Appendix 1-2

STREAM REACH PHOTOGRAPHIC ASSESSMENT

TEHAMA WEST STREAM REACH PHOTOGRAPHIC ASSESSMENT
REEDS, RED BANK, ELDER, AND THOMES CREEKS

As part of the Tehama West Watershed Assessment, VESTRA Resources, Inc. (VESTRA) completed a review of historic air photos to evaluate historical changes to project area streams within the developed area of the Tehama West Watershed. For Reeds, Red Bank, Elder, and Thomes Creeks historic aerial photographs were reviewed and changes that have occurred during the time span of the photographic sequence. This is the summary of findings.

Large format aerial photography covering lower portions of the four assessment streams were reviewed. Natural Resource Conservation Service (NRCS) aerial photographs from 1938 and 1952 were used as a base condition. U.S. Geological Survey (USGS) photography from 1994 and 2004 were used to display current conditions. However, not all stream reaches had full coverage for each of these years.

The assessment considered the following stream segments:

- **Reeds Creek** from the Sacramento River upstream 2.75 miles to Red Bank Road
- **Red Bank Creek** from the Sacramento River upstream approximately 1.5 miles to the Interstate 5 crossing
- **Elder Creek** from the Sacramento River to the Interstate 5 crossing, 6 miles upstream
- **Thomes Creek** from the Sacramento River to the Interstate 5 crossing, 5.7 miles upstream

For each stream segment the available photographs were chronologically compared and summaries were made regarding:

- Existing infrastructure
- Physical features within and adjacent to the stream
- Riparian vegetation quantity and patterns
- Miscellaneous observations

Locations on each stream showing interesting features or examples of characteristic changes were scanned from a chrono-sequence of photographs, so as to visually document the changes. In addition, several upland areas were compared using historic and 2004 photographs. Changes in vegetation, stream and gully erosion patterns, etc. were noted.

REGIONAL EVENTS WITH THE POTENTIAL TO AFFECT STREAM SEGMENTS

A number of regional events have occurred that have the potential to affect one or more of the streams in the Tehama West Watershed. A summary of these events follows to provide a base of knowledge from which to view photo "snaps of time'.

1. The highest recorded stream flows for Thomes and Elder Creeks are shown in Table 1. It is assumed that these events also represent floods for adjacent drainages. The two recorded events occurring prior to the earliest aerial photographs used in the assessment (1938) are highlighted in grey:

2. Shasta Dam was constructed in the early 1940s and began to have control over downstream river flows by 1944.

3. The Corning Canal was constructed between 1954 and 1959.

4. The Red Bluff Diversion Dam was constructed in the mid-1960s.

5. Interstate 5 was constructed through Tehama County in the mid- to late-1960s.

6. The Tehama/Colusa Canal was constructed between 1965 and 1979.

7. Most levees existing along assessed streams were likely constructed in the 1960s.

Table 1
ANNUAL PEAK FLOWS: RETURN PERIOD > 5 YEARS

Thomes Creek (1921-1996)			Elder Creek (1949-2004)		
Date	**Flow (cfs)**	**Gage Height (feet)**	**Date**	**Flow (cfs)**	**Gage Height (feet)**
Dec. 22, 1964	37,800	12.7	Feb. 28, 1983	17,700	12.1
Feb. 17, 1986	32,900	12.11	Feb. 14, 1986	15,300	11.62
Jan. 16, 1974	29,400	12.3	Mar. 04, 2001	15,100	11.58
Dec. 21, 1955	23,500	12.14	Dec. 11, 1983	13,200	11.17
Mar. 09, 1995	20,100	10.54	Dec. 16, 2002	13,100	12.11
Mar. 26, 1928	19,600	10.5	Feb. 24, 1958	11,700	13.9
Jan. 26, 1983	19,500	10.19	Dec. 31, 1996	11,500	10.75
Jan. 31, 1963	19,200	12.63	Dec. 22, 1964	10,300	13.23
Jan. 13, 1980	18,800	10.1	Mar. 09, 1995	9,740	10.3
Feb. 08, 1960	18,700	12.32	Mar. 07, 1975	9,000	11.22
Jan. 21, 1943	18,600	10.92	Jan. 16, 1974	8,850	11.14
Jan. 23, 1970	18,000	12	Dec. 21, 1955	8,840	12.52
Feb. 28, 1940	17,000	14.3	Jan. 23, 1970	8,690	11.05
Dec. 10, 1937	16,500	16.8	Feb. 17, 2004	8,340	10.41
Feb. 15, 1982	16,400	9.57	---	---	---
Feb. 24, 1958	14,300	9.78	---	---	---

Source: Taken from Table 6.4 of Tehama West Watershed Assessment (2005)

RESULTS

Reeds Creek

An evaluation was made from Red Bank Road downstream to the Sacramento River (approximately 2.75 miles in length). Photographs used in the assessment were taken in 1938, 1952, 1994, and 2004.

1938 Photos

The 1938 image was taken prior to the construction of Shasta and Red Bluff Diversion Dams. A number of interesting features in the Red Bluff vicinity give perspective regarding pre-Shasta Dam conditions and how water flow management likely affected the vicinity:

- Virtually all of the community of Red Bluff in 1938 existed west of the Sacramento River, north of Reeds Creek, and south of Dog Island Park. The city was densely in-filled and covered a total of only 0.63 square miles.

- Reeds Creek crossings included Highway 99 (stream mile 0.15), Southern Pacific Railroad (stream mile 0.35), Rawson Road bridge (stream mile 0.65), a low-water crossing at Paskenta Road (stream mile 1.75), and the Red Bank Road bridge (stream mile 2.75).

- Two large islands existed within the Sacramento River at the northeastern tip of Red Bluff. Both showed evidence of recent bed material movement and had modest amounts of short and moderate-height vegetation. River flow was split relatively equally between the three channels around and between the islands (see Image Comparison 1a).

- Little development existed in the Antelope Blvd. area east of the Sacramento River. Nearly all of the land from the Oak Street Bridge east more than 1.25 miles showed evidence of bed-load movement, some recent. Some agriculture was occurring immediately east of Paynes Creek Slough.

- During high river flows the Sacramento River's progress appeared to be slowed by the sharp bend at Red Bluff. This resulted in water spilling out into overflow channels known as (from west to east) East Sand, Sampson, and Paynes Creek Sloughs. These sloughs flowed through most of today's eastern Red Bluff.

Evidence of scour, cut-bank formation, and possible riparian vegetation clearing was noted along Reeds Creek and its tributary Brickyard Creek. This suggests that sometime shortly before 1938 one or more significant floods occurred. It is possible that the 1928 or 1937 flood events (see Table 1) may have been responsible for the stream conditions noted. Graphic down-cutting and bank-cutting occurred in the lower 1,000 feet of Brickyard Creek, as well as its tributary immediately west of Red Bluff (see Image Comparisons 1b and 1c).

Image Comparison 1a. Red Bluff and the Sacramento River in 1938 (top) and 2004 (bottom). Note the two large islands at the bend of the river and the large overflow area to the east of Red Bluff in 1938 and compare the 2004 situation. These changes are likely due to Shasta Dam's moderation of river flows during floods.

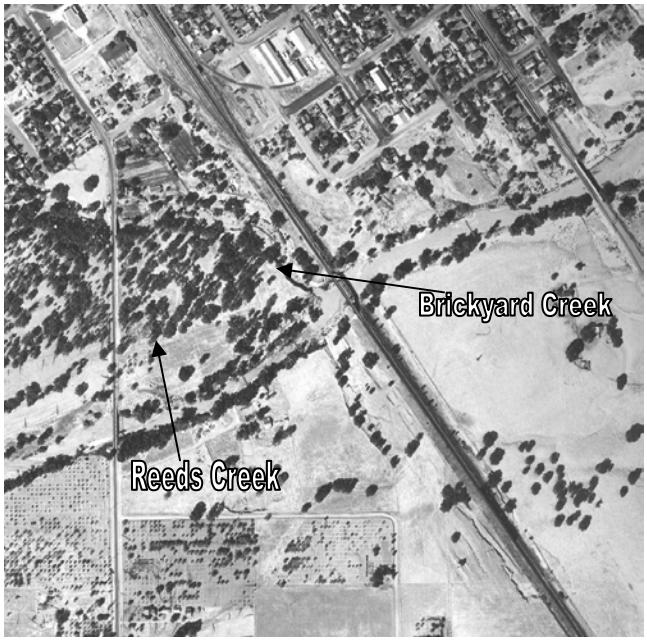


Image Comparison 1b. Red Bluff, Reeds Creek, and Brickyard Creek in 1938 (top) and 1994 (bottom). Note vegetation and stream channel changes at Brickyard Creek's confluence with Reeds Creek, immediately west of the railroad bridge; the density of riparian cover along Reeds Creek; and the degree of urban sprawl to the south of the stream.

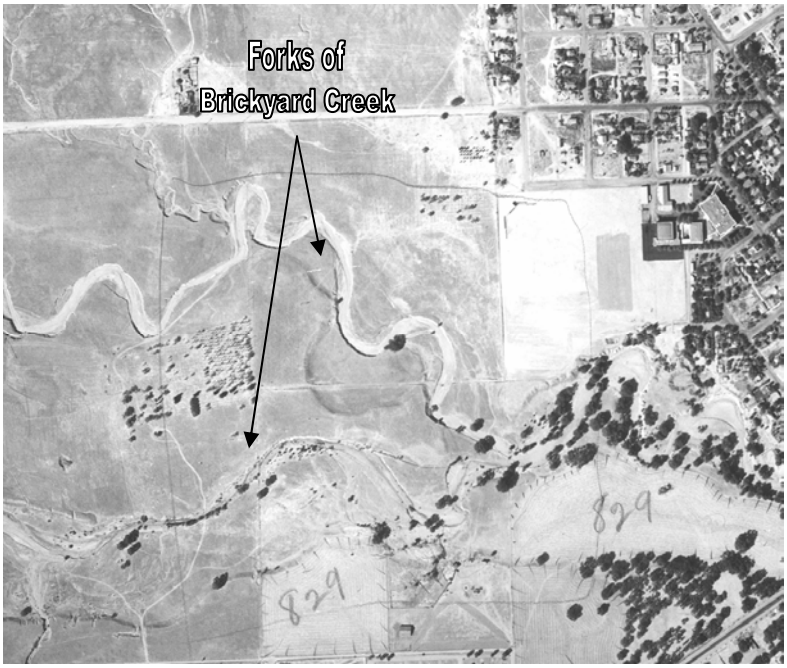


Image Comparison 1c. North and South Forks of Brickyard Creek and western Red Bluff in 1938 (top) and 1994 (bottom). Note evidence of stream bank cutting on both forks of the stream and the lack of riparian cover in 1938, along with changes in 1994.

Reeds Creek was broken into the following three segments and estimates were made of stream bank riparian foliar cover (see Table 2):

- Segment 1—Sacramento River upstream to Southern Pacific Railroad
- Segment 2—Southern Pacific Railroad upstream to Rawston Bridge
- Segment 3—Rawston Road upstream to Paskenta Road

Table 2
ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER, LOWER REEDS CREEK, 1938-2004

Year	Stream Segment		
	1	2	3
1938	30	65	30
1952	40	70	35
1994	70	90	70
2004	70	90	70

The Paskenta Road crossed Reeds Creek with a low-water ford. The crossing location was approximately 650 feet wide and the stream was highly braided at this point. Little if any riparian vegetation existed within several hundred yards either side of the crossing.

1952 Photos
Between 1938 and 1952 both Reeds and Brickyard stream banks appear to have increasing riparian cover, particularly from Rawson Road to the Sacramento River. In 1952 the Paskenta Road crossing was upgraded to a concrete low-water ford, which had a falls on its downstream side that caused some localized scour. Scattered riparian growth is coming in along the edges of the braided streambed along Segment 3.

1994 Photos
A bridge now exists at the Paskenta Road crossing. The stream channel at this point has been narrowed to less than one-half of its original width. Vegetation along Reeds Creek stream banks appears greater than in earlier photographs (see Table 2).

2004 Photos
The lower 1,000 feet of Brickyard Creek is densely covered by riparian vegetation (see Image Comparison 1b). West of Red Bluff, Brickyard Creek's tributaries have riparian vegetation becoming established and the sharp bank cuts, apparent in the 1938 photograph, are much more muted (see Image 2c).

Riparian growth appears to be much greater along Reeds Creek than in 1938 but very similar to what it was in 1994 (see Table 2). The lower portion of Reeds Creek, from the old Highway 99 Bridge to the Sacramento River has changed considerably from 1938, as it is now Lake Red Bluff's summer-time bay. Short to mid-height riparian growth extends densely along the sides of this stream section except adjacent to the Sacramento River, where construction and maintenance of a boat ramp facility may have reduced vegetation.

By 2004 urban uses cover most of the southern banks of Reeds Creek downstream of the Rawson Road and from the eastern abutment of the Oak Street Bridge east on Antelope Blvd.

Also, there is only one island on the bend of the Sacramento River (see Image 2a) and it is heavily covered by riparian vegetation.

Between 1938 and 2004 there were infrastructure changes adjacent to Reeds Creek. Most apparent is the construction of a bridge and narrowing of the stream channel at the Paskenta Road crossing site at stream mile 2.75 and urban sprawl along the southern bank of the stream, extending at least 1.2 miles up from the Sacramento River.

Construction of Shasta and Red Bluff Diversion Dams has a variety of effects on the Sacramento River and adjacent areas, including:

- Floods to the Antelope Blvd. area have been reduced, allowing for the eastern portion of Red Bluff to develop.

- The two islands evident in the Sacramento River in 1938 have been reduced to one and it has become heavily vegetated.

- The Red Bluff Diversion Dam backs up water during the summer to the Southern Pacific Railroad Bridge.

Red Bank Creek

Red Bank Creek was evaluated from the Sacramento River upstream approximately 2.1 miles, to a point 0.5 miles west of the Interstate 5 crossing site. Photographs from 1938, 1952, 1994, and 2004 were used to compare stream and near-stream conditions.

1938 Photos
Conditions in 1938 included:

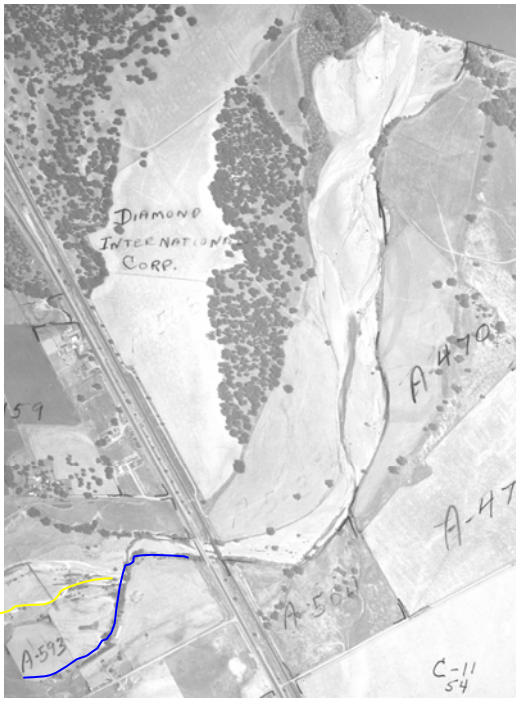
- Red Bank Creek throughout the entire assessment area is a braided stream showing evidence of recent high stream flows and bank cutting. Very little riparian growth exists along the outer stream banks or on island features within the banks, except for small stringers at the stream's confluence with the Sacramento River (see Image Comparisons 2a).

- A sharp stream bank feature exists upstream from the Highway 99/Southern Pacific Railroad Bridges (see Image Comparison 2a).

- Red Bank Creek stream crossings consist of the adjacent Southern Pacific Railroad and Highway 99 bridges.

- Adjacent lands consist of dry land agriculture and oak woodlands. Scattered home sites with outbuildings exist south of the stream.

Image Comparisons 2a—Lower Red Bank Creek in 1938 (above) and 1952 (below). Note braided stream conditions and scarcity of riparian growth both above and below the Highway 99 and Southern Pacific Railroad Bridges. Also, note the stream bank feature lined by scattered hardwoods in the extreme southwest portion of the images (blue line). The area bound by blue and yellow lines has been reclaimed for agricultural uses.



The assessment area was broken into three segments to estimate stream bank foliar cover, including:

- Segment 1—the Sacramento River to Highway 99 Bridge
- Segment 2—Highway 99 Bridge west to the future location of Interstate 5 crossing
- Segment 3—the Interstate 5 crossing site to 0.5 miles west. Estimates of percent foliar cover are shown on Table 3.

Table 3
ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER--LOWER RED BANK CREEK (1938-2004)

Year	Stream Segment		
	1	2	3
1938	<5	<5	15[a]
1952	<5	5	20[a]
1994	Not Available	20	25[a]
2004	75[b]	20	25[a]

Notes: [a]-Most foliar cover is provided by large scattered trees, likely blue or valley oaks.
[b]Entire stream segment is a bay of Red Bluff Diversion Dam during summer-time.

1952 Photos
The stream channel conditions appear to be similar as in 1938; however, there may be slightly more riparian growth within the stream channel upstream from the Highway 99/Railroad Bridges (Segments 2 and 3).

Infrastructure changed little from 1938 to 1952 in the stream's vicinity; however, agriculture encroached upon the stream channel site located slightly upstream from the Highway 99/Railroad bridges, as shown in the Image Comparison 2a

2004 Photos
In the mid-1960s Interstate 5 and the Red Bluff Diversion Dam/Pumping facilities were completed. Interstate 5 crossed Red Bank Creek approximately 0.5 miles west of the Highway 99/Railroad bridges while the Red Bluff Diversion Dam was placed several hundred yards below the mouth of the Red Bank Creek. Following the placement of the Red Bluff Diversion Dam, Red Bank Creek held water nearly to Highway 99. In addition, the Diamond International mill facility was constructed on the north bank of Red Bank Creek, between Highway 99 and the Sacramento River. Construction of this facility eliminated hardwood habitat adjacent to Red Bank Creek. Finally, small residential developments were constructed between Interstate 5 and Highway 99, immediately south of Red Bank Creek.

During this period of time there were changes to the stream and near-stream habitats, including:

- Heavy streamside vegetation (species unknown) increased along the stream banks from the Sacramento River up to Highway 99. This is in marked contrast to 1938 and 1952 when there was very little streamside vegetation in this segment (see Table 3). The cause is likely the construction of the Red Bluff Diversion Dam that backs water up through this reach (similar to the lowest reach of Reeds Creek).

- Additional stream channel portions have been reclaimed to agricultural uses, both between Interstate 5 and Highway 99 crossings and immediately upstream from Interstate 5 (see Image Comparisons 2b).

- Stream bank and within-channel vegetation appears to have increased modestly in Segments 2 and 3 above Highway 99 (see Table 3).

Very little change was noted when comparing the 1994 and 2004 photographs regarding the stream or riparian vegetation.

Elder Creek

Elder Creek was evaluated along its lower 6 miles, from the Interstate 5 crossing downstream to the Sacramento River. Photos were reviewed for the lowest 1.5 miles of the stream for 1952, 1994, and 2004, while from that point upstream to the Interstate 5 crossing photos were reviewed for 1938, 1952, 1994, and 2004.

1938 Photos
Due to the lack of 1938 images of the lower stream segment, no assessment could be made for this period of time. The following are observations about conditions from stream mile 1.5 up to the future Interstate 5 crossing site:

- Stream crossings consisted of the Tehama Road low-water ford; Highway 99 and Southern Pacific Railroad bridges at Gerber; and Rawson Road Bridge approximately 1 mile west of Gerber.

- Irrigated agriculture crops were adjacent to Elder Creek upstream to about 0.5 miles east of the Interstate 5 crossing site. From that point west the land is either rangeland or dry land farmed.

- The community of Gerber exists close to the stream's northern banks but only about one-quarter of the lots support buildings.

- The Elder Creek stream channel tends to be relatively narrow (<200 feet wide) upstream to about 1.3 miles east of the future Interstate 5 crossing. (It is possible that levees extend along the stream banks along this portion of Elder Creek.) Upstream from that point the stream channel noticeably widens and varies from 400-1,000 feet in width.

- Riparian vegetation cover values are shown on Table 4, broken down in the following segments:

    - Segment 1—the Sacramento River to Tehama Road crossing
    - Segment 2—Tehama Road crossing to Highway 99
    - Segment 3—Highway 99 to Rawson Road
    - Segment 4—Rawson Road to 1.3 miles east of Interstate 5
    - Segment 5—1.3 miles east of Interstate 5 to Interstate 5

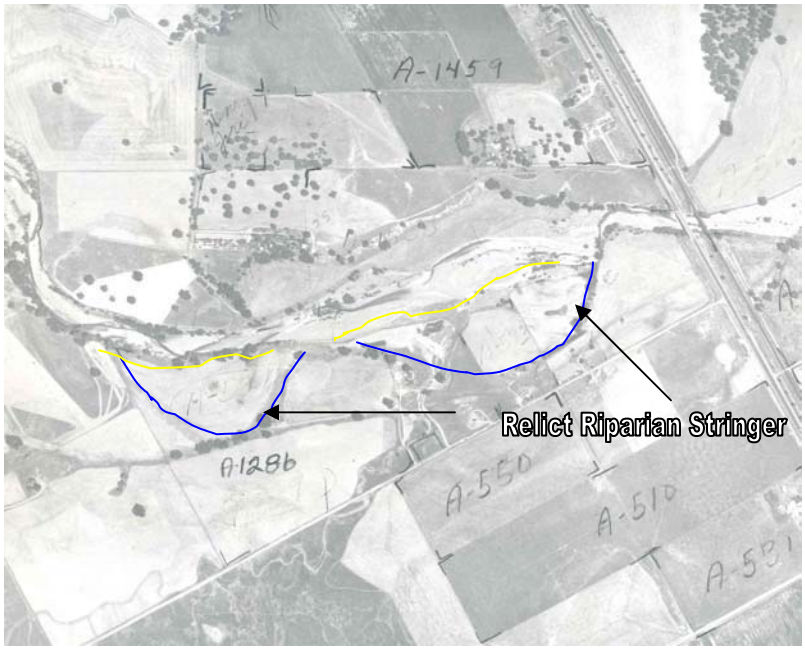


Image Comparison 2b. Red Bank Creek in 1952 (top) and 1994 (below). Highway 99 crosses the stream near the right edge of both images and I-5 crosses in the center of the 1994 image. Note wide stream channel features between Highway 99 and the I-5 crossing site that has been converted to agricultural land in 1994. (Stream cut bank shown with blue line and reclaimed land bound by yellow and blue lines.) Also note the "riparian" hardwood stringers that line the historic stream banks that are now distant from the stream.

Table 4 ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER LOWER ELDER CREEK (1938-2004)					
Year	Stream Segment				
	1	2	3	4	5
1938	Not Available	20	30[a]	50[a]	15
1952	35	15	Not Available	Not Available	20
1994	25	5	Not Available	15	10
2004	35	5	10	30	15
Notes: [a]Most foliar cover provided by large scattered trees, likely blue or valley oaks.					

1952 Photos

The earliest view of the mouth of Elder Creek was from a 1952 photograph. At this date the stream's lowest reach (Segment 1) is relatively narrow (<200 feet wide) with moderate amounts of riparian cover, primarily provided by hardwoods with large crown diameters. It is possible that small levees extend along the stream's banks.

1938–2004 Photos

Between 1938 and 1994 marked changes have occurred along the entire assessment segment, including:

- Interstate 5 and the Tehama-Colusa Canal have been constructed and cross Elder Creek.
- The Tehama-Colusa Canal crosses the stream approximately 0.6 miles west of Highway 99.
- Large levees now extend along both south and north sides of the stream from the Sacramento River upstream at least to Interstate 5.
- Irrigated agricultural fields exist on both sides of the stream and west at least as far as Interstate 5.
- Several portions of stream overflow channels have been converted to agricultural use.
- Most city lots have been built upon in Gerber.
- Changes from 1994 to 2004 appear to be slight.

The degree and variety of 1938-2004 changes appear much more pronounced along Elder Creek than in either the Reeds or Red Bank Creeks situation. Construction of large levees, likely in the 1960s, and their constraining effects on the stream is probably responsible for these changes. Some of the effects or results of levee construction or enlargement include:

- Stream bank cover in the lowest portion of Elder Creek (Segment 1) is similar to what it was in 1952 but the riparian corridor width is much reduced with nearly all trees outside the levees having been removed (see Image Comparison 3b).

- In Segments 3 and 4 the hardwood canopy cover is much reduced in 1994 and 2004 relative to 1938. This reduction may be due to enlargement of levees (see Image Comparison 3c).

- Large areas of stream overflow channel have been converted to farmland (see Image Comparison 3a).

By 1994 Elder Creek's channel width is relatively consistent throughout the assessed swath, except for portions of Segment 3 (immediately above Highway 99) and Segment 5. Construction of the Interstate 5 crossings, the Tehama-Colusa Canal, and a concrete slab dam constructed immediately below the Tehama-Colusa Canal (to protect the canal siphon from stream scour) have all constricted the stream flow from its 1938 pattern (see Image Comparison 3a for changes at the Interstate 5 crossing site). In each of these locations the stream's total overflow channel width was constricted to less than one-half of its 1938 width. This constriction has allowed conversion of portions of the flood overflow channels into agricultural fields (see Image Comparison 3a). Stream constriction caused by levee construction deepens and speeds water discharge during floods and creates a homogeneous stream profile.

Elder Creek differs from the other assessed streams because it may have had levees much earlier. The relatively narrow condition of the stream shown in the 1938 image may be due to early directing efforts, which allowed agriculture to extend to the levee walls. Image Comparison 3c shows a portion of Segment 3 that is tightly constrained in 1938, with a narrow stringer of hardwoods within the old levees. When the levees were enlarged (possibly in the 1960s) much of the residual hardwood cover was removed.

Thomes Creek

Thomes Creek historical changes were assessed using 1952, 1994, and 2004 photographs. The stream's assessment reach extends from the Sacramento River west to the Interstate 5 crossing, a distance of approximately 5.7 miles.

1952 Photos

The Thomes Creek confluence at the Sacramento River produces a pronounced debris fan (see Image Comparison 4a). The Sacramento River appears to form a wide eastward bend to flow around the fan. Topographic maps of this delta show overflow channels radiating both north and south from Thomes Creek to the Sacramento River, along the lower 0.8 miles of the tributary.

Due to the size of the Thomes Creek delta and its relationship with the Sacramento River, it may be possible to use the fan to assess changes to address management effects in the Thomes Creek drainage. If sediment discharge from the drainage changes, one would expect that the delta will change. Specifically, if sediment discharge (through increased man-caused erosion) increases and all other factors remain stable, the delta may push further to the east and build in size. If sediment production is reduced, perhaps by gravel mining, the Sacramento River may show

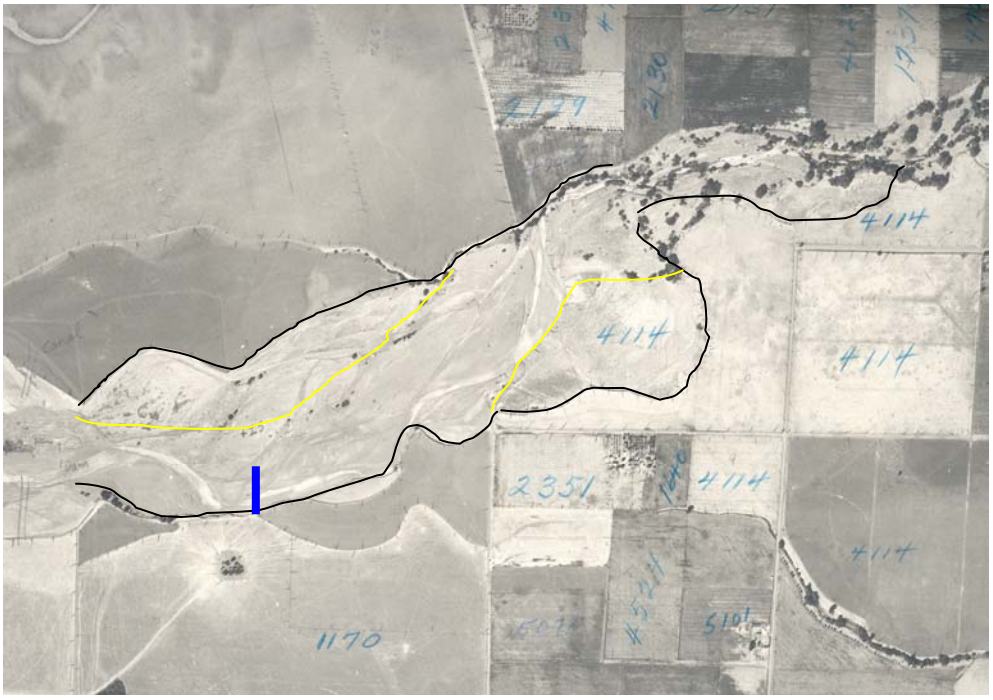


Image Comparison 3a. Elder Creek at the I-5 crossing in 1938 (top) and 1994 (bottom). The 1938 stream channel extent is shown with black lines and the site and length of the Interstate 5 crossing is shown as a blue bar. The areas between black and yellow lines are reclaimed farmland following Interstate 5 and levee construction, resulting in much more constrained stream. Also, note the vegetation changes either side of the I-5 crossing between the two images. Much of the 1994 vegetation is likely *Arundo* or Tamarisk.

Image Comparison 3b. The lowest reach of Elder Creek in 1952 (top) and 1994 (bottom). Note the distinctive levee system along the stream in 1994, along with the reduction in hardwood cover along the stream and adjacent areas compared with 1952. This area is stream "Segment 1".

Image Comparison 3c. Elder Creek's Segment 4 in 1938 (top) and 1994 (bottom). The constrained nature of this segment in 1938 is likely due to early levees which allowed the surrounding land to be used for agricultural purposes. The large hardwoods along the stream may be residual oaks, from woodlands that pre-dated agricultural development. The 1994 image shows the enhanced levee system, possibly built in the 1960s, and the elimination of nearly all large hardwoods.