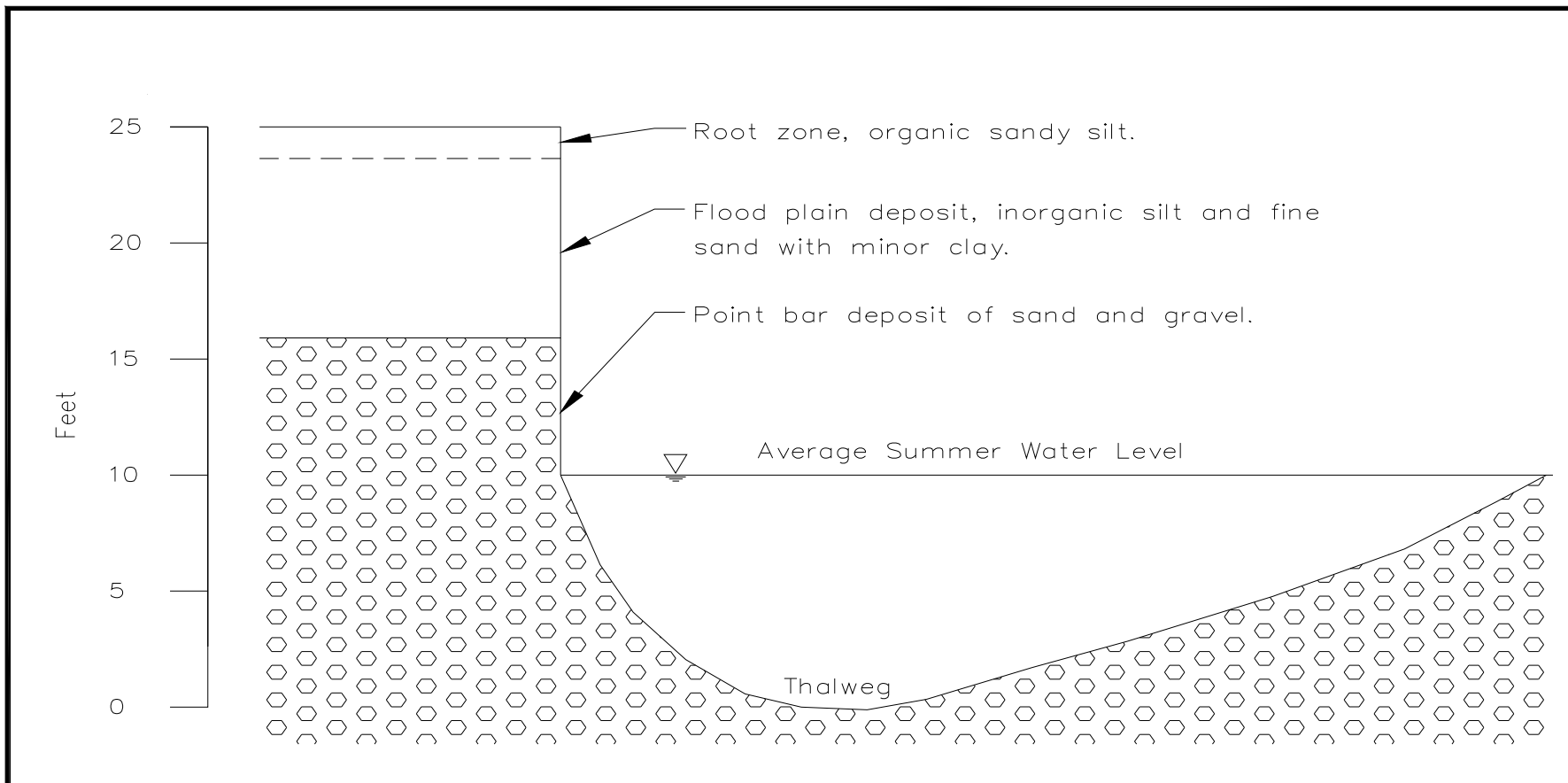
SAND AND GRAVEL BANKS

- MODERATE TO HIGH EROSION RATES DEPENDING ON SAND CONTENT
- LAYERS OF SAND CAUSE RAPID EROSION THROUGH BANK COLLAPSE
- GRAVEL BANKS ONLY ERODE AT MODERATE TO HIGH FLOWS

GRAVEL BANKS



“AVERAGE” BANK IS A COMPOSITE



Sacramento River
Bank Erosion Investigation

Average Eroding Bank Cross-Section Red Bluff to Ord Ferry



RADIUS OF CURVATURE

- LARGER RADIUS OF CURVATURE-
SLOWER BANK EROSION
- SMALLER RADIUS OF CURVATURE-
FASTER BANK EROSION
- CAUSED BY ANGLE OF INCIDENCE



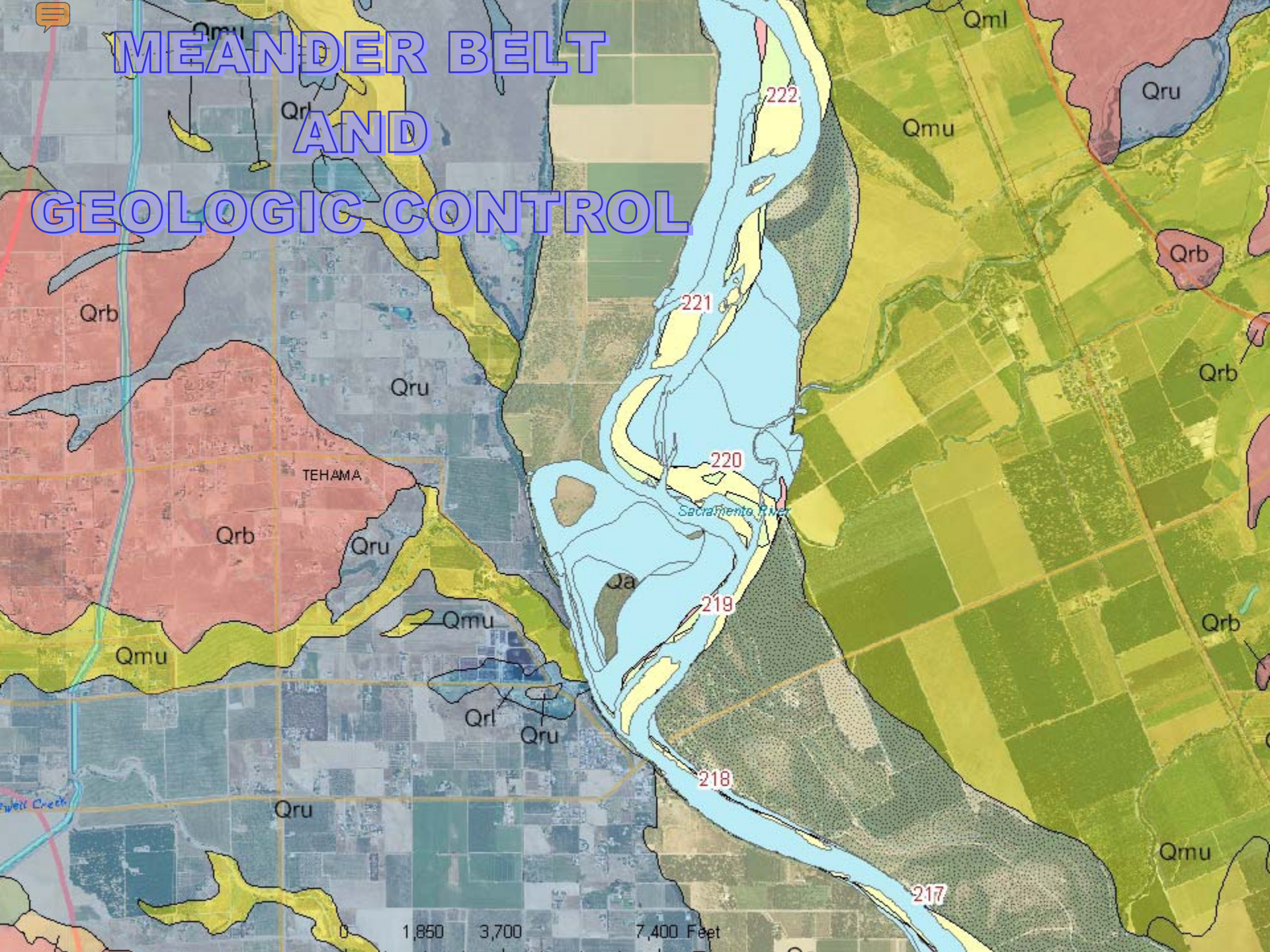
MOISTURE CONTENT

- MORE MOISTURE MEANS MORE WEIGHT
- WATER LUBRICATES
- WATER REDUCES SURFACE TENSION BETWEEN CLAY PARTICLES
- RISING LIMB VS. FALLING LIMB OF STORM
- FALL EROSION VS. SPRING EROSION

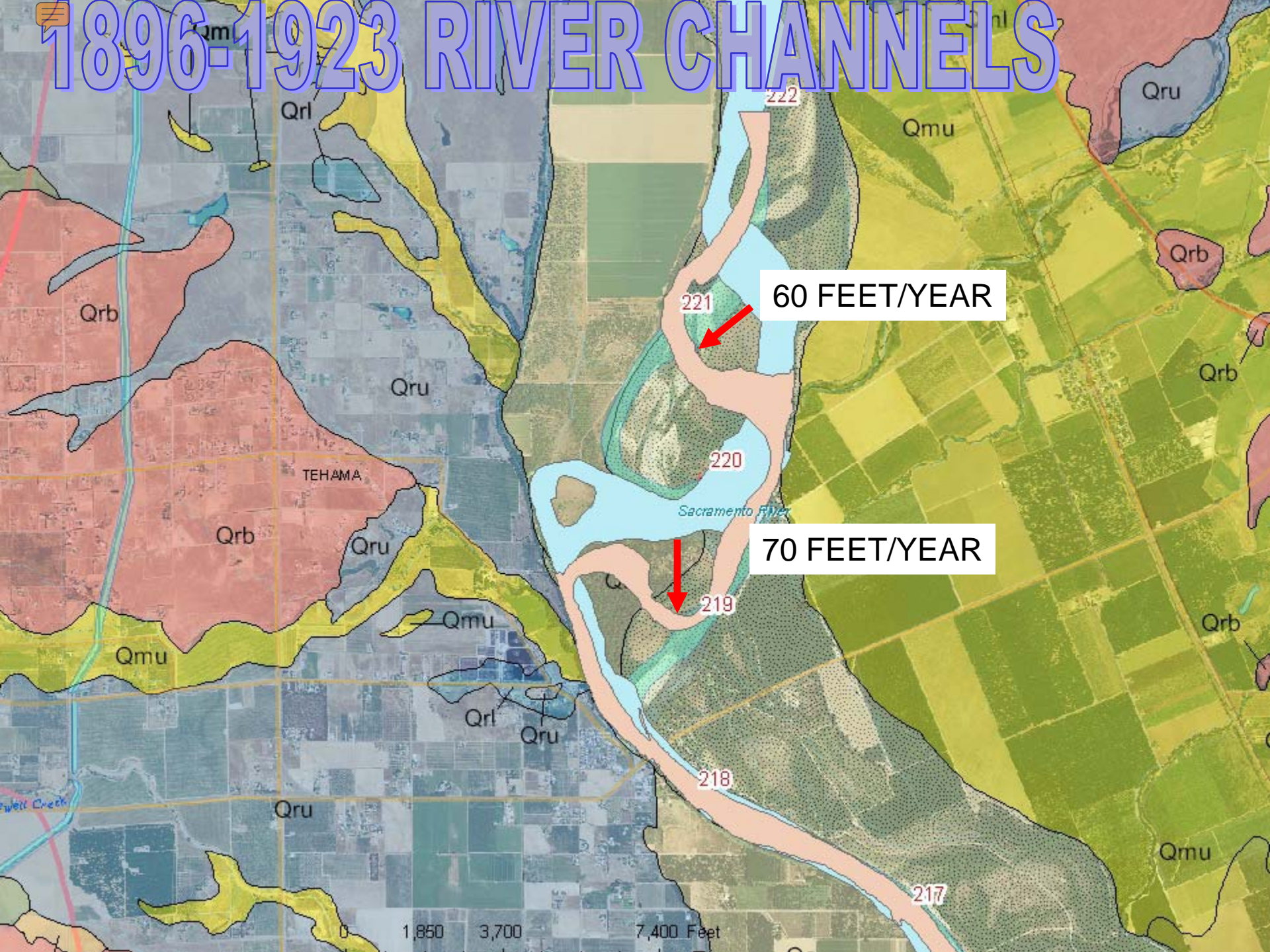
CHANNEL MIGRATION OR MEANDERING

- BANK EROSION RATES
- OCCURRENCE OF MAJOR FLOOD EVENTS
- BEND SHAPE
- BANK COMPOSITION
- VEGETATION?
- BEND CUTOFFS

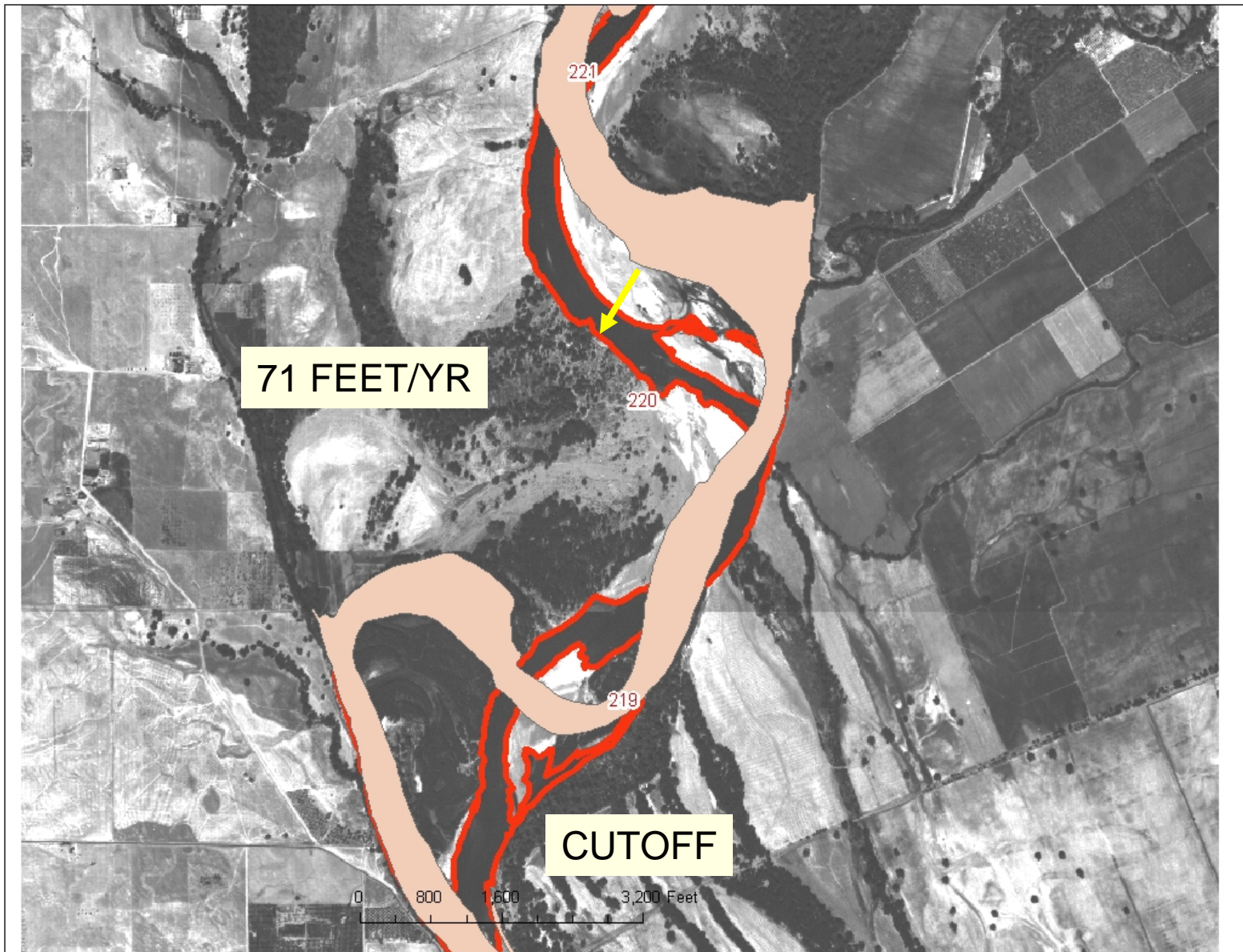
MEANDER BELT AND GEOLOGIC CONTROL



1896-1923 RIVER CHANNELS



1923 to 1938 CHANNEL CHANGE



1923-1947 CHANNEL



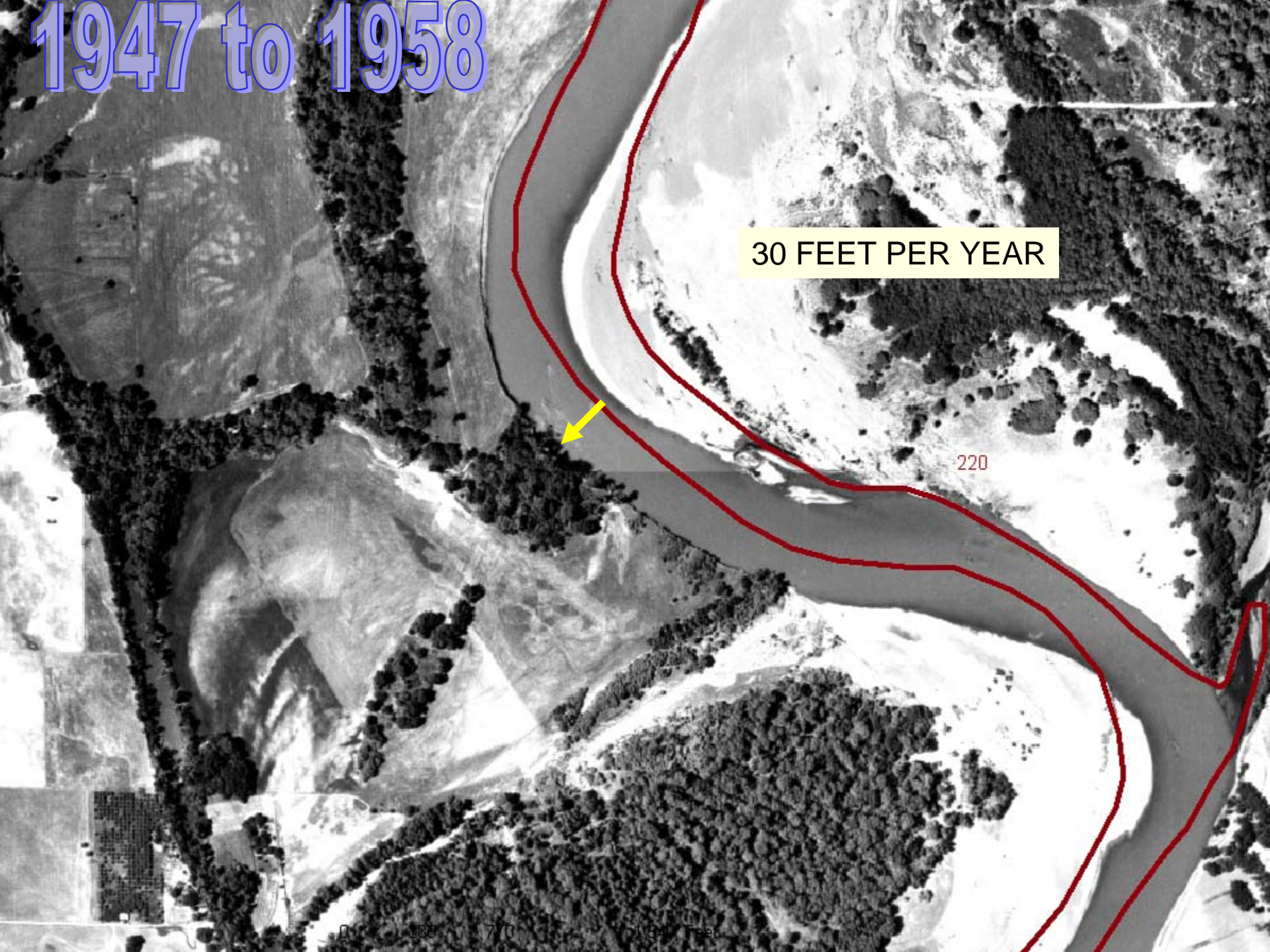
90 Feet/Year

90 Feet/Year

1947 to 1958

30 FEET PER YEAR

220



BANK PROTECTION



221

1963

220

219

218

217

0 1,875 3,750 7,500 Feet

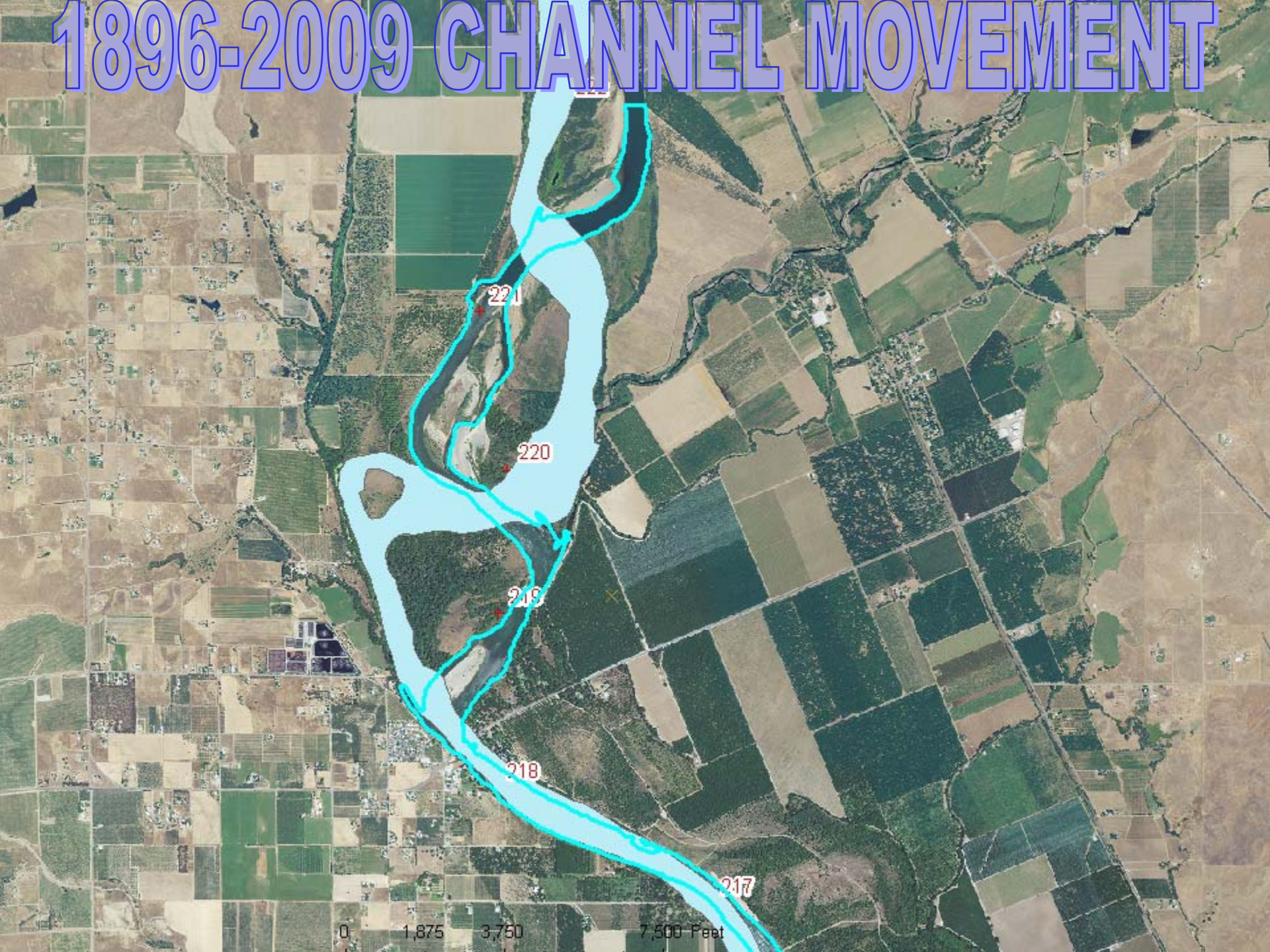
1981 TO 1997 CHANNEL



1997 TO 2009 CHANNEL

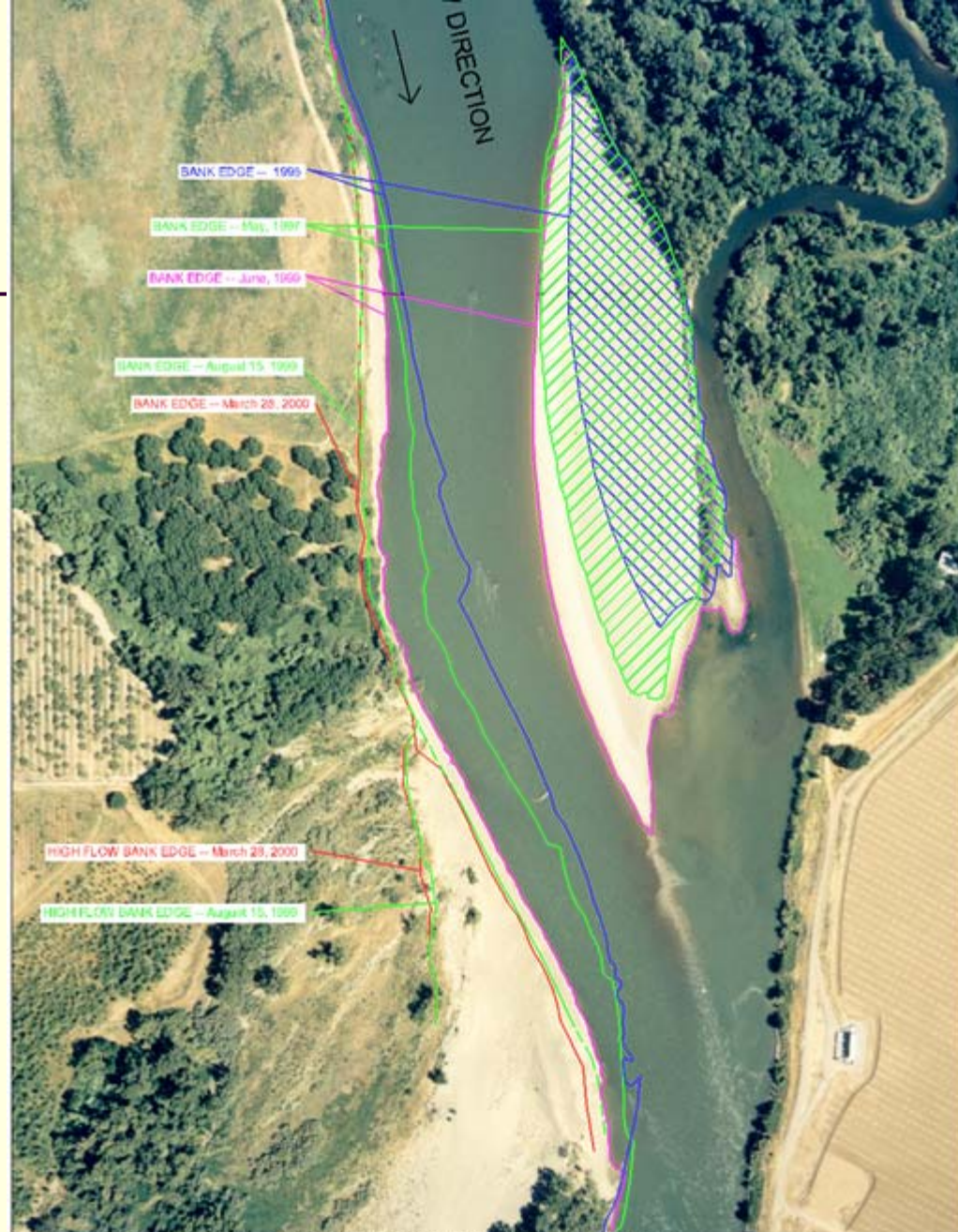


1896-2009 CHANNEL MOVEMENT



0 1,875 3,750 7,500 Feet

PARALLEL MOVEMENT OF EROSION AND DEPOSITION



SACRAMENTO RIVER BANK EROSION SITE
M & T RANCH

June 14, 1999 Aerial Photo

0 500 1000
Feet

BEND EVOLUTION

- ASYMMETRIC, MOVE FASTER IN A DOWNSTREAM DIRECTION
- AFFECTED BY GEOLOGIC CONTROL AND BANK PROTECTION



CUTOFFS



BEND CUTOFFS

- WHEN UPSTREAM BEND CATCHES UP WITH DOWNSTREAM BEND
- GENERALLY OCCURS DURING MAJOR FLOODS
- GENERALLY, THE SMALLER THE HYDRAULIC RADIUS THE MORE LIKELY THE CUTOFF

HUMAN-INDUCED CUTOFFS

- BANK PROTECTION
- VEGETATION REMOVAL
- DRAINAGE



INCIPIENT CUTOFF???

JACINTO BEND



PROPOSED PROJECT

- BANK PROTECTION REMOVAL
- PILOT CHANNEL
- BANK PROTECTION PLACEMENT

BANK PROTECTION REMOVAL

- BACK TO NATURE
- NATURE'S RESPONSIBILITY
- LIMITED LIABILITY
- NATURE KNOWS BEST
- NEW HABITAT

BANK PROTECTION REMOVAL

1800 FEET



60 YEARS @ 30 FT/YR

20 YEARS @ 90 FT/YR

CUTOFF ??

220

0 385 770 1,540 Feet

LOSS OF SRA

- BREAK AN EGG.....
- WOULD NOT BE THERE IF NO RIPRAP
- WOULD BE LOST ANYWAY
- THE SRA IS NOT NATURAL.....
- CUTBANKS AND BANK SWALLOWS
- KEY IS TO RESTORE NATURAL
FUNCTION

FULL-LENGTH ROCK REMOVAL OPTION

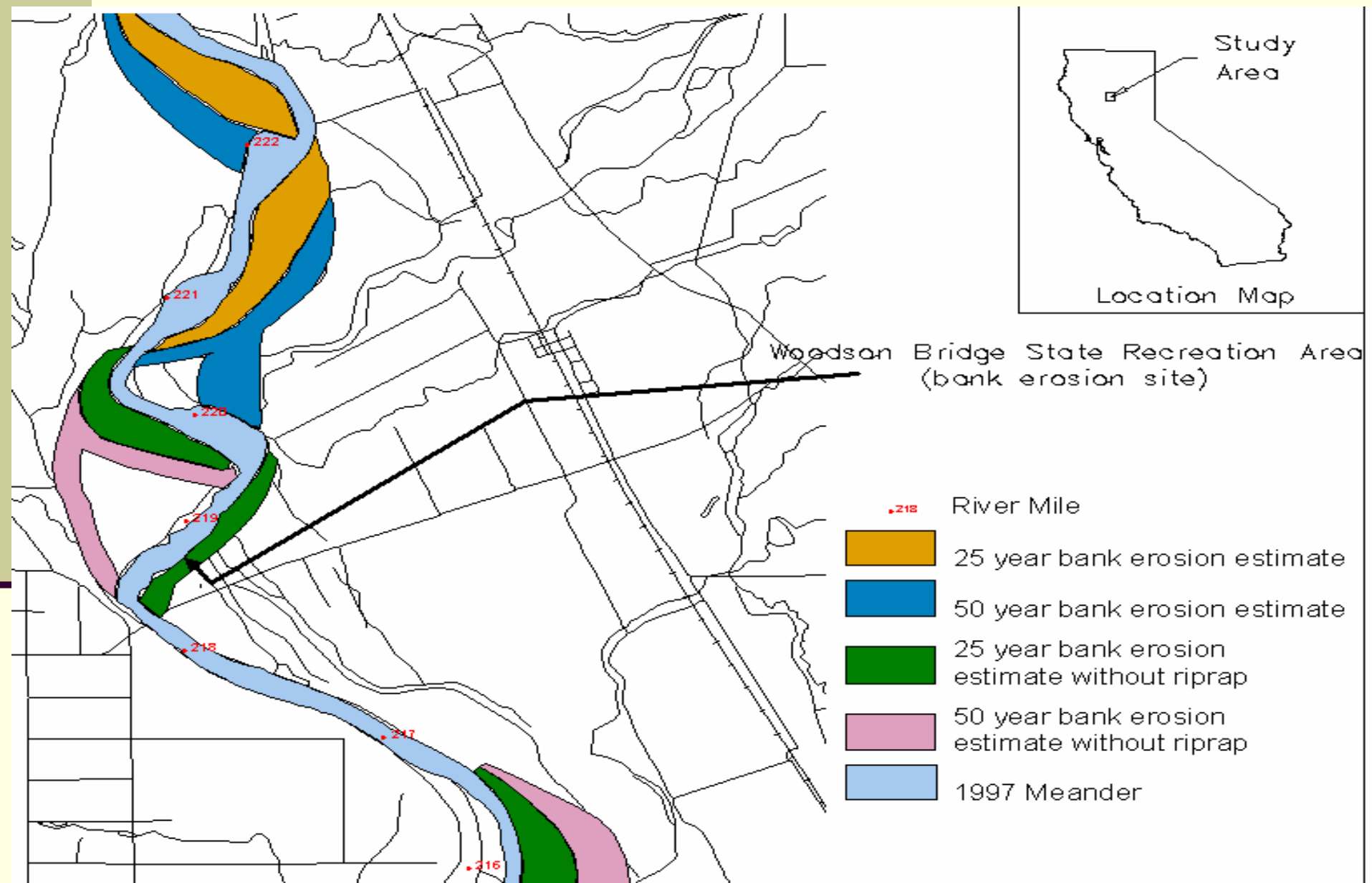


REMOVE

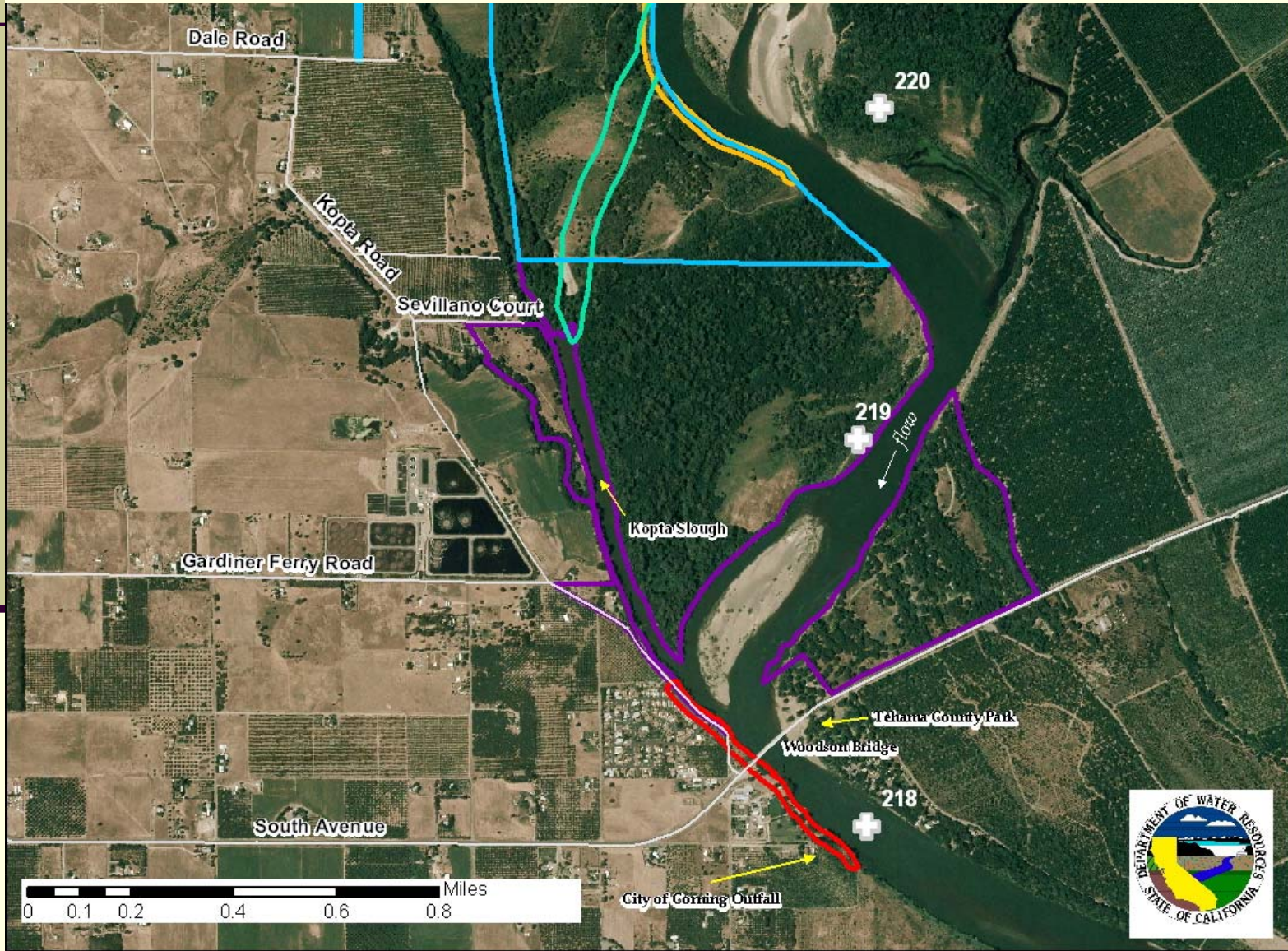
RE-USE

RELEASE

Future Erosion



WOODSON BRIDGE SRA Cutoff Construction



PILOT CHANNEL DISADVANTAGES

- COMPROMISE HABITAT CREATION ON OPPOSITE BANK
- BANK SWALLOWS AND NATURAL CUTBANKS
- LIABILITY
- EXPENSIVE
- COMPLICATES ENVIRONMENTAL CLEARANCE

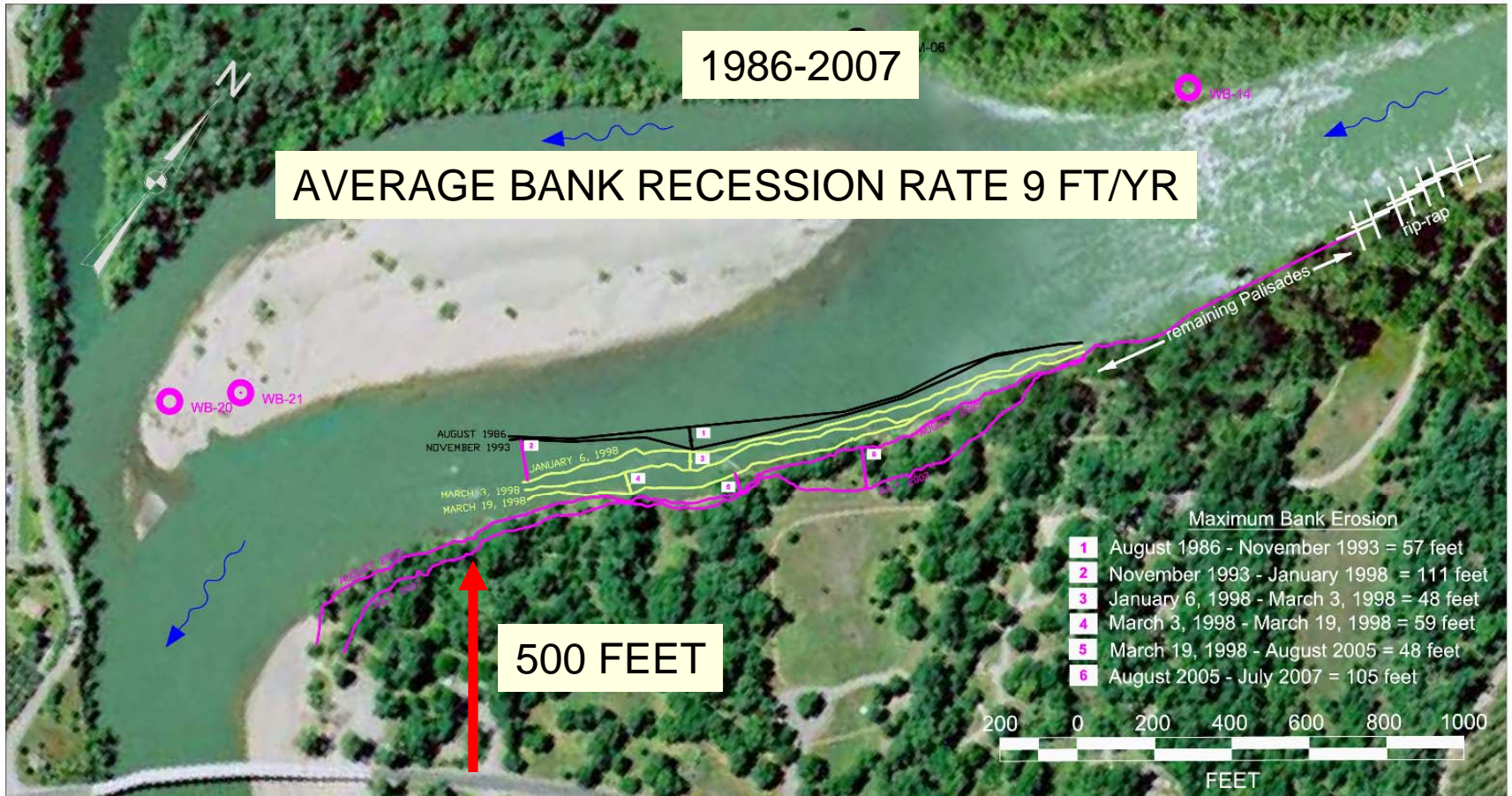
NO TO THE PILOT CHANNEL- Let nature take over



PROTECTING THE PARK AND BRIDGE



BANK EROSION @ WB SRA

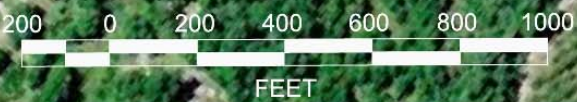


1986-2007
AVERAGE BANK RECESSON RATE 9 FT/YR

500 FEET

Maximum Bank Erosion

1	August 1986 - November 1993 = 57 feet
2	November 1993 - January 1998 = 111 feet
3	January 6, 1998 - March 3, 1998 = 48 feet
4	March 3, 1998 - March 19, 1998 = 59 feet
5	March 19, 1998 - August 2005 = 48 feet
6	August 2005 - July 2007 = 105 feet



LEGEND

	1986 - 1997 erosion prior to removal of Palisades
	1997 - 2007 erosion after removal of Palisades
	1997- 1998 erosion during high flow event
	WB-BM-01 old DWR control points for theodolite surveys
	WB-21 new DWR control points for SET3 surveys

NOTES

- 1) The aerial photography base is 2005 AirPhoto USA (<http://www.airphotousa.com>)
- 2) Control points set by DWR-Geology in 1986, 2005 and 2007 consist of concrete and pipe capped and centerpunched, then GPS'd with a Geoinformatics RTK total station. Coordinates obtained are accurate plus/minus 0.1 feet.
- 3) From 1986 - 2000 the surveys were performed with a theodolite from DWR control. From 2000 - 2005 the surveys were performed with a Trimble GPS (accuracy +/- 5 feet). From 2005 - present the surveys have been performed from new real-world DWR control points and a SET3 total station. Bank edge points were selected wherever there were significant vertical or horizontal changes.

STATE OF CALIFORNIA
 DEPARTMENT OF WATER RESOURCES
 NORTHERN DISTRICT

Sacramento River Bank Erosion Study

Woodson Bridge Erosion Site
 River Mile 218.4 - 219.0
 Bank Erosion Surveys
 1986 - 2007

Prepared by: Dave Forweller Date: 1/24/08
 Filename: Woodson SET3 Surveys2 01-24-08.dwg

BANK PROTECTION PLACEMENT





BANK PROTECTION


- RIPRAPPING GEOLOGIC CONTROL DOES MINIMAL GEOMORPHIC HARM
- PROTECT INFRASTRUCTURE

BENDWAY WEIR OPTION



CONCLUSION

- REMOVE RIPRAP AND PLACE ON GEOLOGIC CONTROL
- PROTECT BRIDGE ABUTMENTS AND INFRASTRUCTURE AS NECESSARY
- RETURN TO “NATURAL” MEANDERING
- NO PILOT CHANNEL
- LIMIT LIABILITY
- RETURN TO RIPARIAN SUCCESSION

An aerial photograph of a river landscape. The foreground shows a wide, light-colored riverbank with sparse vegetation. A dense, dark green forest follows the curve of the river. In the background, there are green agricultural fields, some with small buildings, and a large, curved, light-colored area that could be a field or a natural feature. The text "Riparian Succession" is overlaid in the center of the image.

Riparian Succession



Hi!

THE END

“AND SEE YA LATER”