2017 TECHNICAL STUDIES AND 20-YEAR RETROSPECTIVE FOR THE CACHE CREEK AREA PLAN

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EXECUTIVE SUMMARY

ES.1 OVERVIEW

The structure of the 1996 Cache Creek Area Plan (CCAP) is based on the concept of adaptive management. The program requires regularly conducted modeling, monitoring, surveying, and reporting. The resulting information is to be analyzed for patterns and fed back into the program for the purpose of program update/modification if appropriate, when the County conducts regularly required program reviews. The County is required to conduct a comprehensive review every ten years that focuses on the following key areas:

- <u>Changes in creek conditions</u> that have occurred over the prior ten years.

- <u>Analysis of collected data</u> from monitoring programs, habitat restoration, channel stabilization, and reclamation efforts over the prior ten years.

- <u>New regulatory requirements</u> over the prior ten years.

In June of 2015, the County Board of Supervisors approved a work plan for the ten-review review and update of the CCAP and the County engaged the technical experts on the Cache Creek Technical Advisory Committee (TAC) to independently undertake the work. This approach was taken for a number of reasons including: the TAC members' existing familiarity with the program; their professional expertise in appropriate technical areas, and the desire to reinforce TAC understanding of the program through the rigors of the analysis.

The three TAC members undertook extensive technical analysis of collected data, other available information and analysis, and conditions within the creek within their respective disciplines. Three technical reports have been prepared and are presented herein that together provide an update to the 1995 Technical Studies. The three reports have been combined and released as one report entitled *2017 Technical Studies and 20-Year Retrospective for the Cache Creek Area Plan*.

ES.2 EXECUTIVE SUMMARY FOR LOWER CACHE CREEK FLUVIAL GEOMORPHOLOGY STUDY

A twenty year retrospective evaluation of lower Cache Creek (the Cache Creek Resources Management Plan area between approximately river mile 12 and 28) that included extensive analysis of geomorphic conditions was conducted to inform an update of the Cache Creek Area Plan. The primary objectives of this evaluation were to quantify changes in Cache Creek related to sediment transport and channel evolution, evaluate the effectiveness of measures in the CCAP plans and ordinances, and recommend changes to plans and ordinances to improve future implementation of the program.

A variety of technical analyses were conducted to quantify active channel migration and sediment transport for the period between 1996 and 2016, including:

- Review of the 1995 Technical Studies and extraction of relevant geomorphic data from study results.
- Collection, integration, and organization of aerial photography and elevation data for the CCRMP area collected between 1996 and 2016.
- Mapping of active channel areas using historical aerial photographs taken between 1996 and 2016 to delineate and quantify channel change.
- Measuring and comparing channel slope and sinuosity between 1996 and 2016.
- Calculating differences in elevations from historical topography data collected between 1996 and 2016 to quantify volume, timing, and location of sediment deposition and erosion in the CCRMP area.
- Developing recommendations to improve the CCAP documents and ordinances based on analysis results.
- Creating an organized database and simple "dashboard" viewer tools to archive and provide ongoing web access to all data and analysis results generated by this effort.
- Analyses were completed for the entire CCRMP area and broken out by geomorphic reach.

The most significant findings of this evaluation updated the previous understanding of Cache Creek geomorphology and included the following:

- The streamway influence boundary delineated in the 1995 Technical Studies is a product of sound geomorphic principles and should continue to be used in future implementation of the CCAP.
- The general idea behind the Test 3 Concept and Boundary remains valid, however, some assumptions of the Test 3 hydraulic modeling have not been fully implemented, so the Test 3 Boundary should be updated (and renamed) to reflect current understanding of channel conditions and change.
- The primary active channel of Cache Creek has migrated extensively since 1996.
- A total of approximately ten million tons of sediment was deposited in Cache Creek in the CCRMP area between 1996 and 2011.
- Sediment deposition has occurred almost exclusively on channel bars.
- The long term trend of sediment deposition in Cache Creek since 1996 is interspersed with years of erosion in the CCRMP area.
- Lateral channel migration in dynamic reaches typically occurs during peak flows between 15,000 and 25,000 cfs (greater than two-year but less than ten-year recurrence interval flows).
- Active channel sinuosity has increased from the degraded 1995 condition in all of the reaches in the CCRMP except for the Hoppin and Rio Jesus Maria reaches.
- Lateral channel migration and magnitude of erosion and/or deposition varies by reach and with magnitude of peak flows.

These findings informed the TAC geomorphologist's recommendations for changes to program plans and ordinance, which include the following:

- The CCRMP boundary to incorporate the latest FEMA 100-year floodplain boundary (map effective date June 17, 2010) and the 2015 active channel extent, whichever is further from the centerline of the Cache Creek corridor.
- The Test 3 Boundary should be updated based on observations of active channel and topography change over the past twenty years and renamed the Channel Form Template (CFT).
- The flood protection purpose of the plan should be refined to require maintenance of existing level of flood flow capacity as opposed to maintenance of a specific level of flood protection.
- Major stabilization projects should be replaced with more general guidance to maximize available area for continued channel evolution, while still achieving some measure of channel smoothing at bridges.
- Multiple in-channel mining templates should be replaced with a single generalized in-channel mining template that is easier to understand and implement.
- Priority projects should replace site specific bridge transition and stabilization projects with standard river management and bank protection design approaches for bank stabilization at bridges and other locations.
- Gravel bar skimming instream maintenance projects should be included in priority projects to address significant sediment deposition on gravel bars over the last twenty years.

ES.3 Executive Summary for Lower Cache Creek Hydrology and Water Quality Study

A twenty-year retrospective look at Cache Creek hydrology and water quality since the initiation of the CCAP was performed looking at data collected between 1996-2016. The primary goals of this effort were to document any changes in Cache Creek conditions related to hydrology and water quality and to evaluate the effectiveness of measures in the CCAP plans and ordinances recommending changes for the future where appropriate.

The analyses leading to this retrospective on Cache Creek Area Plan included the following tasks:

- Collecting and evaluating available data sets related to surface and groundwater hydrology and water quality,
- reviewing CCAP Plans and Ordinances and recommend any changes based on the data evaluation and other analyses, and
- developing a new 2D hydraulics model of Cache Creek to inform future projects and management.

The major results obtained from the data analysis include:

- The period 1996-2016 produced statistically expected peak flow patterns characterized by cycles of wet and dry periods. No extraordinary flow events occurred during the period evaluated in this study. Wet and dry cycles are historically common in the Sacramento Valley.
- Groundwater levels near Cache Creek have continued their seasonal trends of depression in the irrigation season and recovery in the rainy season and the impacts of drought periods (particularly the drought starting in 2012) are evident.
- The water quality monitoring program under CCAP (both surface water samples collected by the County and samples collected at mining site by operators) is providing a reasonable overview of the condition of the Creek. While there are no obvious long term trends, and most contaminants are below action levels, the Gordon Slough site frequently has the highest recordings of many contaminants and may be a key source of nutrient and organic contaminants.
- Mercury continues to be a concern for Cache Creek and its surrounding areas, but CCAP and mining activities do not seem to be exacerbating mercury impacts.

The TAC Hydraulic Engineer recommends some changes to the program and its supporting documents. Major recommendations include:

- The "Test 3 Concept" should be revised based on new data and understanding of creek processes and renamed the 2017 Channel Form Template.
- In general, CCIP monitoring requirements should be amended to reflect up to date scientific methods and funding realities and better data management practices should be put in place.
- There should be amendments to plan documents to avoid overly prescriptive approaches to management of the Creek.
- The water quality monitoring program should be further streamlined and clarified.

ES.4 Executive Summary for Lower Cache Creek Biological Resources Study

This report summarizes changes and trends in biological resources within the Cache Creek Area Plan (CCAP) area on lower Cache Creek (Yolo County, CA) from 1995–2016. Biological resources present along the creek include native riparian and upland vegetation, in addition to over 200 species of common and special-status amphibians, reptiles, mammals, birds, invertebrates, and fish. Nonnative and invasive species are also considered within the biological resources framework, due to their significant impacts on native species and communities, creek flows, and other aspects of the terrestrial and aquatic habitat along the creek and in the surrounding landscape.

Beginning with the 1995 Technical Studies, numerous historical reports and biological datasets from 1995–2015 were compiled, reviewed, and synthesized. Both qualitative and quantitative data on biological resources were extracted and analyzed, with quantitative data on vegetation being more readily available than for other biological resource elements. Additional new data were collected on native and nonnative vegetation, wildlife, and other biological resource elements from 2015–2016.

The results of the integrated analysis indicate that, over the last two decades since implementation of the CCAP, native riparian vegetation has generally increased, especially in areas that were formerly mined. In addition, special-status native blue elderberry shrubs are presently abundant along lower Cache Creek, and there is strong evidence that the local population is on an increasing trajectory. Numerous opportunities exist to accelerate further recovery of native vegetation, including restoring additional riparian and upland habitat, increasing base creek flows during spring and summer seasons, and expanding treatment of invasive species. The three invasive plant species (arundo, ravennagrass, and tamarisk) that have been historically prioritized for treatment since the early 2000s have been greatly reduced, although many additional nonnative and invasive species are now present and should be targeted for removal and replacement with native species.

While assessment of changes and trends in native wildlife, invertebrates, and fish were primarily qualitative due to data limitations, over 200 species were observed from 1995–2016. Within the mosaic of riparian and upland habitat across the CCAP area, many species were consistently observed during the study period, such as Swainson's hawk, riparian bank swallow, numerous migratory songbirds, Western pond turtle, river otter, Columbian black-tailed deer, bobcat, Sacramento pikeminnow, and Sacramento sucker. The continued recovery of native vegetation and natural ecological processes should provide additional habitat and resources for these and other native species, further increasing the value of lower Cache Creek as habitat within the matrix of agricultural and urban lands in Yolo County. Opportunities for additional monitoring of native wildlife, invertebrates, and fish should be explored, likely in partnership with local universities and non-profit organizations, to better understand the status of local populations and to develop targeted conservation strategies as a component of the multi-benefit CCAP framework.

Lastly, the results of this analysis were used to make a suite of recommendations regarding updates to the planning documents and ordinances that serve as the foundation of the CCAP. The standardized methodologies employed in this effort should support future assessments of changes and trends in biological resources along lower Cache Creek as CCAP implementation continues.

Chapter 1:

Lower Cache Creek
Fluvial Geomorphology Study
(1996–2016)

1.1 INTRODUCTION

This report describes the methods and results of a retrospective analysis of Cache Creek fluvial geomorphology (including hydrology, hydraulics, channel evolution, and sediment transport analyses) since the initiation of the Cache Creek Area Plan (CCAP) in 1996. The analyses summarized in this report cover the Cache Creek Resource Management Plan (CCRMP) area from Capay Dam downstream to I-5 (Figure 1.1). The first objective of this effort was to quantify changes in Cache Creek geomorphic conditions between 1996 and 2016. The second objective of this effort was to evaluate the effectiveness of measures in the CCAP documents and ordinances in light of the changes in geomorphic conditions between 1996 and 2016. The final objective of this effort was to recommend changes to the existing CCAP documents and ordinances to improve future implementation of the program based on quantified geomorphic changes since the program was implemented. This evaluation included a comprehensive review of all CCAP documents and ordinances, review and extraction of data from the 1995 Technical Studies, collection and integration of all relevant geomorphic data generated by the program since 1996, review of previous Technical Advisory Committee (TAC) annual reports, and new analyses of Cache Creek topography change, channel form change, and hydraulic modeling.

1.2 METHODS AND ASSUMPTIONS

This retrospective analysis included the following analyses:

- Review of the 1995 Technical Studies (Northwest Hydraulic Consultants, David Keith Todd Consulting Engineers, and EIP Associates, 1995) and extraction of relevant geomorphic data from study results.
- Collection, integration, and organization of aerial photography and elevation data for the CCRMP area collected between 1996 and 2016.
- Mapping of active channel areas using historical aerial photographs taken between 1996 and 2016 to delineate and quantify channel change.
- Measuring and comparing channel slope and sinuosity between 1996 and 2016.
- Calculating differences in elevations from historical topography data collected between 1996 and 2016 to quantify volume, timing, and location of sediment deposition and erosion in the CCRMP area.
- Developing recommendations to improve the CCAP documents and ordinances based on analysis results.
- Creating an organized database and simple “dashboard” viewer tools to archive and provide ongoing web access to all data and analysis results generated by this effort (provide as an internet web service, not a component of this report).
- Analyses were completed for the entire CCRMP area and broken out by geomorphic reach.

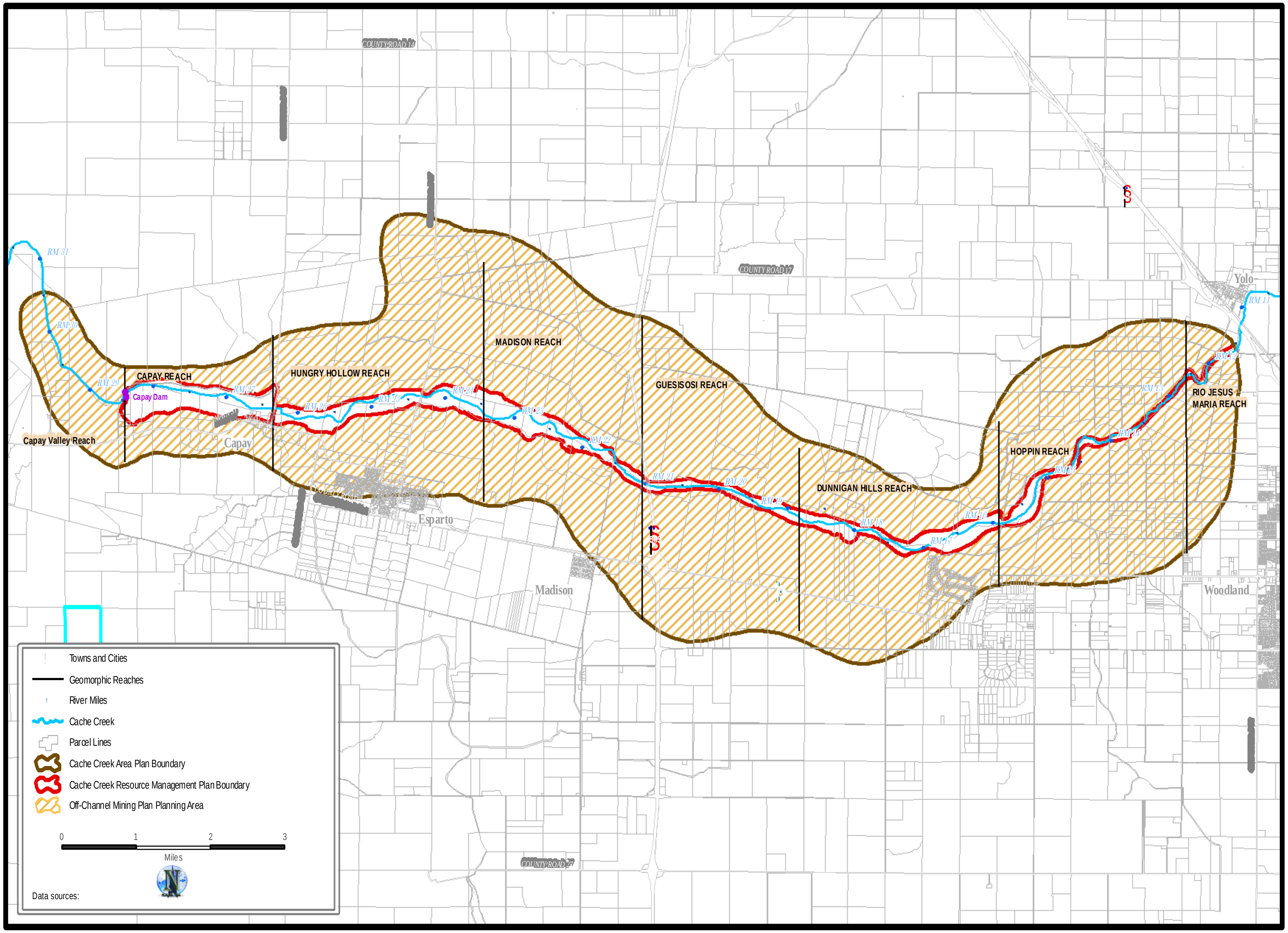

FIGURE 1.1: STUDY AREA EXTENT FOR GEOMORPHIC ANALYSES SHOWING RIVER MILES AND PROGRAM BOUNDARIES.

The major assumption of this evaluation is that the available topographic and aerial photography data for the period between 1996 and 2016 accurately captures channel change through time along Cache Creek in the CCRMP area. While this assumption is reasonable with respect to longer term analyses and results (e.g. comparison of topography between 2011 and 1997), it does result in knowledge gaps around channel change from year to year. This analysis also assumes that these data were collected in consistent ways, are comparable across years, and are of similar quality.

1.3 RESULTS AND DISCUSSION

The major findings of this analysis are summarized below. Detailed results and discussion follow the summary.

1.3.1 FLUVIAL GEOMORPHOLOGY FINDINGS SUMMARY

- ***The streamway influence boundary delineated in the 1995 Technical Studies is a product of sound geomorphic principles and should continue to be used in future implementation of the CCAP.***

  This boundary was developed based on an evaluation of extremely long term processes that have shaped the Cache Creek corridor for centuries and precede in-channel commercial aggregate mining. Because these historical geomorphic conditions have not changed in the past twenty years, this boundary remains relevant for the future management of Cache Creek.

- ***The general idea behind the Test 3 Concept and Boundary remains valid, however, some assumptions of the Test 3 hydraulic modeling have not been fully implemented, so the Test 3 Boundary should be updated (and renamed) to reflect current understanding of channel conditions and change.***

  The hydraulic modeling analyses conducted in support of Test 3 assumed a “smoothed” Cache Creek corridor shape (i.e. removal of flow redirections and obstructions), hardened river bed areas at bridges, and more gradual channel width transitions upstream and downstream of bridges. The hydraulic modeling completed in 1995 indicated that if implemented, the Test 3 Boundary would result in more stable channel conditions. New mine operations have been required to implement measures to achieve the Test 3 Boundary, and the bridge transition at I-505 has been smoothed with training berms since 1996. However, these changes constitute a relatively small portion of the change assumed under the Test 3 concept. The channel boundary throughout most of the CCRMP has remained unchanged since 1996, most bridge transitions have not been smoothed, and no river bed hardening has occurred at bridges since 1996.

Even without these changes, some of the geomorphic improvements expected under the Test 3 concept have occurred between 1996 and 2016: sediment has significantly aggraded in parts of the channel, active channel sinuosity has increased and slope has decreased in parts of the channel, and riparian vegetation has become more widely established throughout the CCRMP. Some of the increased stability expected under the Test 3 concept has occurred without full implementation of the concept. Because current best management practices in creek restoration (Wohl et al 2015) have evolved away from the structural approaches of the Test 3 concept and toward process-based approaches that stress the importance of channel complexity and maximizing available area for channel evolution, the Test 3 line should be updated and renamed the "Channel Form Template" to reflect current understanding of Cache Creek geomorphology and best management practices.

- ***The primary active channel of Cache Creek has migrated extensively since 1996.***

  In highly active reaches, the primary active channel has migrated laterally over 1,000 feet within the CCRMP area over the past twenty years. This long-term channel change varies significantly by reach and is described in more detail in the following sections.

- ***A total of approximately ten million tons of sediment was deposited in Cache Creek in the CCRMP area between 1996 and 2011.***

  The most recent topographic data available for this analysis was from 2011. However, because peak flows and resulting sediment transport have been very low during the drought years of 2012 to 2016, significant additional deposition did not occur after 2011. This long-term net-deposition trend varies annually (i.e. it doesn't occur at the same rate from year to year), with the majority of deposited sediment occurring during peak flows between 25,000 to 30,000 cfs (approximately a 10-year recurrence interval flow). The ten million tons deposited in the CCRMP area is approximately 55% of the 18.6 million tons of sediment estimated to be moving through the CCRMP area between 1996 and 2011.

- ***Sediment deposition has occurred almost exclusively on channel bars.***

  While there has been large-scale sediment deposition in the CCRMP area over the past twenty years, it appears to have occurred mainly on large gravel bars that have increased in size since 1996. The active channel thalweg (i.e. the lowest portion of the channel) elevation has not increased significantly over the last twenty years. Some portions of the active channel have lowered and others have increased in elevation. In general, the base level (i.e. the controlling low elevation) in most reaches of Cache Creek has not changed significantly over the last twenty years.

- ***The long term trend of sediment deposition in Cache Creek since 1996 is interspersed with years of erosion in the CCRMP area.***

  It appears that smaller peak flows (less than 25,000 cfs) can erode more sediment than the volume deposited the CCRMP area. This occurred between 2002 and 2004 (net erosion with peak flows of 12,400 cfs and 22,300 cfs), 2005 and 2006 (net erosion with a peak flow of 5,100 cfs), and 2010 and 2011 (net erosion with a peak flow of 9,890 cfs).

- ***Lateral channel migration in dynamic reaches typically occurs during peak flows between 15,000 and 25,000 cfs (greater than two-year but less than ten-year recurrence interval flows).***

  Peak flows of this magnitude, especially when followed by additional peaks in a water year or followed by more than ten days of base flows greater than 5,000 to 10,000 cfs result in significant channel migration in most reaches of Cache Creek. This migration is driven by the sediment transport that causes deposition in some areas and erosion in others that builds in-channel and point bars.

- ***Active channel sinuosity has increased from the degraded 1995 condition in all of the reaches in the CCRMP except for the Hoppin and Rio Jesus Maria reaches.***

  Sediment transport during peak flows in Cache Creek causes erosion and deposition that has produced more sinuous active channel configurations over the past twenty years. The increased sinuosity has also resulted in more topographic diversity (i.e. differences in elevation) in many reaches of Cache Creek.

- ***Lateral channel migration and magnitude of erosion and/or deposition varies by reach and with magnitude of peak flows.***

  While channel conditions have changed throughout Cache Creek, the magnitude of change varies considerably from reach to reach. Increases in sinuosity are greatest in wider reaches where hydraulics and sediment transport during high flows are more conducive to erosion and deposition.

1.3.2 Fluvial Geomorphology Data Availability 1996-2016

The 1996 to 2016 period is an informative but somewhat challenging period over which to evaluate changes in geomorphic conditions. The periods is characterized by extremely high flows and sediment transport (which drive geomorphic change) in the first few years of the period, followed by relatively low flow conditions for the rest of the period, with the 2012 to 2016 period as one of the most extreme droughts on record in California. Surface water hydrology data was available for the entire study period. Aerial photography suitable for mapping of active channel features was available in 1996, 1998, 2005, 2006, 2010, 2011, and 2015. The seven-year gap between 1998 and 2005 limited interpretations of channel change after the high magnitude 1998 peak flows. Topographic data suitable for calculating deposition and erosion of sediment was available for 1997, 1998, 2002, 2004, 2005, 2006, 2010, and 2011. The lack of suitable topographic data between 2006 and 2010 and 2010 and 2015 limited evaluation of sediment transport conditions over these relatively long periods. Despite these limitations on geomorphic data availability, this evaluation included sufficient data to characterize and quantify major geomorphic changes during the study period.

1.3.3 CCRMP AREA RESULTS

Hydrology

Hydrology is the primary driver of channel and topographic change in any creek system. The discussion of results by geomorphic reach that follows requires a basic understanding of the hydrologic conditions that have occurred in Cache Creek between 1996 and 2016, as well as during the period before 2016. Table 1.1 summarizes results from a flood frequency analysis developed with the U.S. Army Corps of Engineers Statistical Bulletin 17B approach detailed in the Hydraulic Engineering technical report. The purpose of duplicating these results here is to provide context for the comparisons of active channel areas and topography that comprise the majority of this geomorphic analysis. Peak flow conditions in Cache Creek range from a 2-year flow of approximately 11,000 cfs up to a 100-year flow of approximately 45,000 cfs. Table 1.2 provides a summary of every peak flow that occurred between 1996 and 2016. This table is useful for interpreting the channel changes illustrated for each geomorphic reach between years with available aerial photography data and topographic data. Table 1.2 also provides Water Year types that are an index of how wet or dry a particular year was in the entire Sacramento River Valley.

TABLE 1.1: CACHE CREEK FLOW FREQUENCY ANALYSIS.

Return Interval (yr.)	Annual % Chance of Exceedance	Cache Creek at Yolo (1903-2014)		
		Computed Flow (cfs)	Confidence Limits	
			0.05	0.95
100	1	44,761	58,772	35,475
50	2	41,529	54,156	33,078
20	5	35,843	46,138	28,818
10	10	30,187	38,304	24,516
5	20	23,097	28,722	19,015
2	50	11,185	13,408	9,383

TABLE 1.2: CACHE CREEK PEAK FLOWS AND SACRAMENTO VALLEY WATER YEAR TYPE CLASSIFICATION.

Water Year	Cache at Yolo		Water Year Type [1]
	Peak Flow (cfs)	Date of Peak	
1996	17,400	2/4/1996	W
1997	28,700	1/1/1997	W
1998	34,600	2/3/1998	W
1999	9,830	2/9/1999	W
2000	5,740	2/14/2000	AN
2001	9,270	3/5/2001	D
2002	12,400	1/2/2002	D
2003	22,300	12/16/2002	AN
2004	14,900	2/26/2004	BN
2005	5,100	3/22/2005	AN
2006	29,900	12/31/2005	W
2007	1,770	2/11/2007	D
2008	13,900	1/26/2008	C
2009	3,150	3/3/2009	D
2010	9,890	1/21/2010	BN
2011	15,900	3/20/2011	W
2012	2,380	3/28/2012	BN
2013	10,900	12/24/2012	D
2014	325	3/1/2014	C
2015 [2]	16,500	12/12/2014	C

1 DWR water year type classification for the Sacramento Valley based on hydrologic classification indices (http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST)

2 Peak flow from 15-minute USGS data at Yolo gage

Fluvial Geomorphology

The geomorphic reaches identified in the 1995 Technical Studies (NHC 1995) were based on sound geomorphic principles and still provide a useful geographic organizing structure. Figure 1.2 shows all of the geomorphic reaches in the CCRMP area. Table 1.3 summarizes the major geomorphic changes across all CCRMP reaches between 1996 and 2016. The active channel did not move significantly in the Capay, Dunnigan Hills, Hoppin, and Rio Jesus Maria reaches. The active channel moved extensively in the Hungry Hollow reach and moderately in the Madison and Geusisosi reaches. The reaches with significant channel migration are mobilized by much lower flows than the reaches with minimal channel migration. Sinuosity has increased in all but the two most downstream reaches. The Dunnigan Hills, Guesisosi, Hungry Hollow, and Capay reaches have all achieved the sinuosity targets set in the 1995 Technical Studies. Finally, all reaches have experienced significant sediment deposition since 1996.

TABLE 1.3: SUMMARY OF MAJOR GEOMORPHIC CHANGES BETWEEN 1996 AND2015 IN ALL CCRMP REACHES.

Reach	**Scale of Lateral Migration**	**Migration Flow Threshold**	**Sinuosity Change**	**1996 - 2011 Deposition (tons)**
Capay	Minimal	30,000	4%	2,292,505
Hungry Hollow	Extensive	15,000	16%	3,081,493
Madison	Moderate	15,000	6%	2,823,057
Geusisosi	Moderate	15,000	6%	1,239,833
Dunnigan Hills	Minimal	30,000	6%	2,684,507
Hoppin	Minimal	30,000	-1%	2,377,213
Rio Jesus Maria	Minimal	30,000	-9%	281,976
			Total	**14,780,584**

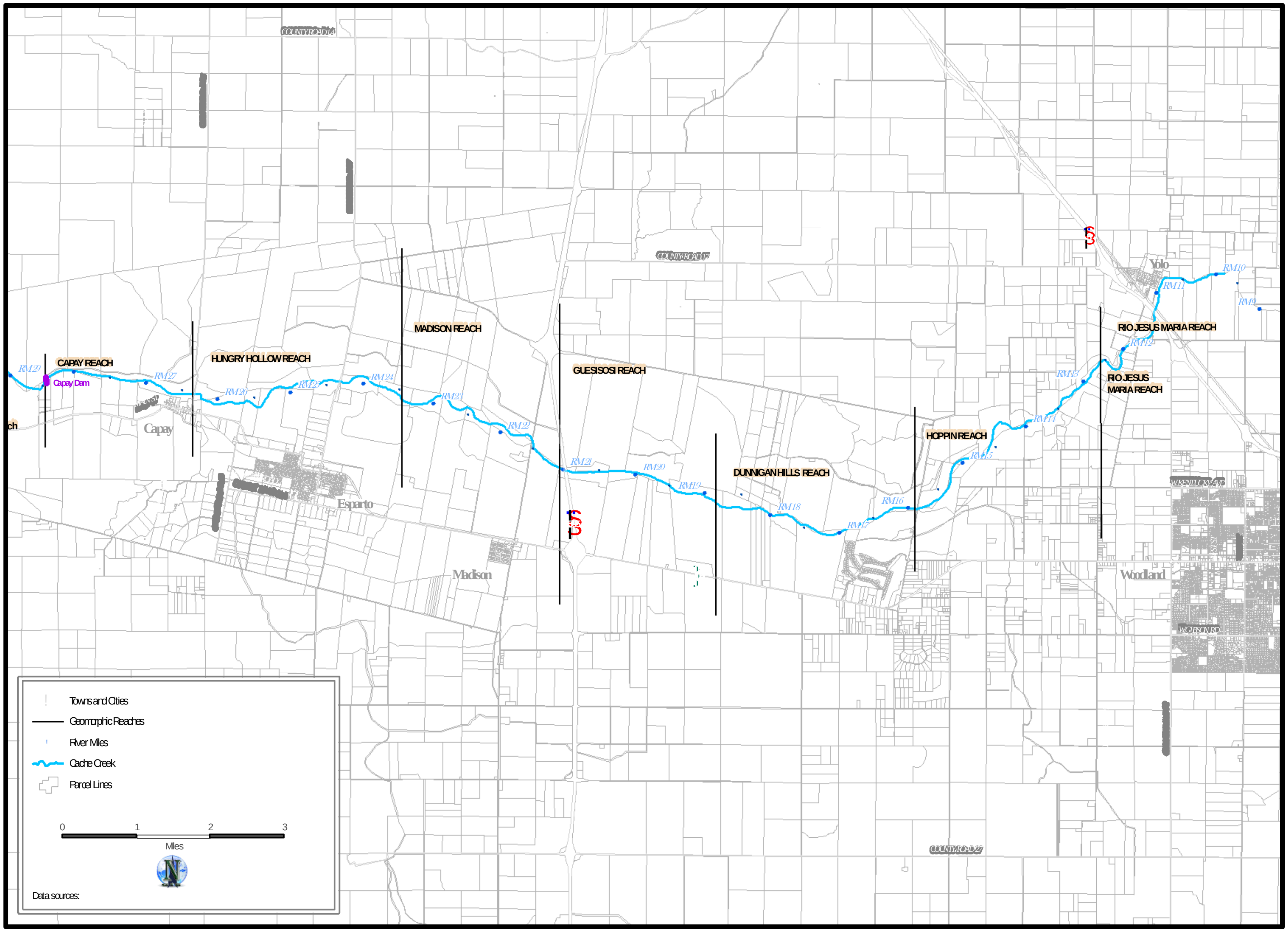

FIGURE 1.2: GEOMORPHIC REACHES IN THE CCRMP AREA.

Figure 1.3 shows total sediment transport through the CCRMP area between Water Year 1995 and Water Year 2016 calculated using a regression equation based on suspended sediment measurements at the USGS Yolo flow gage. It is clear that the majority of sediment transport occurred in the late 1990s, with very low sediment transport over the last sixteen years. This is important because the majority of sediment delivered to Cache Creek over the last twenty years occurred immediately before or immediately after in-channel mining ceased. Over eighteen million tons of sediment was transported during this period, with a peak annual transport of 4.5 million tons and an average annual transport of 860,000 tons.

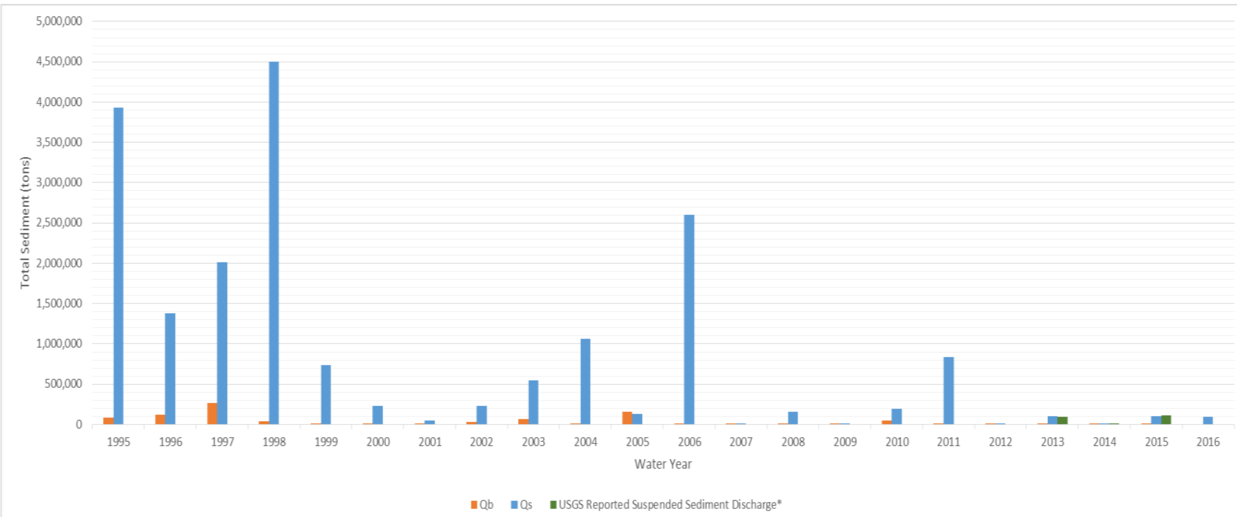

FIGURE 1.3: ESTIMATED SUSPENDED (QS) AND BEDLOAD (QB) SEDIMENT TRANSPORT IN THE CCRMP AREA WITH USGS MEASURED SEDIMENT TRANSPORT WHEN AVAILABLE.

Figure 1.4 shows channel thalweg elevation profiles for the entire CCRMP area in 1998, 2006, and 2011. The trend of elevation change over this time period is not consistent across all CCRMP reaches. Over long distances the channel thalweg elevation has remained about the same since 1998. However, there are areas where the channel thalweg elevation has increased or decreased significantly since 1998. This indicates that the significant sediment deposition throughout the CCRMP area is not yet raising the base channel elevation in Cache Creek. Rather, the deposition is occurring in a spatially distributed way on channel bar features that have increased in size and extent over the past twenty years. This phenomena is discussed in more detail in the reach-specific results that follow.

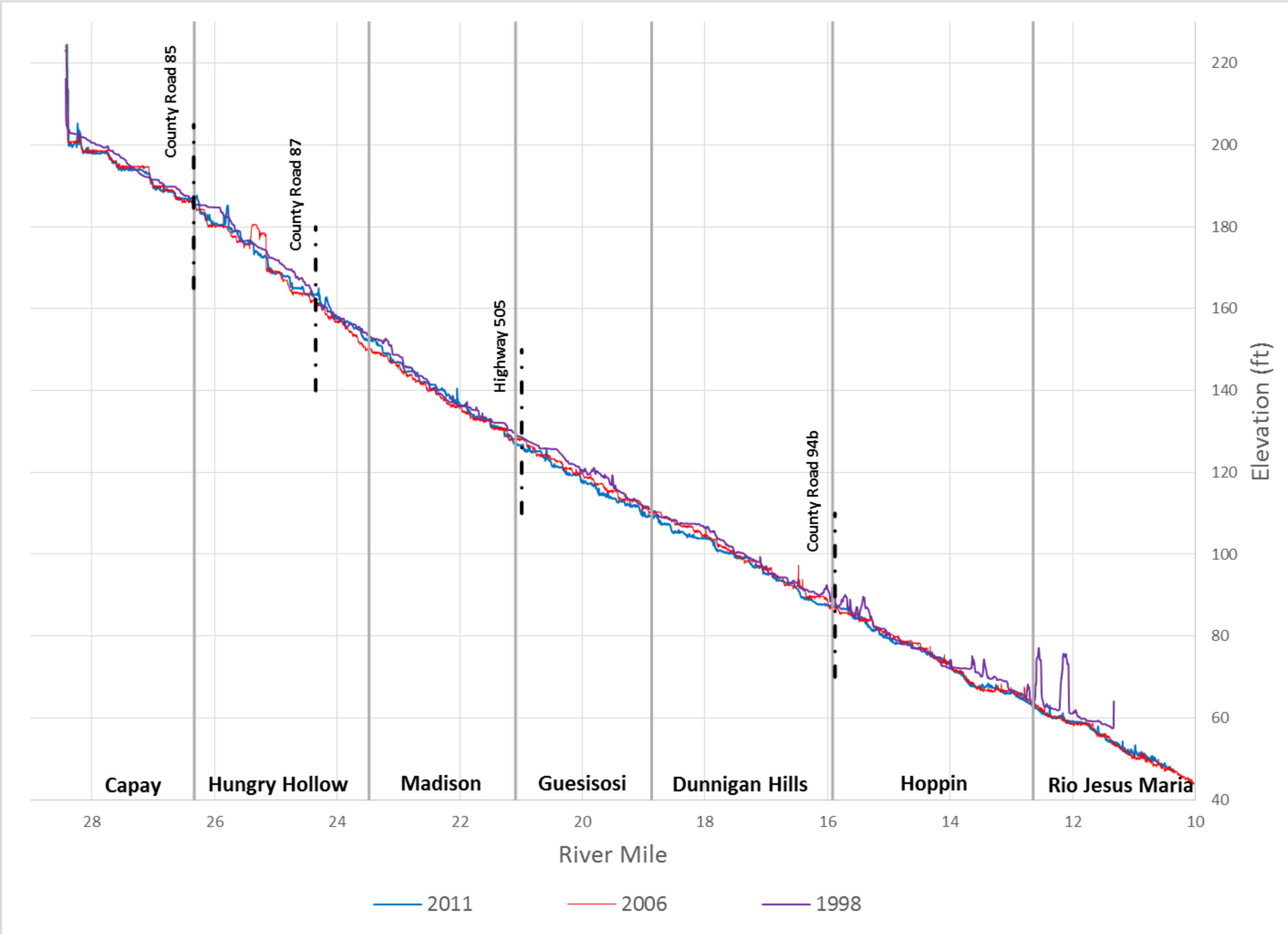

FIGURE 1.4: CHANNEL THALWEG PROFILES IN THE CCRMP AREA IN 1998, 2006, AND 2011.

1.3.4 CCRMP Geomorphic Reach Specific Results

Capay Reach

The upstream end of the Capay reach is immediately below the Capay Dam spillway, and the reach extends approximately two miles downstream to the Capay Bridge (Road 85). The Capay reach is as a steep, confined, and incised reach formed predominantly on bedrock of the Capay and Tehama formations. This reach is a gaining reach, in that groundwater drains into the creek here during low-flow periods. Riparian vegetation covers the banks of the active channel throughout this reach, with some remnant stands of mature riparian forest on the upper terraces adjacent to this reach.

Channel and Topographic Change

The Capay Reach channel has been mostly stable laterally since 1996, with minimal lateral migration occurring only near the downstream end of the reach during peak flows exceeding 30,000 cfs. This reach has experienced approximately 424,000 tons of net deposition between 1996 and 2011, with small volumes (tens of thousands of tons) of inter-annual erosion. Figure 1.5 is a channel migration map showing the location of the active channel as it migrated between 1996 and 2015. The only area of significant channel migration is the large left bank channel bar near the downstream end of the reach. Most of the net deposition on this reach occurred on this bar. Figure 1.6 is a map of the deposition and erosion that has occurred throughout this reach, and Figure 1.7 is a plot of the channel thalweg profile in 1998, 2006, and 2011. While the thalweg elevation has decreased in the upstream half of the reach and both increases and decreases in the downstream half of the reach, the deposition and erosion maps shows mostly areas of relatively minor deposition, with the only significant erosion adjacent to the significant deposition of the bar feature at the downstream end of the reach that has pushed the primary active channel to the south.

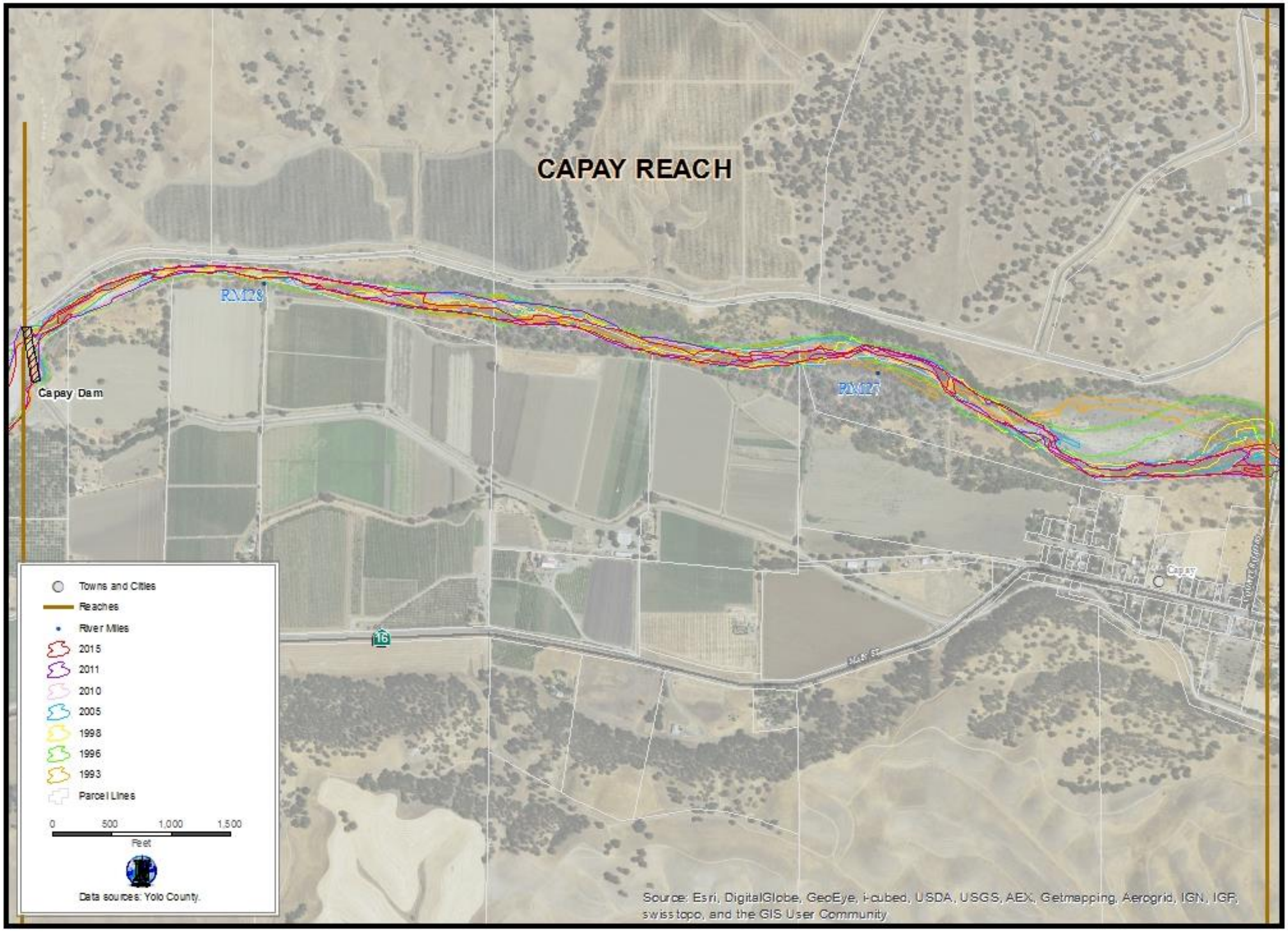

FIGURE 1.5: ACTIVE CHANNEL LOCATIONS IN THE CAPAY REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

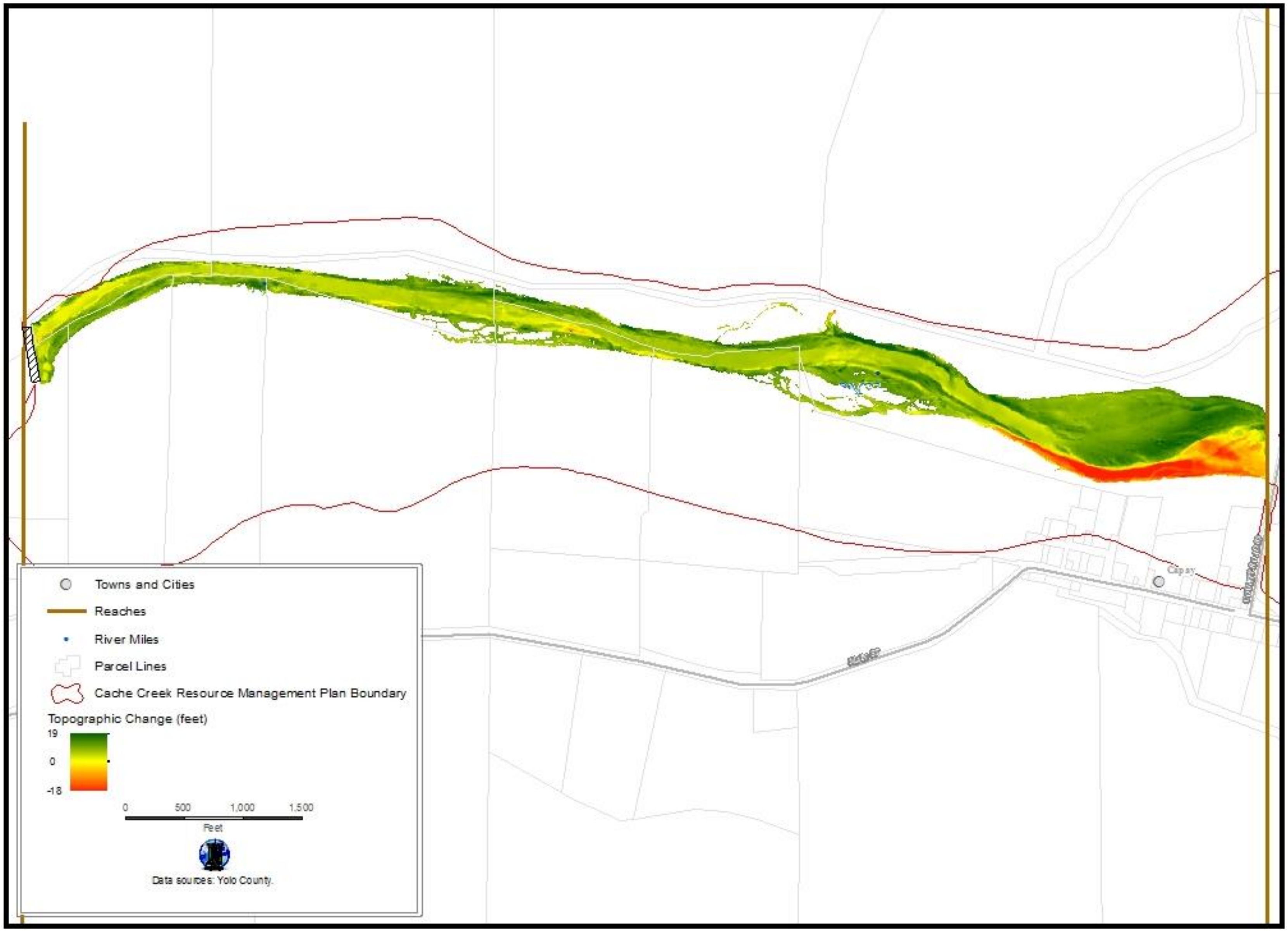

FIGURE 1.6: AREAS OF EROSION (REDS) AND DEPOSITION (GREENS) BETWEEN 1996 AND 2011.

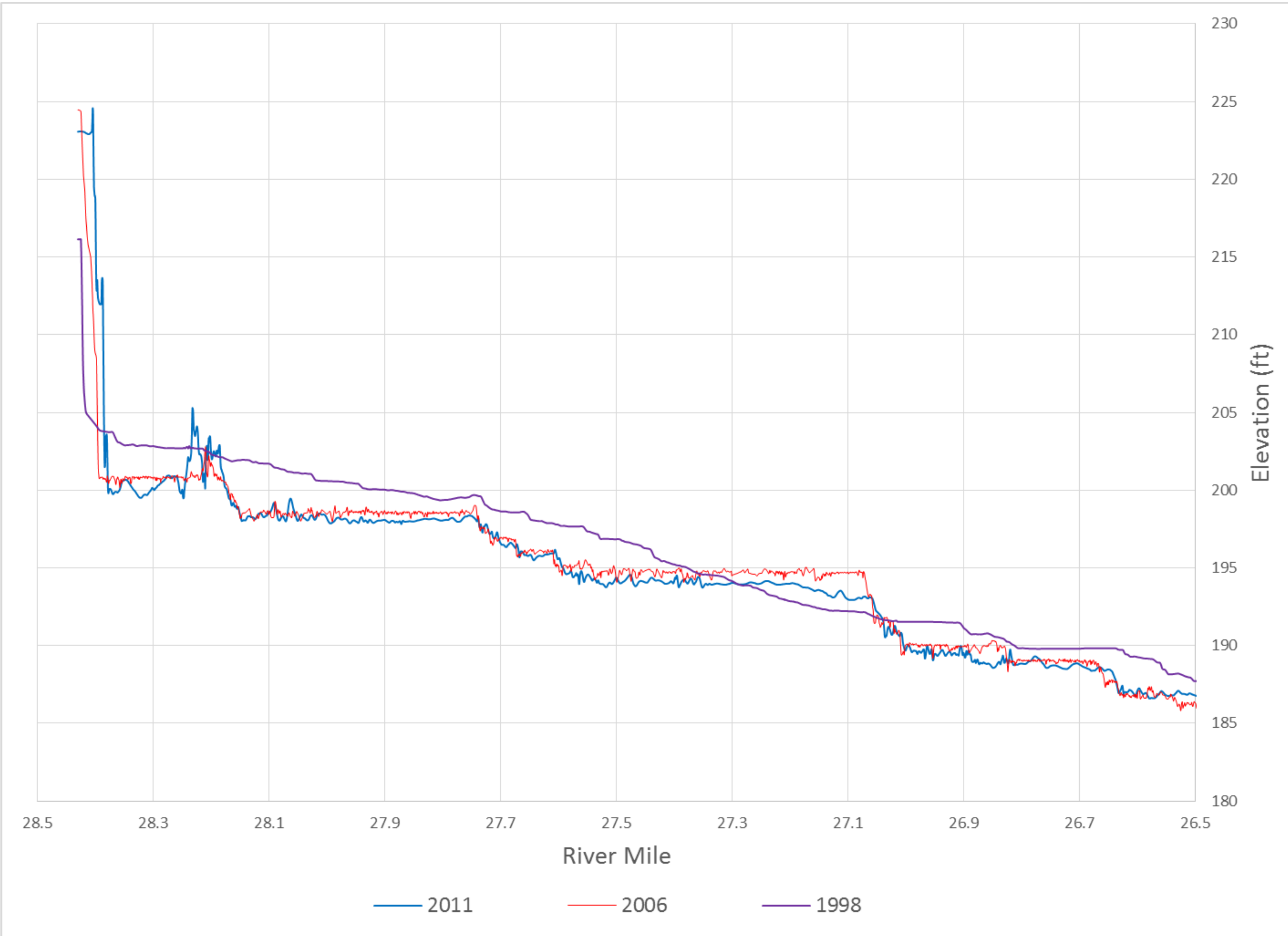

FIGURE 1.7: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE CAPAY REACH IN 1998, 2006, AND 2011.

Hungry Hollow Reach

This 2.8-mile reach extends from the Capay Bridge to just below the Esparto Bridge. The channel here is developed variably on bedrock and alluvium within the reach. Downstream of the Capay reach, the channel widens and is braided. Prior to 1996, imbalances between sediment supply and transport lowered the channel bed in this reach and reduced the degree of braiding and the width of the corridor occupied by the actively migrating channel. This is the beginning of a losing reach of Cache Creek (i.e. surface flows are lost to groundwater), and the hydrology here appears to limit establishment and succession of riparian vegetation.

Channel and Topographic Change

The Hungry Hollow reach channel is extremely dynamic, with large-scale lateral migration occurring throughout the reach during peak flows as low as 15,000 cfs. This reach has experienced approximately 2.4 million tons of net deposition between 1996 and 2011, with smaller volumes (hundreds of thousands of tons) of inter-annual deposition and erosion. Figure 1.8 is a channel migration map showing the location of the active channel as it migrated extensively between 1996 and 2015. This channel migration has been accompanied by significant sediment bar deposition throughout the reach. Figure 1.9 is a map of the deposition and erosion that has occurred throughout this reach, and Figure 1.10 is a plot of the channel thalweg profile in 1998, 2006, and 2011. Similar to the Capay Reach, the thalweg elevation has decreased in the upstream half of the reach, and both decreased an increased in the downstream half of the reach. As in the Capay reach, the large volume of deposition in this reach has not increased the base elevation of the channel thalweg. Rather it has formed large bars as the active channel has migrated laterally over time. Notably, it appears that the active channel bed has aggraded several feet at both of the bridges in this reach.

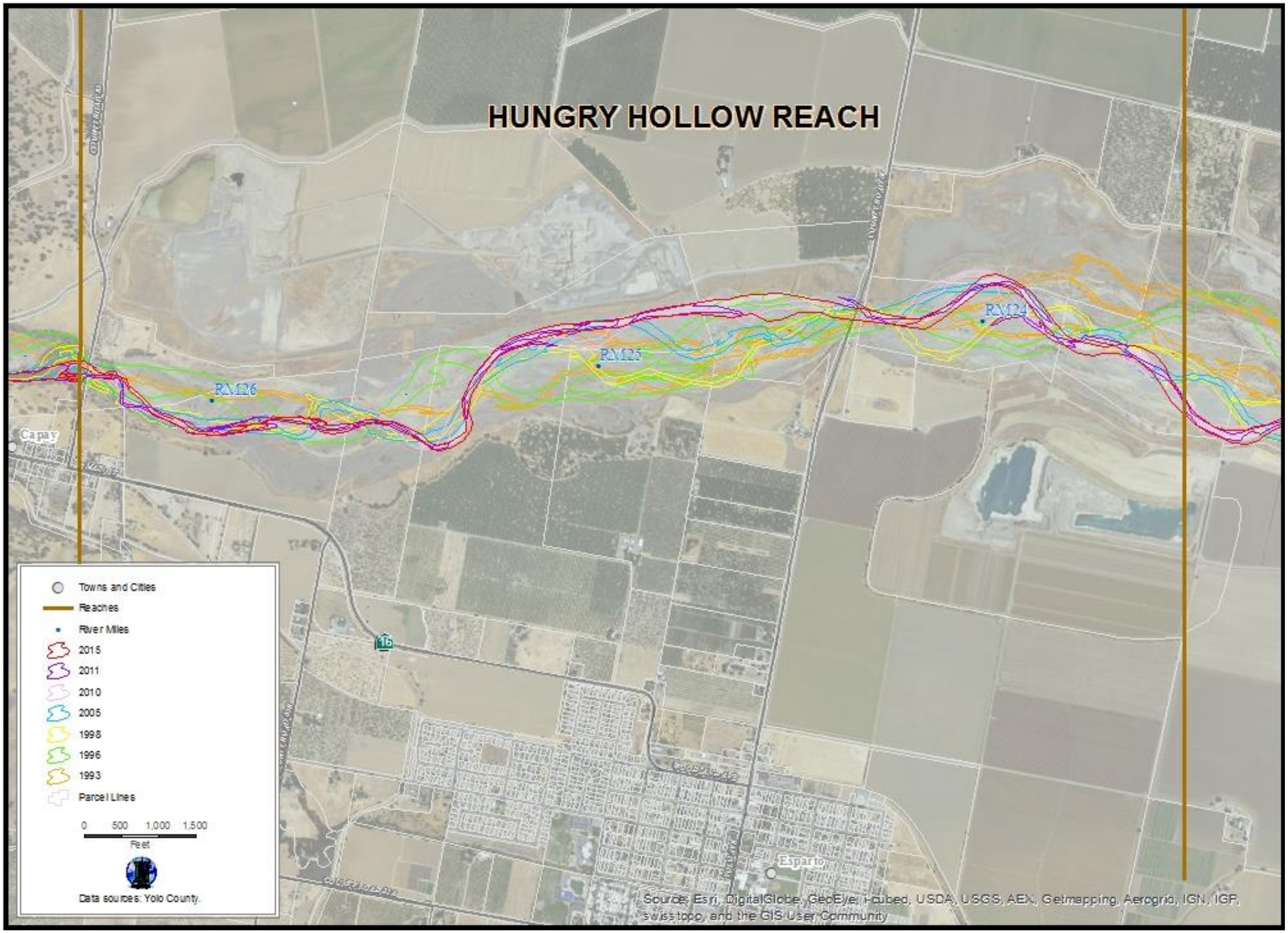

FIGURE 1.8: ACTIVE CHANNEL LOCATIONS IN THE HUNGRY HOLLOW REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

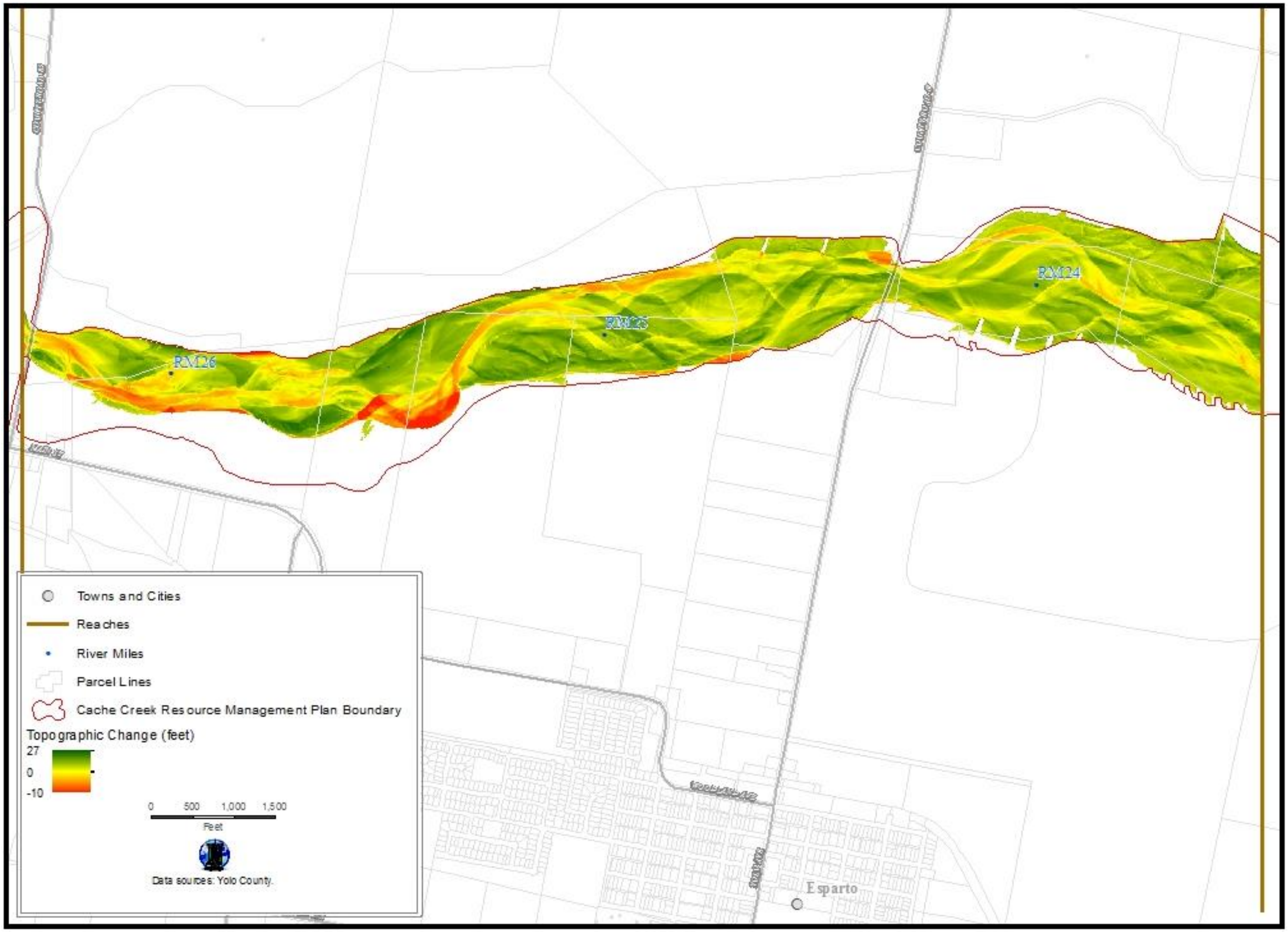

FIGURE 1.9: AREAS OF EROSION (REDS) AND DEPOSITION (GREENS) BETWEEN 1996 AND 2011.

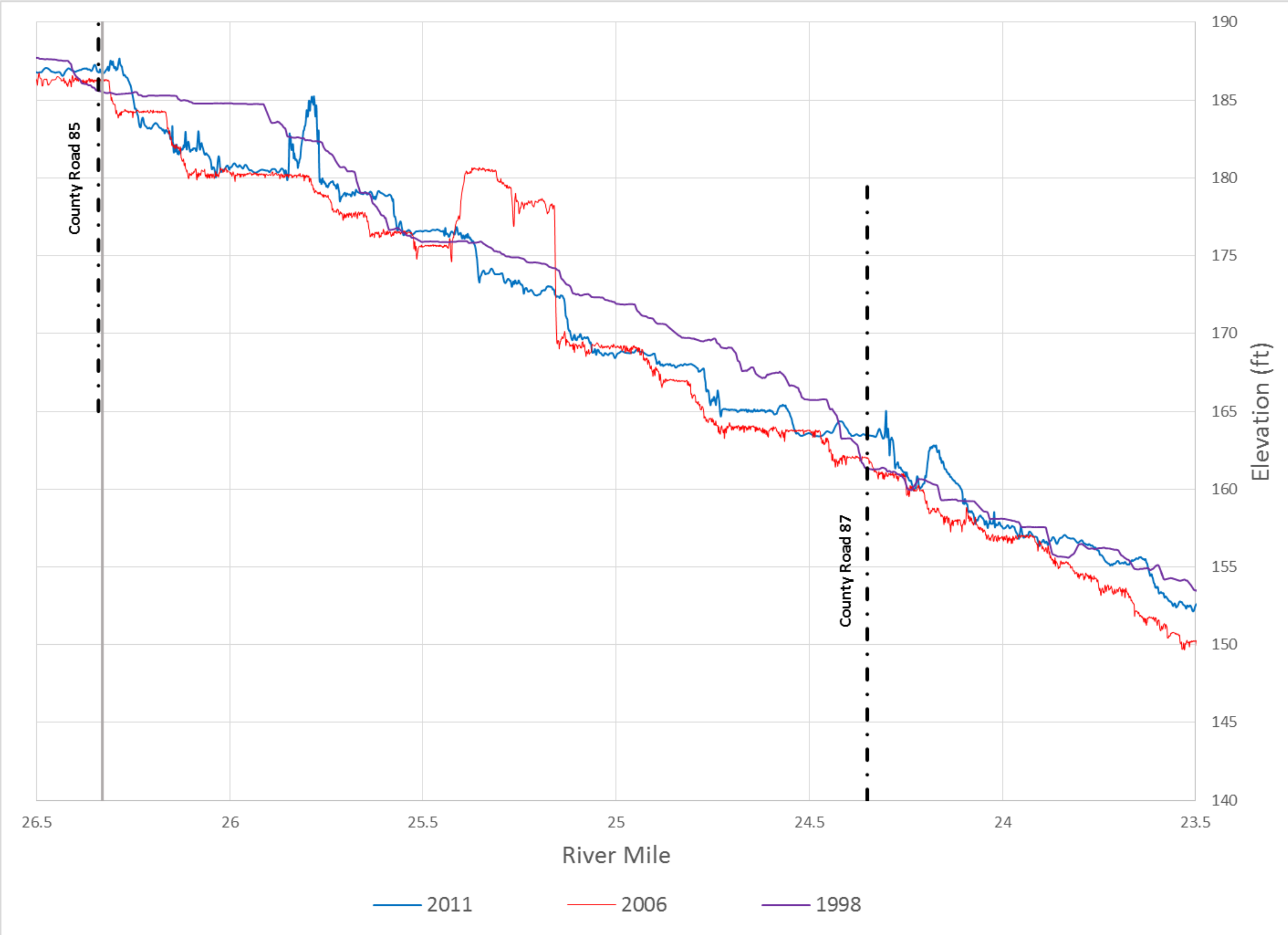

FIGURE 1.10: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE HUNGRY HOLLOW REACH IN 1998, 2006, AND 2011.

Madison Reach

The 2.4-mile-long Madison reach is located between the Esparto Bridge and just upstream of the Highway 505 Bridge. Within the Madison reach, the amplitude and curvature of the active channel meanders increase. The channel in this reach is developed entirely on alluvial sediments. The upstream portion of this reach is a continuation of the losing Hungry Hollow reach. The channel transitions into the gaining Guesisosi reach as it progresses through the lower portion of the reach. Extensive gravel bars and a lowered water table characterize this reach and influence vegetation establishment and succession.

Channel and Topographic Change

The Madison reach channel is dynamic, with moderate lateral migration occurring throughout the reach during peak flows as low as 15,000 cfs. This reach has experienced approximately 1.9 million tons of net deposition between 1996 and 2011, with smaller volumes (hundreds of thousands of tons) of inter-annual deposition and erosion. Figure 1.11 is a channel migration map showing extensive migration in the upstream half of the reach between 1996 and 2015, and more limited migration in the downstream half of the reach that has progressed into and through the Test 3 Boundary. As in the Hungry Hollow Reach, channel migration has been accompanied by significant sediment bar deposition, primarily in the upstream half of the reach. Figure 1.12 is a map of the deposition and erosion that has occurred throughout this reach, and Figure 1.13 is a plot of the channel thalweg profile in 1998, 2006, and 2011. The thalweg elevation has mostly increased in the upstream half of the reach, and mostly decreased in the downstream half of the reach. The large volume of deposition in this reach may be increasing the base elevation of the channel thalweg in the upstream half of the reach, but not in the downstream half of the reach. Therefore, deposition in this reach appears to be occurring both in the active channel and on channel bars.

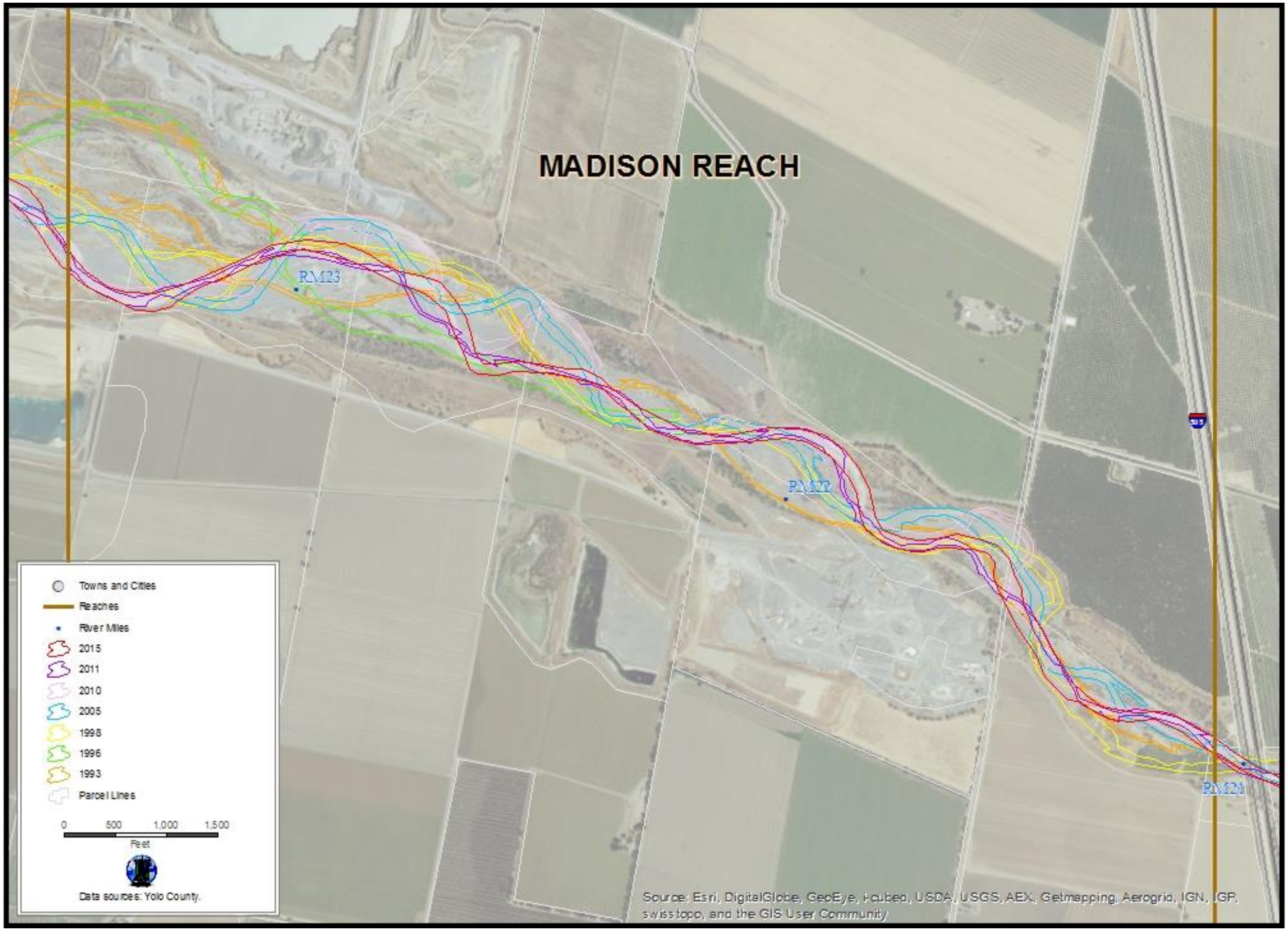

FIGURE 1.11: ACTIVE CHANNEL LOCATIONS IN THE MADISON REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

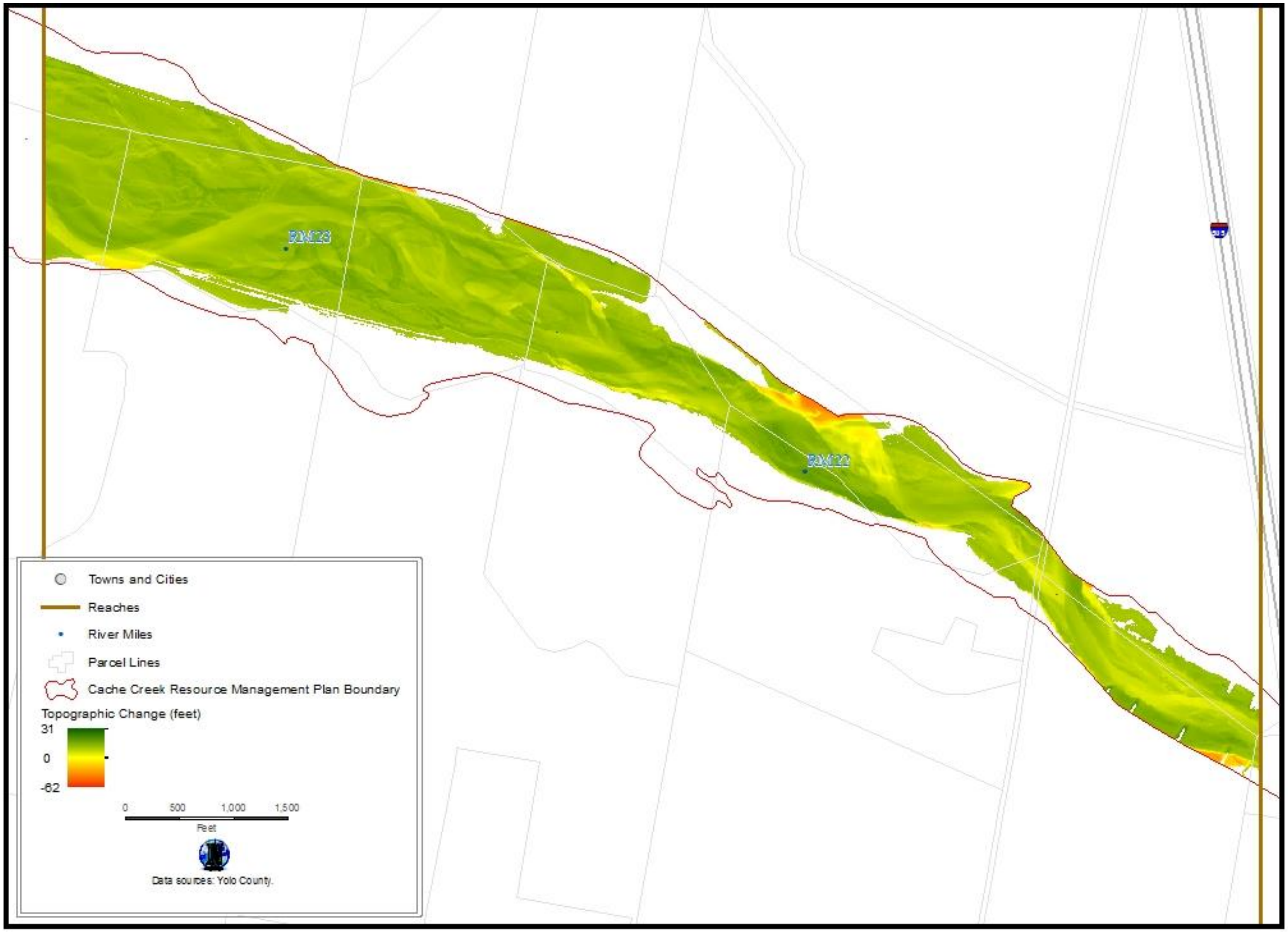

FIGURE 1.12: AREAS OF EROSION (REDS) AND DEPOSITION (GREENS) BETWEEN 1996 AND 2011.

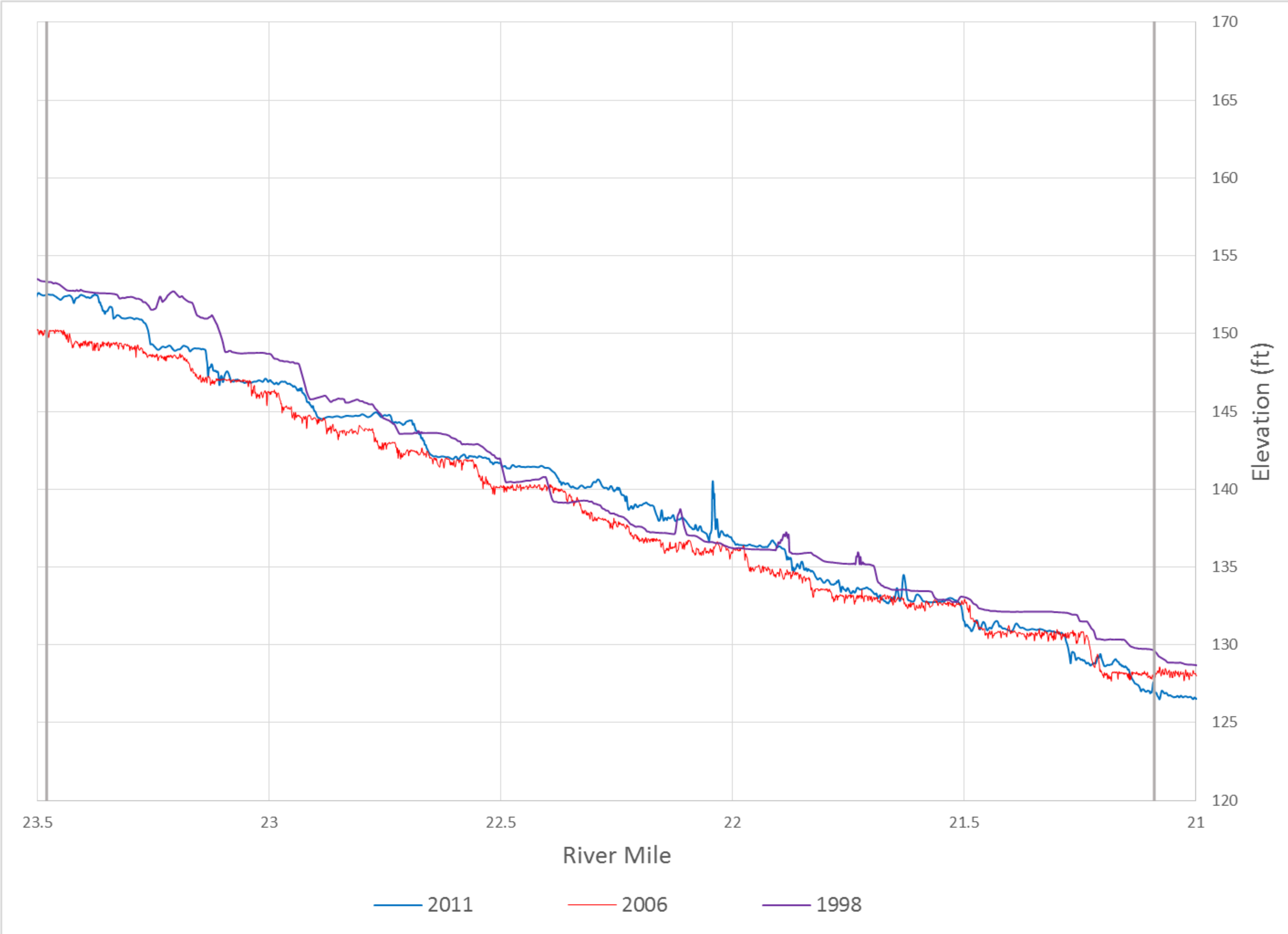

FIGURE 1.13: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE MADISON REACH IN 1998, 2006, AND 2011.

Guesisosi Reach

The Guesisosi reach begins just downstream of the Highway 505 bridge and extends for 2.2 miles downstream. Relative to the Madison reach, the Guesisosi reach is narrower and straighter, and the channel is developed entirely on alluvium. The channel varies from somewhat straight in the upper section to meandering in the lower section. This reach is a gaining reach where the groundwater table is relatively high due to the presence of a bedrock constriction along the Dunnigan Hills - Plainfield Ridge transition. Riparian vegetation is more prevalent in this area in comparison to upstream reaches, likely due in part to the higher groundwater levels.

Channel and Topographic Change

The Guesisosi reach channel is partly dynamic, with moderate lateral migration occurring in the upstream third of the reach during peak flows as low as 15,000 cfs. This reach has experienced approximately 789,000 tons of net deposition between 1996 and 2011, with smaller volumes (tens of thousands of tons) of inter-annual deposition and erosion. Figure 1.14 is a channel migration map showing how the channel becomes much more laterally constrained in this reach, with the only significant migration occurring in the upstream third of the reach. There is very limited room for bar formation in the middle of this reach. However, significant bar formation has occurred at the upstream and downstream ends of the reach. Figure 1.15 is a map of the deposition and erosion that has occurred throughout this reach, and Figure 1.16 is a plot of the channel thalweg profile in 1998, 2006, and 2011 showing consistent lowering throughout the reach. The deposition in this reach is not increasing the base elevation of the active channel and is therefore occurring almost exclusively on the bars at the upstream and downstream ends of the reach. The lateral confinement in this reach, combined with the bar deposition that has occurred since 1996, may be causing the decreasing thalweg elevation trend as high flows become increasingly confined to the active channel and the increased shear stresses from these flows erode channel bed sediments and transport them downstream. The active channel beneath the Highway 505 bridge has lowered several feet since 1997 and should continue to be carefully monitored for signs of additional channel degradation.

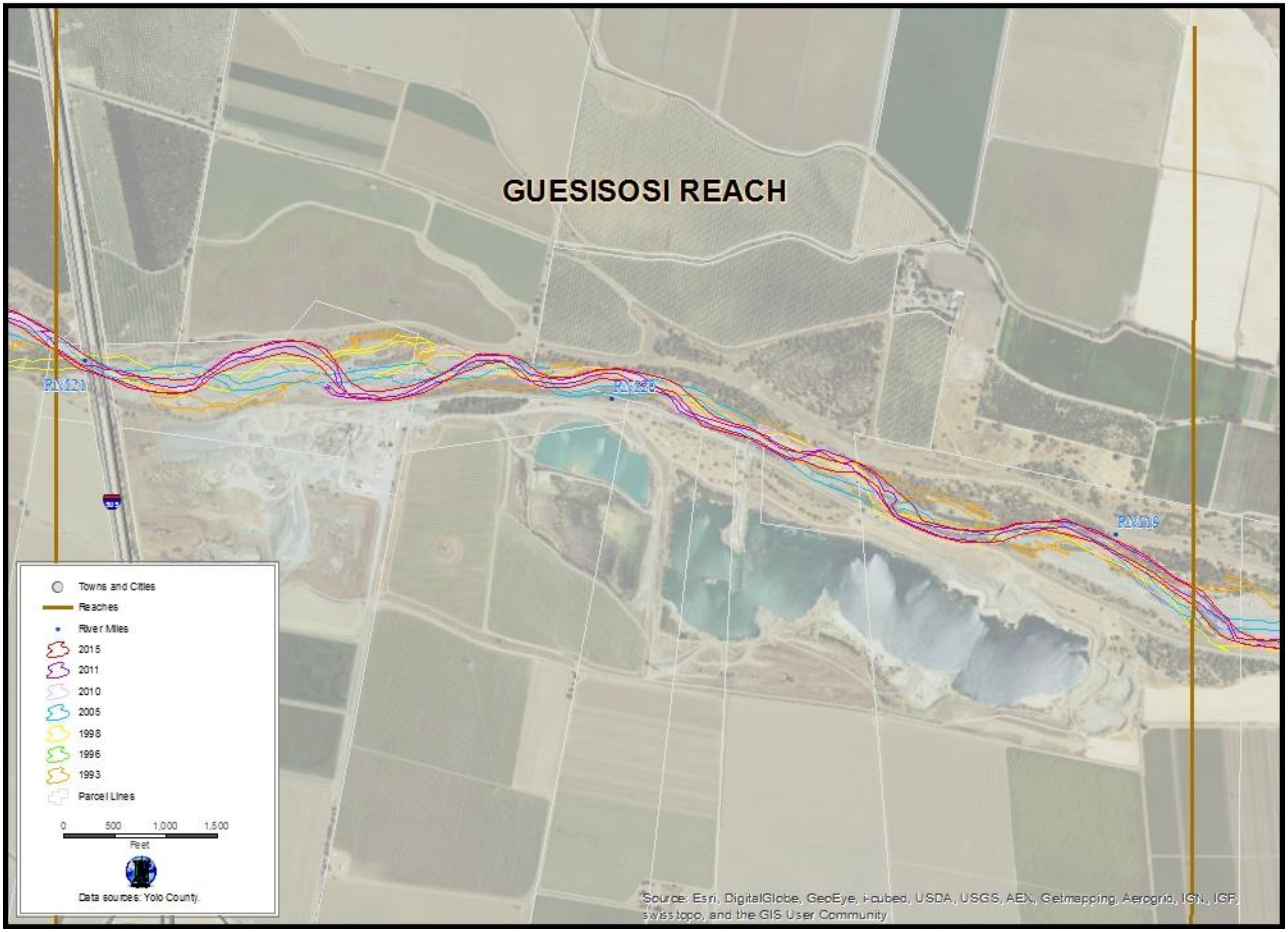

FIGURE 1.14: ACTIVE CHANNEL LOCATIONS IN THE GUESISOSI REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

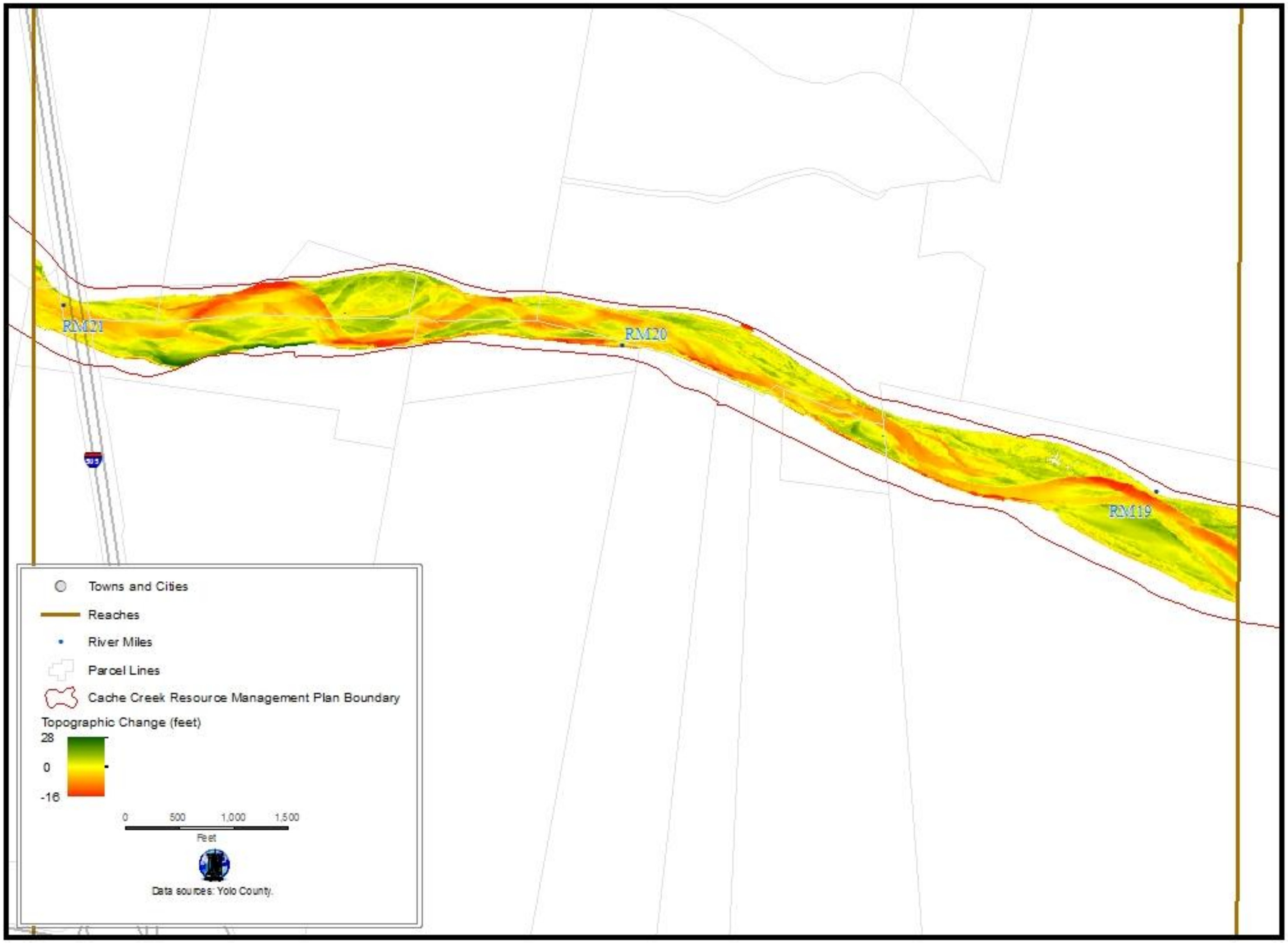

FIGURE 1.15: AREAS OF EROSION (REDS) AND DEPOSITION (GREENS) BETWEEN 1996 AND 2011.

FIGURE 1.16: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE GUESISOSI REACH IN 1998, 2006, AND 2011.

Dunnigan Hills Reach

The Dunnigan Hills reach extends downstream from the Guesisosi reach about 2.8 miles to just upstream of Road 94B. Within the Dunnigan Hills reach, the active channel is incised into bedrock, which underlies the hills. The channel is responding to the active tectonic uplift of the hills by continuing to cut down as the land rises. The channel morphology in this reach transitions into a pattern of widely spaced meanders. This is the only area within the CCRMP that includes natural river terraces above the active floodplain.

Channel and Topographic Change

The Dunnigan Hills reach channel is mostly stable laterally, with some lateral migration occurring during peak flows exceeding 30,000 cfs. This reach has experienced approximately 2.2 million tons of net deposition between 1996 and 2011, with small volumes (tens to hundreds of thousands of tons) of interannual deposition and erosion. Figure 1.17 is a channel migration map showing how the channel becomes even more laterally constrained in this reach, with only limited migration occurring in the upstream third of the reach between 1996 and 2015. As in the Guesisosi reach, there is very limited room for bar formation in the middle of this reach. Some bar formation has occurred at the upstream and downstream ends of the reach. Figure 1.18 is a map of the deposition and erosion that has occurred throughout this reach, and Figure 1.19 is a plot of the channel thalweg profile in 1998, 2006, and 2011 showing how elevation has decreased consistently throughout the reach over time. As in the Guesisosi reach, the deposition in this reach is not increasing the base channel elevation and is therefore occurring on the bars at the upstream and downstream ends of the reach. Again, the lateral confinement in this reach, combined with the bar deposition that has occurred since 1996, may be causing the decreasing thalweg elevation trend as flows become increasingly confined to the active channel and the increased shear stresses from these flows erode the channel bed.

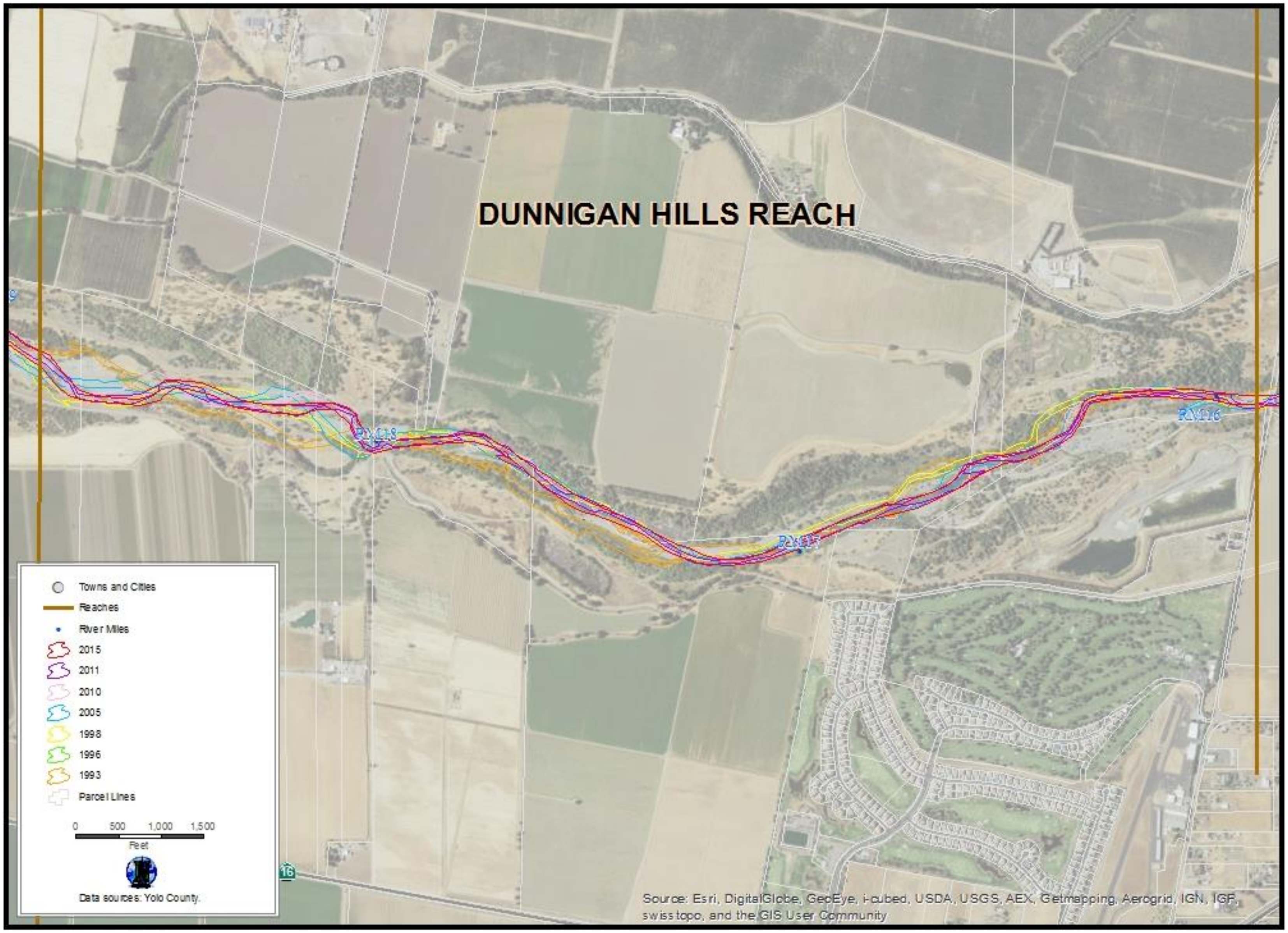

FIGURE 1.17: ACTIVE CHANNEL LOCATIONS IN THE DUNNIGAN HILLS REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

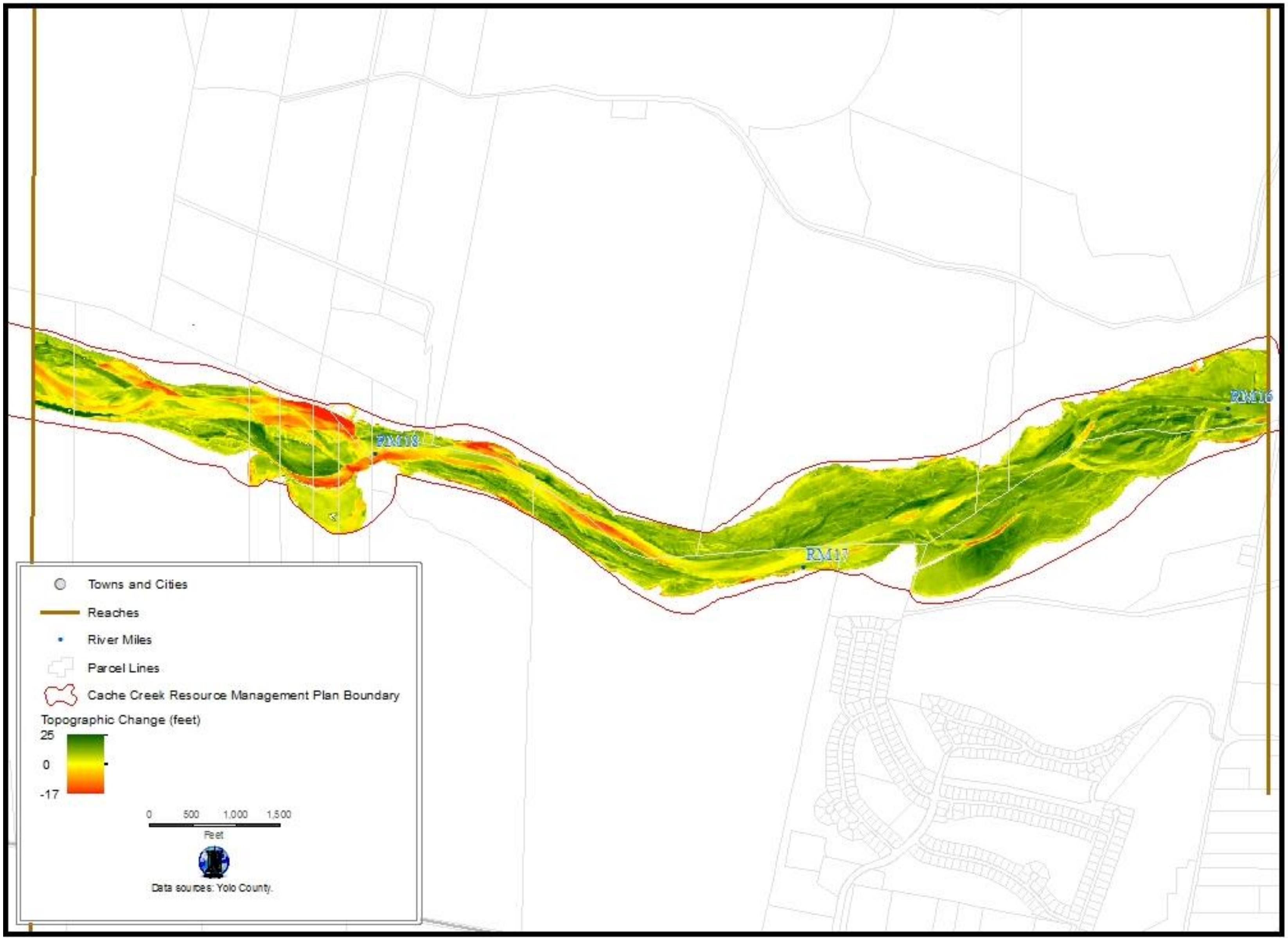

FIGURE 1.18: AREAS OF EROSION (REDS) AND DEPOSITION (GREENS) BETWEEN 1996 AND 2011.

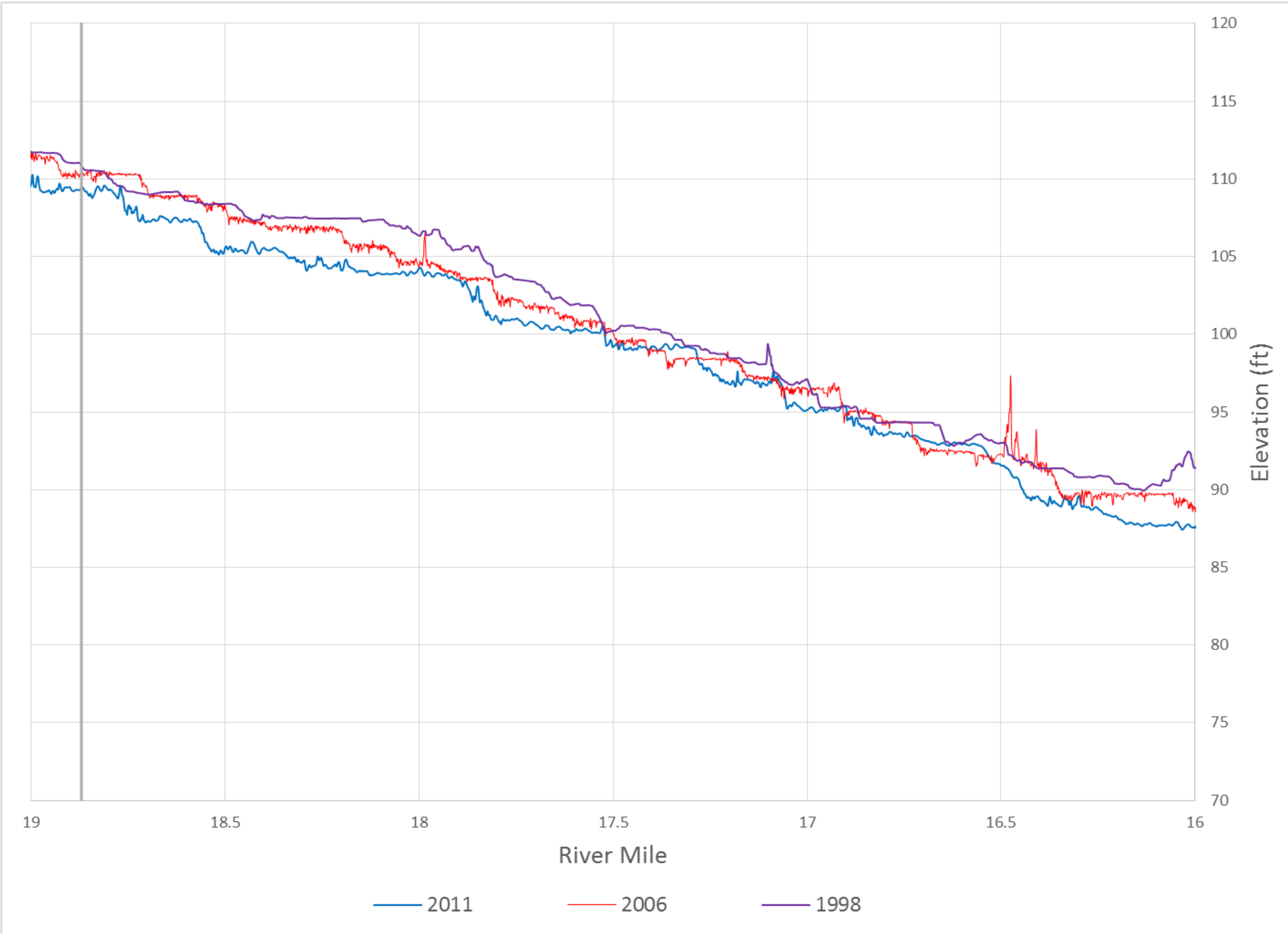

FIGURE 1.19: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE DUNNIGAN HILLS REACH IN 1998, 2006, AND 2011.

Hoppin Reach

This reach of the creek extends approximately 3.2 miles downstream of Road 94B and is characterized by more pronounced channel meanders, similar to the other upstream alluvial reaches.

Channel and Topographic Change

The Hoppin reach channel is mostly stable laterally, with some lateral migration occurring only near the upstream end of the reach after peak flows exceeding 30,000 cfs. This reach has experienced approximately 2.3 million tons of net deposition between 1996 and 2011, with small volumes (tens of thousands of tons) of interannual erosion and deposition. Figure 1.20 is a channel migration map showing how this reach is extremely laterally confined, with only limited migration occurring in the upstream quarter of the reach between 1996 and 2015. Figure 1.21 is a map of the deposition and erosion that has occurred throughout this reach, and Figure 1.22 is a plot of the channel thalweg profile in 1998, 2006, and 2011 showing how thalweg elevation has remained relatively stable in the upstream third of the reach but has decreased in the downstream two-thirds of the reach. As in the two reaches upstream (Guesisosi and Dunnigan Hills), the deposition in this reach is not increasing the base channel elevation and is therefore occurring on the bars at the upstream end of the reach. Channel confinement in the downstream two-thirds of the reach could be causing the decreasing trend in thalweg elevation.

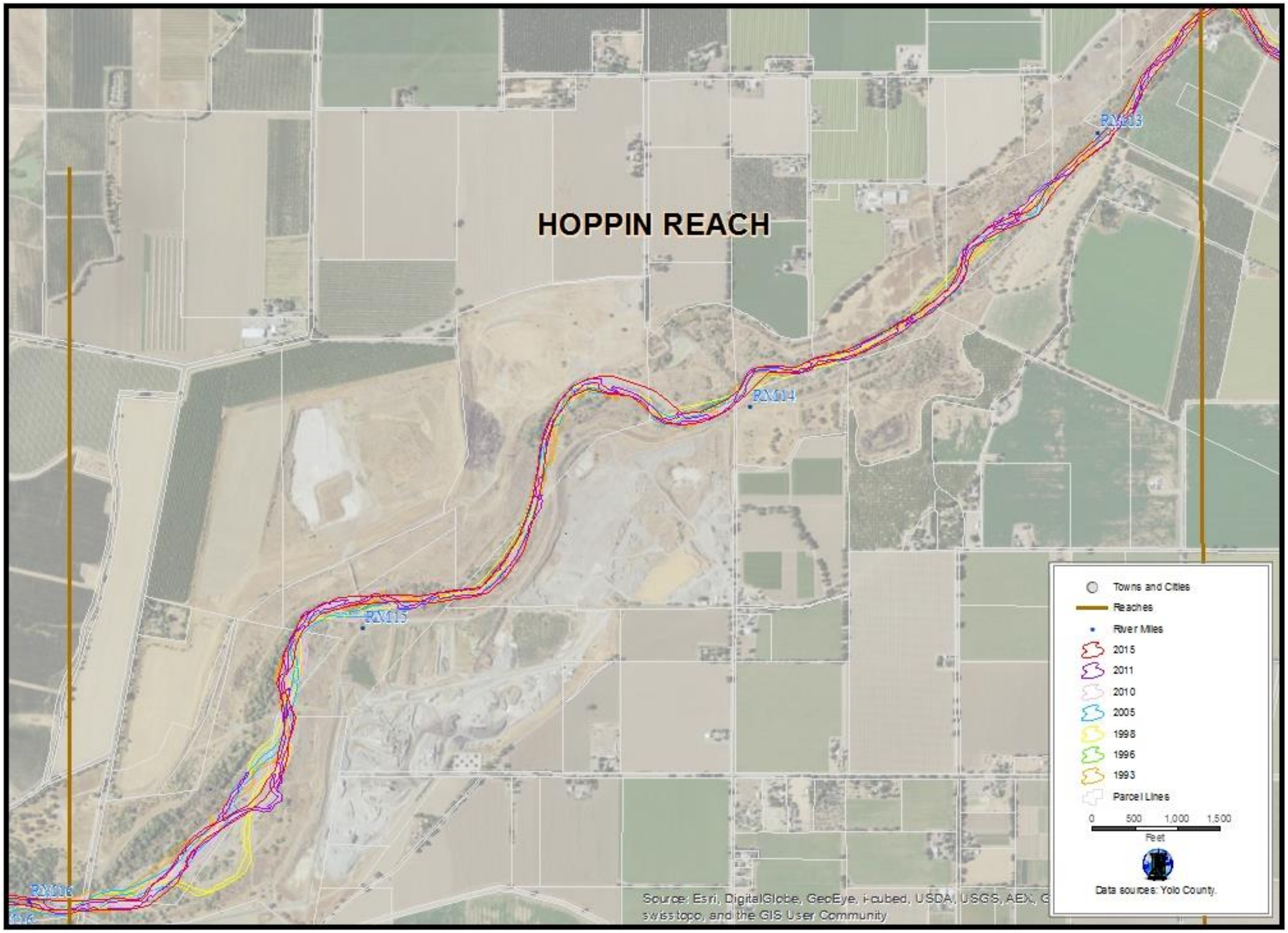

FIGURE 1.20: ACTIVE CHANNEL LOCATIONS IN THE HOPPIN REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

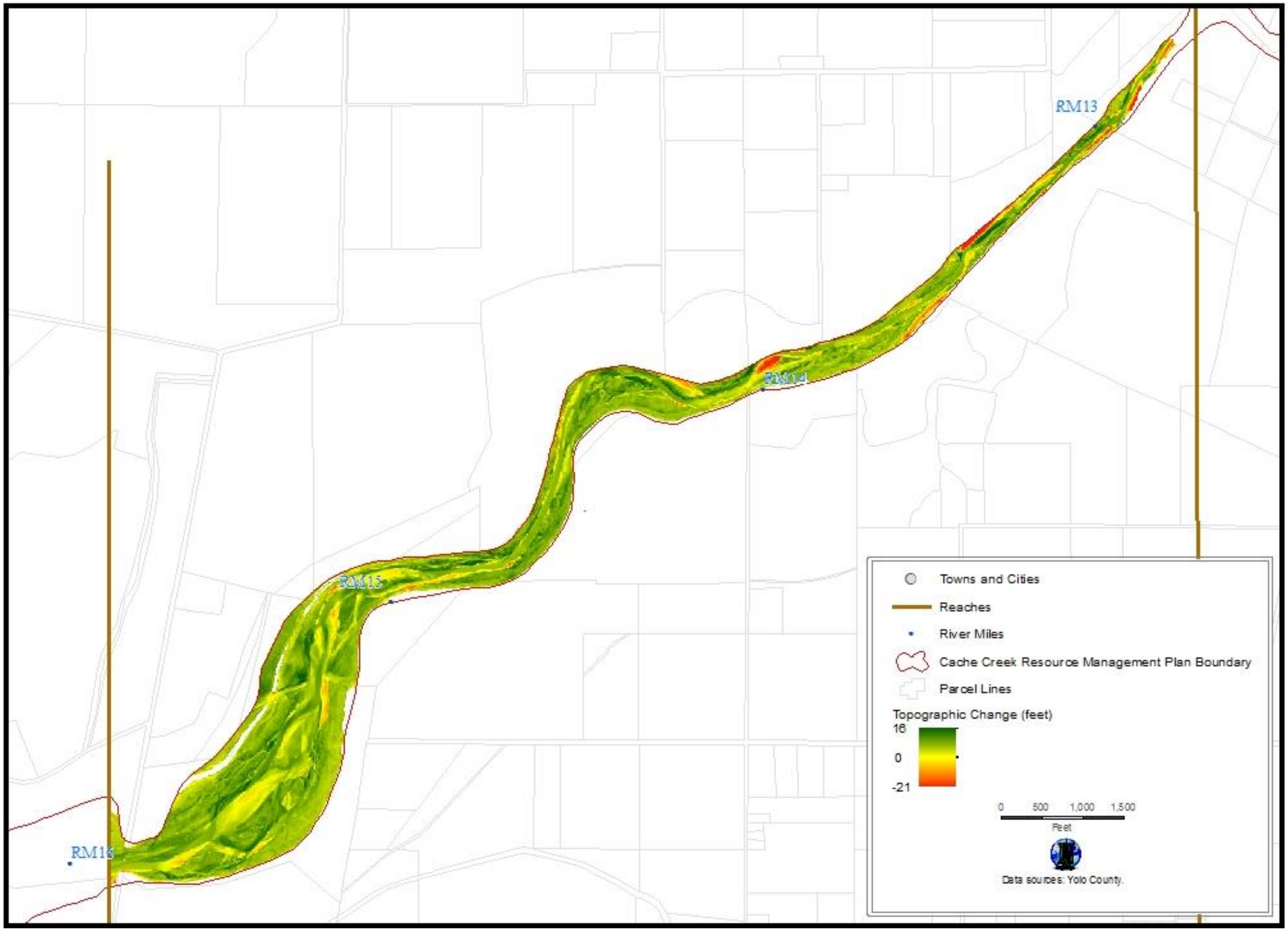

FIGURE 1.21: AREAS OF EROSION (REDS) AND DEPOSITION (GREENS) BETWEEN 1996 AND 2011.

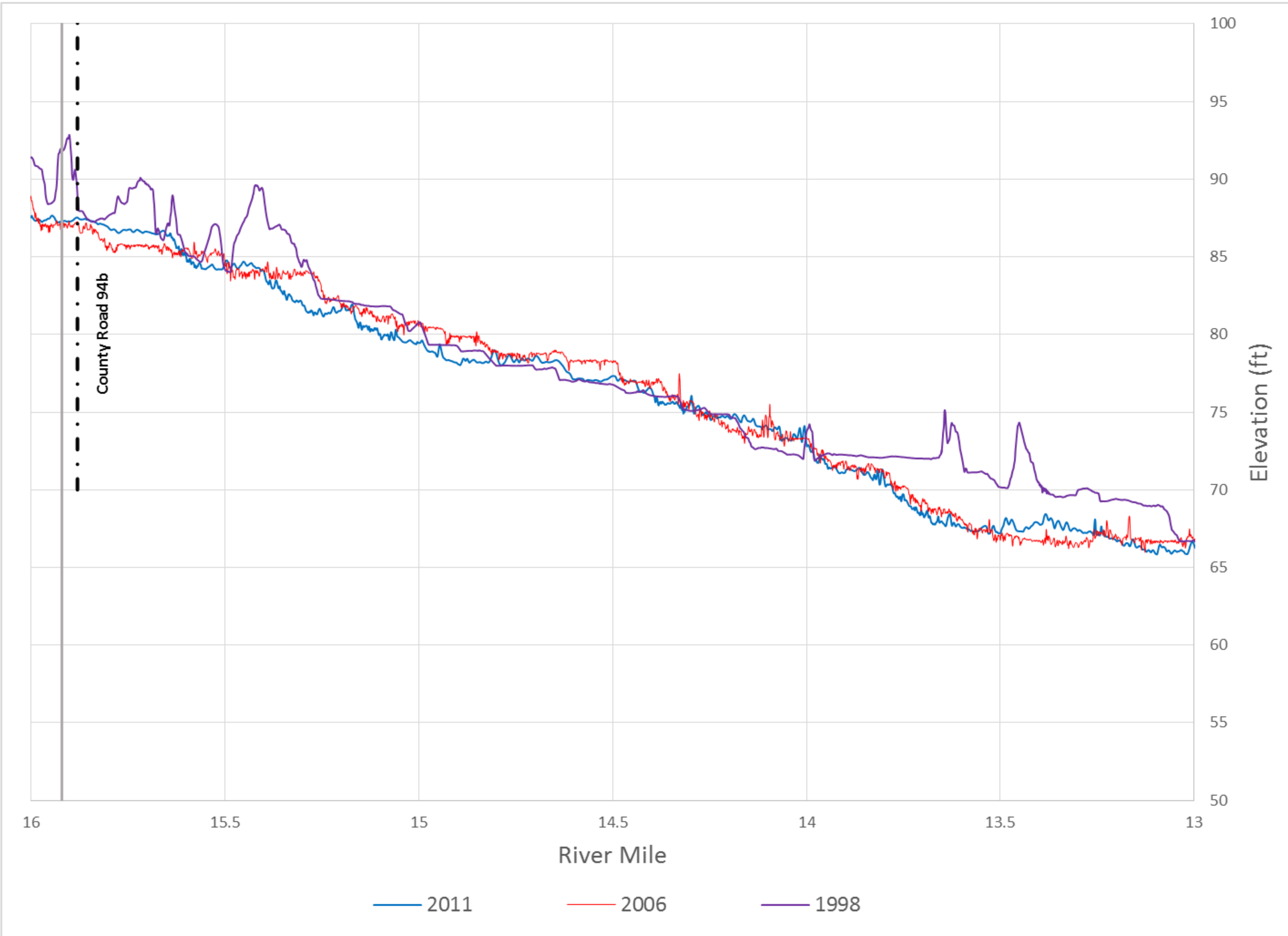

FIGURE 1.22: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE HOPPIN REACH IN 1998, 2006, AND 2011.

Rio Jesus Maria Reach

The Rio Jesus Maria Reach is a 1.6-mile-long reach that starts downstream of the Hoppin reach and extends downstream to Interstate Highway 5. This reach is relatively narrow and deep. Similar geomorphic conditions to this reach continue for an additional six miles downstream to the Cache Creek settling basin (outside of the CCRMP area).

Channel and Topographic Change

The Rio Jesus Maria reach is quite stable laterally, with minimal migration after peak flows exceeding 30,000 cfs. This reach has experienced approximately 282,000 tons of net deposition between 1996 and 2011, with small volumes (tens of thousands of tons) of interannual erosion. Figure 1.23 is a channel migration map showing how this reach is the most laterally confined of all the geomorphic reaches in the CCRMP area, with almost no lateral channel migration occurring between 1996 and 2015. Figure 1.24 is a plot of the channel thalweg profile showing how the thalweg elevation has remained relatively stable throughout the reach between 2006 and 2011. Topographic data from 1998 was not available for most of this reach. Deposition in this reach between 2006 and 2011 has been relatively limited, and it appears that it could be occurring in the active channel, as the base thalweg elevation has increased in many locations and has not decreased significantly elsewhere in the reach.

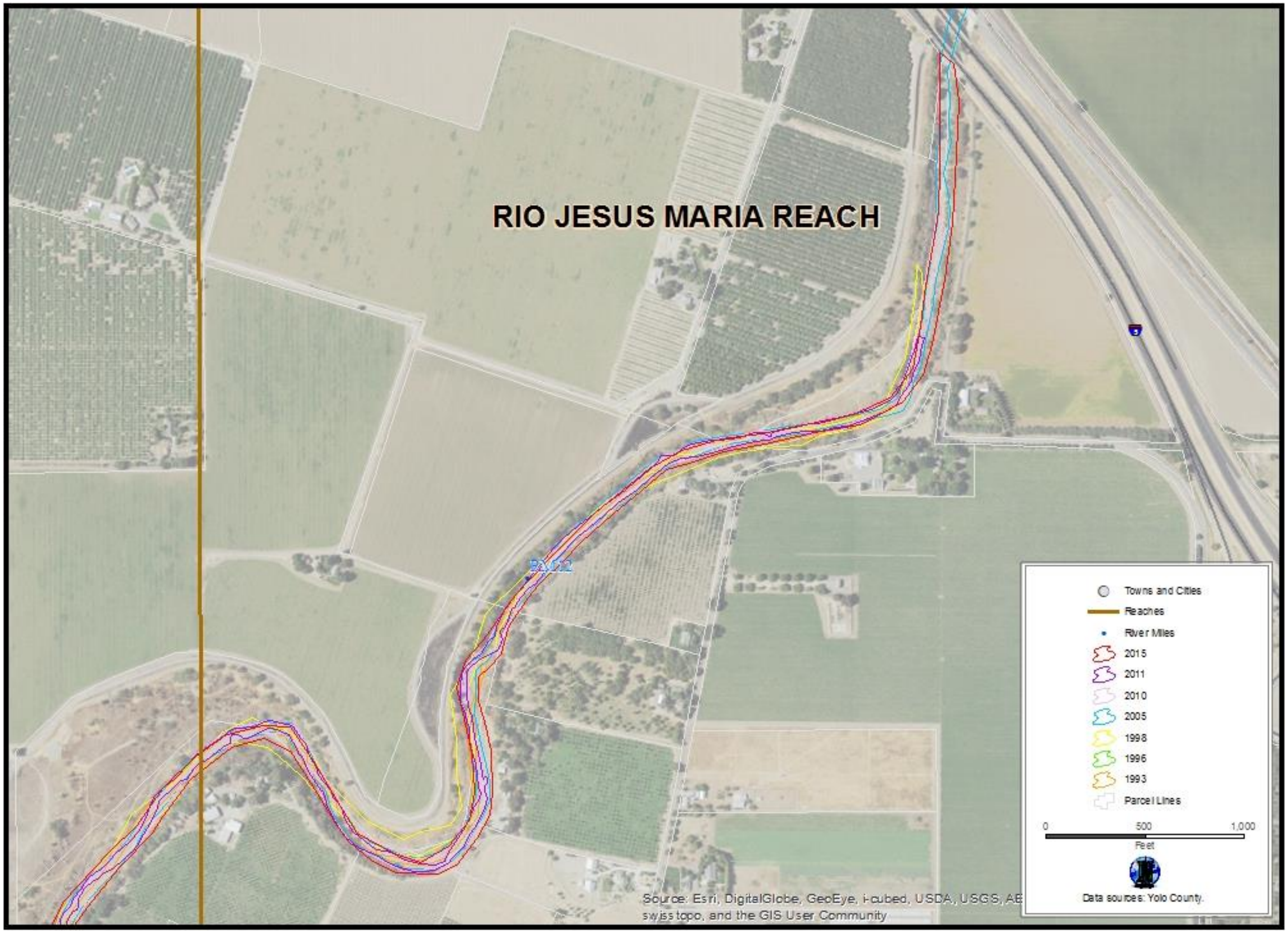

FIGURE 1.23: ACTIVE CHANNEL LOCATIONS IN THE RIO JESUS MARIA REACH IN 1996, 1998, 2005, 2006, 2011, AND 2015.

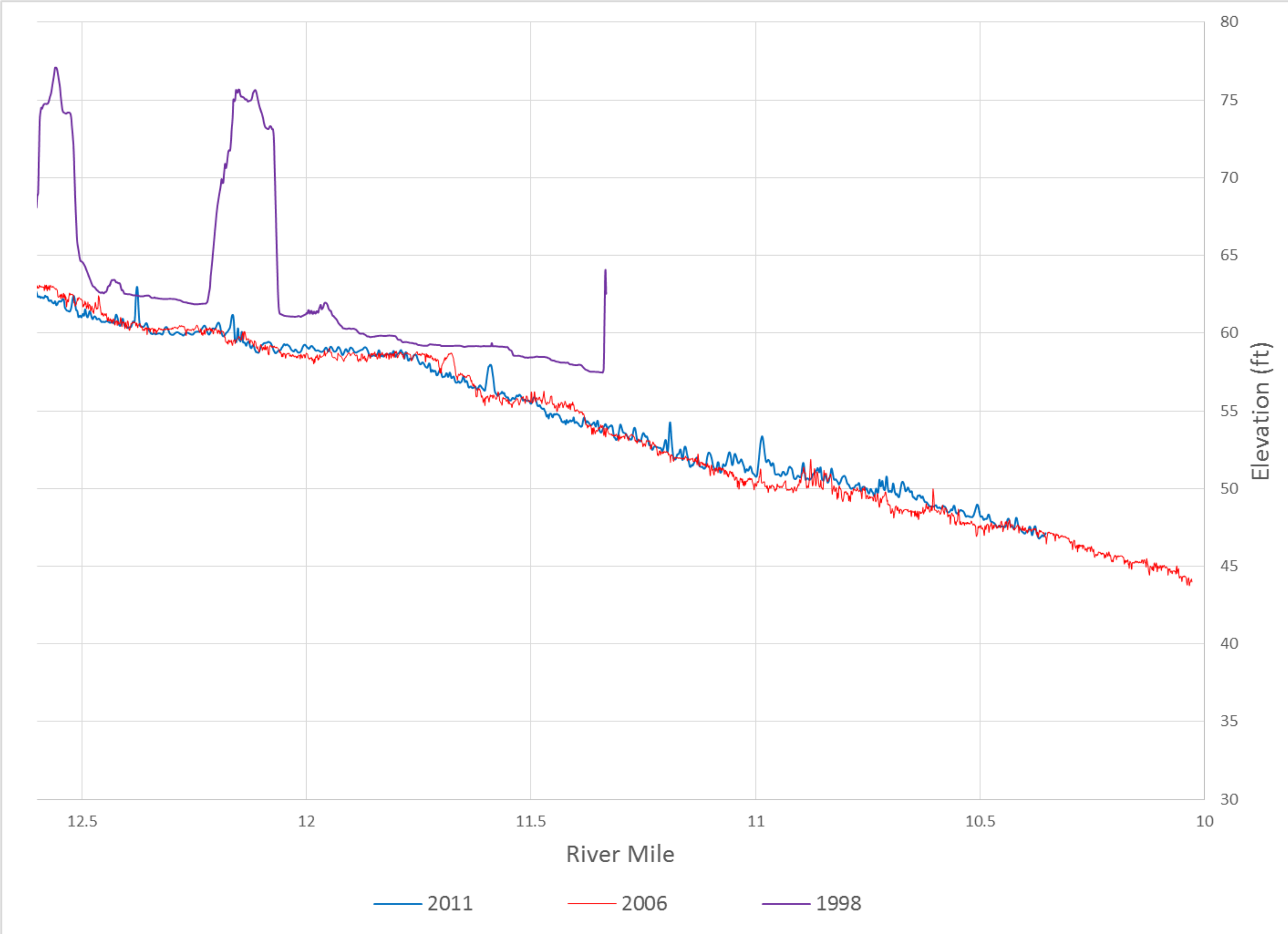

FIGURE 1.24: APPROXIMATE CHANNEL THALWEG ELEVATION PROFILES IN THE RIO JESUS MARIA REACH IN 1998, 2006, AND 2011.

NOTE: 1998 ELEVATION DATA NOT AVAILABLE FOR MOST OF THIS REACH.

1.4 RECOMMENDATIONS

The original CCAP ordinances and program documents were informed by evaluations of historical and existing Cache Creek conditions prior to the elimination of in-channel mining, and predictive modeling of hydraulic and sediment transport conditions anticipated in the future with implementation of the CCAP. The original CCAP authors made adaptive management a cornerstone of implementation. Under this adaptive management approach, actions have been taken along Cache Creek to implement the CCAP, regular monitoring and data collection on geomorphic, hydraulic, and biological conditions has occurred, and refinements to actions, monitoring, and data collection have been developed. This twenty-year retrospective analysis has further distilled lessons learned about the program and responses of Cache Creek to implementation of the program to support the following recommendations for changes to the ordinances and documents that guide the program. The changes described have also been incorporated into each of the program documents.

1.4.1 RECOMMENDATIONS ON CCAP DOCUMENTS

Off-Channel Mining Plan (OCMP)

The OCMP balances off channel mining with protection of the natural resources in the Cache Creek corridor. Because mining will continue to occur in the Streamway Influence Zone, albeit under controlled and highly regulated circumstances, it has the potential to influence geomorphic conditions over the long term. Observations of changes in geomorphic conditions over the past twenty years informed a review of the OCMP. Recommended changes to this plan include:

Section	Recommendation
Throughout	Update and rename the Test 3 Boundary with a new boundary called the Channel Form Template (CFT). This new boundary recognizes that some improvements in geomorphic conditions have occurred even though not all of the elements of Test 3 concept have been implemented. The CFT incorporates observations of active channel and topography change over the past twenty years and provides a new boundary that addresses the importance of channel complexity and maximizing available area for channel evolution, while still improving overall channel stability as envisioned under the Test concept.
Section 4.1	Updated discussion of present conditions.
Section 4.1	Revision to OCMP vision based on observations of channel change from the past twenty years.

Cache Creek Resources Management Plan (CCRMP)

The Cache Creek Resources Management Plan (CCRMP) recognizes that the creek must be viewed as an integrated system, with an emphasis on management of all of Cache Creek's resources, rather than a singular focus on any one issue. The fluvial geomorphology of Cache Creek is central to the CCRMP as creek dynamics both influence and are influenced by adjacent land uses. Observations from the past twenty years of geomorphic change on Cache Creek have informed a comprehensive assessment of the CCRMP, and recommended changes to this plan include:

Section	Recommendation
Throughout	Update the CCRMP boundary to incorporate the latest FEMA 100-year floodplain boundary (map effective date June 17, 2010) and the 2015 active channel extent, whichever is further from the centerline of the Cache Creek corridor.
Throughout	Update and rename the Test 3 Boundary with a new boundary called the Channel Form Template (CFT). This new boundary recognizes that some improvements in geomorphic conditions have occurred even though not all of the elements of Test 3 concept have been implemented. The CFT incorporates observations of active channel and topography change over the past twenty years and provides a new boundary that addresses the importance of channel complexity and maximizing available area for channel evolution, while still improving overall channel stability as envisioned under the Test concept.
Throughout	Refinement of the flood protection purpose of the ordinance to require maintenance of existing level of flood flow capacity as opposed to maintenance of a specific level of flood protection.
Reference to Cache Creek Improvement Program	Revisions to make CCRMP consistent with changes summarized in the following section.
Section 2.1	Revisions to existing conditions description that recognize changes in Cache Creek over the last twenty years.
CCRMP Vision	Revisions to the vision that recognize changes in Cache Creek over the last twenty years.
Section 2.4-3	Replace the Test 3 Concept with the CFT.
Section 2.4-12	Revision of guidance for channel modifications at bridges.

Section 6.5-12	Revision of guidance to be consistent with changes to the in-channel maintenance mining ordinance.

Cache Creek Improvement Program (CCIP)

The Cache Creek Implementation Plan (CCIP) is a component of the Cache Creek Resources Management Plan and defines the procedures and methodologies for stream monitoring and maintenance activities. Evaluation of geomorphic conditions and changes over the past twenty years has identified strengths and weaknesses of this plan. Recommended changes to this plan include:

Section	Recommendation
Throughout	Update the CCRMP boundary to incorporate the latest FEMA 100-year floodplain boundary (map effective date June 17, 2010) and the 2015 active channel extent, whichever is further from the centerline of the Cache Creek corridor.
Throughout	Update and rename the Test 3 Boundary with a new boundary called the Channel Form Template (CFT). This new boundary recognizes that some improvements in geomorphic conditions have occurred even though not all of the elements of Test 3 concept have been implemented. The CFT incorporates observations of active channel and topography change over the past twenty years and provides a new boundary that addresses the importance of channel complexity and maximizing available area for channel evolution, while still improving overall channel stability as envisioned under the Test concept.
Throughout	Refinement of the flood protection purpose of the ordinance to require maintenance of existing level of flood flow capacity as opposed to maintenance of a specific level of flood protection.
Section 2.1	Removal of major stabilization projects and replacement with more general guidance to maximize available area for continued channel evolution, while still achieving some measure of channel smoothing at bridges.
Section 3.3	Clarification of background information and incorporation of observations from last twenty years.
Section 3.4	Replacement of Test 3 Concept with CFT.

Section 3.5	Replacement of multiple in-channel mining templates with a single generalized in-channel mining template that allows more flexibility in design of gravel bar skim projects and is easier to understand and implement.
Section 3.6	Modification of priority projects to remove site specific bridge transition and stabilization projects and replace with reference to standard design approaches for bank stabilization at bridges and other locations.
Section 3.6	Gravel bar skimming instream maintenance projects should be included in priority projects to address significant sediment deposition on gravel bars over the last 20 years.
Section 4.2	Emphasize the need for gravel bar skimming projects to address significant sediment deposition on gravel bars over the last twenty years along with lack of any in-channel maintenance mining projects.
Section 4.2	Refinement of guidance on maintenance of a perennial low flow channel.
Section 4.2	Removal of the concept of internal levee repair, and addition of discussion around accommodation of levee breaches that connect reclaimed mine areas to the active channel.
Section 5.4	Revision of design guidelines to make them consistent with changes described above.

1.4.2 Recommendations on Ordinances

Off-Channel Mining Ordinance

The off-channel mining ordinance guides the production of sand and gravel from off-channel areas in a manner that protects other societal values, including but not limited to recreation, water resources, wildlife, agriculture, and aesthetics. Fluvial geomorphic conditions in Cache Creek are influenced by off-channel mining through the existing mines that are within 700 feet of the channel and potential new mines that are required to implement the 2017 Channel Form Template. Recommended changes to this ordinance include:

Section	Recommendation
Section 10-4.429	Clarification to the language describing requirements for new mining operations in the Streamway Influence Zone less than 700 feet from the channel banks.

Surface Mining Reclamation Ordinance

The purpose of the surface mining reclamation ordinance is to ensure that mined land is reclaimed to end uses such as agriculture, habitat, groundwater recharge, flood control, and channel stabilization in a consistent manner to maximize their overall management in the CCRMP. Because reclaimed mines are and will continue to be in the Streamway Influence Zone, especially mines that pre-date the CCAP, reclaimed conditions could have long term effects on channel morphology. Recommended changes to this ordinance include:

Section	Recommendation
General	Addition of a new section providing guidance on how to deal with levee breaches or other channel changes that connect reclaimed mine areas to the active channel. This occurred at the Woodland Reiff reclamation site and it was determined that the levee breach provided sufficient benefits to justify maintaining the breach. However, guidance for ongoing maintenance of the breach has not been available.
Section 10-5.532	Modification to requirements for use of overburden and fine sediments to allow off-channel use of sediments if they are of suitable quality.

In-Channel Maintenance Mining Ordinance

The in-channel maintenance mining ordinance provides specific regulations for channel maintenance within the creek. The elimination of commercial in-channel mining fundamentally changed sediment transport dynamics through the CCRMP area, making them more natural and encouraging long-term sediment accumulation within the CCRMP area. This ordinance recognizes that the Cache Creek corridor is still influenced by and influences conditions adjacent to the channel, and that in some locations in-channel mining could be required to enhance long term channel stability and protect important features of the landscape along the channel. Recommended changes to this ordinance include:

Section	Recommendation
Throughout	Refinement of the flood protection purpose of the ordinance to require maintenance of existing level of flood flow capacity as opposed to maintenance of a specific level of flood protection.
Section 10-3.401	Clarification of access road design guidance.
Section 10-3.406	Simplification of limitation on excavation at the head of in-channel bars to make implementation of gravel bar skimming easier to implement.

Section 10-3.406	Revision of annual excavation volume limits to allow excavation proportional to total sediment deposition since previous in-channel mining rather than deposition in the previous year.
Section 10-3.414	Clarification of streambed regrading requirements to make gravel bar skimming projects easier to implement.
Section 10-3.417	Clarification of setback requirements to make gravel bar skimming projects easier to implement.

1.4.3 Other Recommendations

This evaluation of changes in channel geomorphology over the past twenty years has confirmed several principles of fluvial geomorphology and provided useful hydrologic thresholds that should be used to improve future implementation of the CCAP. First, channel migration appears to be initiated in dynamic reaches at flows exceeding approximately 25,000 cfs. However, lower peak flows, especially in periods with consecutive peak flows greater than approximately 15,000 cfs, can cause significant lateral channel migration. Further, peak flows with receding limbs that exceed 5,000 cfs for several days also appear to increase the extent of lateral channel migration. Therefore, the CCAP should adopt a “tiered” protocol for triggering data collection including aerial photography and channel topography that considers peak flow magnitude, recent peak flow conditions, and duration of elevated receding limb.

In addition, given the occurrence of net erosion during relatively moderate peak flows in Cache Creek, the CCAP should elevate the importance of the “bar skim” routine channel maintenance approach. Successfully implemented bar skim projects will help the program better understand the volume of sediment supply from upstream associated with peak flows of different magnitudes and durations. The CCAP should also include at least targeted topographic surveys of bar skim areas after peak flows greater than approximately 10,000 cfs. A suite of implemented bar skim projects will likely also provide valuable flood damage protection during peak flows greater than approximately 30,000 cfs (a ten-year recurrence interval) as Cache Creek continues to be net depositional, which will increasingly force lateral channel migration (and associated bank erosion problems). While this analysis of trends over the past twenty years has identified important geomorphic relationships and thresholds, going forward the CCAP should target data collection to validate and refine this understanding. Specifically, the CCAP should implement a range of trigger flows for collection of new topographic data, and collect this data in sub-reaches expected to change with the exceeded trigger.

Status of Past Recommendations

Chapter 4.0 includes information on how recommendations from previous TAC annual reports and the 2006 Cache Creek Status Report and Trends Analysis (Yolo County 2006) have or have not been addressed. In addition, Section 4.1.2 discusses the geomorphic implications of the status of each previous recommendation.

1.5 REFERENCES

Technical Studies and Recommendations for the Lower Cache Creek Resources Management Plan, Northwest Hydraulic Consultants, David Keith Todd Consulting Engineers, and EIP Associates, for Yolo County Community Development Agency, October 1995.

Wohl, E., S. N. Lane, and A. C. Wilcox (2015), The science and practice of river restoration, Water Resour. Res., 51, 5974-5997, doi:10.1002/2014WR016874.

Yolo County Planning, Resources, and Public Works Department – Julia McIver, Chris Alford, Jeff Hart, Kevin O'Dea, and Geoff Schladow (2006). 2006 Cache Creek Status Report and Trend Analysis 1996 – 2006.

CHAPTER 2

LOWER CACHE CREEK
HYDROLOGY AND WATER QUALITY STUDY
(1996–2016)

2.1 INTRODUCTION

This section describes the results of a retrospective look at Cache Creek hydrology and water quality since the initiation of the CCAP. The primary goals of this effort were to document any changes in Cache Creek conditions related to hydrology and water quality and to evaluate the effectiveness of measures in the CCAP plans and ordinances recommending changes for the future where appropriate.

This was undertaken through a comprehensive review of collected data under and related to the CCAP since its inception, review of similar retrospectives in the past including TAC annual reports, review of the CCAP plan and ordinance documents, and new analyses of Cache Creek hydrology, hydraulics, and water quality.

2.2 METHODS AND ASSUMPTIONS

The analyses leading to this retrospective on Cache Creek Area Plan included the following tasks:

- Collect available data sets related to surface and groundwater hydrology and water quality:
    - Stream gage data (surface water hydrology)
    - CCAP water quality monitoring program data (surface water quality)
    - Groundwater well level data (groundwater hydrology)
    - Groundwater monitoring reports from aggregate producers (groundwater hydrology and groundwater quality)
- Evaluate large storm hydrographs during the last twenty years
- Analyze collected data for temporal and spatial trends, and connecting any trends to changes in Creek conditions
- Review CCAP Plans (CCIP, CCRMP, and OCMP) and CCAP Ordinances (In-channel mining, Off-channel mining, and reclamation) for language related to hydrology, flood management, and water quality for continued appropriateness
- Develop a new 2D hydraulics model of Cache Creek and use it to inform re-evaluation of key boundaries such as the “Test 3 Line” and the Streamway Influence Boundary. This modeling is documented in a separate report (FlowWest 2017).
- Develop recommendations for update and improvement of CCAP based on analyses outcomes and specifically related to Plan and Ordinance language and future collection, analysis, and use of data.

2.3 RESULTS AND DISCUSSION

The major findings of this analysis are summarized below. Detailed results and discussion follow the summary.

2.3.1 HYDROLOGIC FINDINGS SUMMARY

The period 1996 to 2016 represents an interesting period for hydrology, because it includes 1997, which for much of the Central Valley was one of the largest flood events on record (although on Cache Creek it was an approximately 20-year return interval event), and the 2012-2015 drought period. Significant findings include:

- ***The period 1996-2016 produced flow patterns in line with statistical averages.***

  This twenty-one-year period produced one event exceeding the 20-year return flow, two events at or exceeding the 10-year return flow, four events exceeding the 5-year flow, and 11 events exceeding the 2-year flow. These are exactly in line with statistical averages, meaning that no extraordinary events have occurred and Cache Creek's hydrology since the start of CCAP is historically representative.

- ***The period 1996-2016 was characterized by cycles of wet and dry years.***

  The record shows that cycles of wet and dry years of between approximately 2-4 years occurred, such as a sequence of wet years from 1996 to 1999, and dry years from 2007 - 2009 and 2013 - 2015. Such cycles of multiple years are not uncommon in the Sacramento River Valley, with dry cycles occurring between 1987-1992, 1947-1950, and 1924-1931. Wet cycles have occurred between 1982-1984, 1978-1978, 1940-1943, 1935-1938, 1921-1923, and 1914-1917.

- ***Groundwater levels near Cache Creek have continued their seasonal trends of depression in the irrigation season and recovery in the rainy season and the impacts of drought periods are evident.***

  The twenty-one-year record between 1996-2016 shows that while drought periods such as occurred in 2007-2009 and 2012-2015 create a noticeable decline in groundwater levels in excess of annual seasonal variation, they can rebound within one to two years if a wet year (such as occurred in 2011) occurs. However, the full impacts of the 2012-2015 drought will not be evident for a few more years.

- ***As described in the 2006 Status and Trends Report, peak flows at Yolo are always less than peak flows at Rumsey for the same storm event.***

  The Status and Trends Report (Yolo County 2006) offered several hypotheses for this. In that report, an additional gage at Capay Dam was proposed, but such a gage has not been installed.

2.3.2 WATER QUALITY FINDINGS SUMMARY

Based on a retrospective analysis of water quality data from the start of the CCRMP water quality monitoring program in 1999 through 2016, the TAC Hydraulic Engineer has developed the following significant findings and recommendations:

- ***Gordon Slough is unique amongst sampling sites as having either the highest or lowest average concentrations of most water quality parameters.***

  Gordon Slough had the highest average concentrations of turbidity, fecal coliforms, TKN, orthophosphate, and TPH as Diesel. It also had the lowest average concentrations of dissolved oxygen, pH, boron, and both total and dissolved mercury. The only water quality parameters for which Gordon Slough was not an outlier were nitrate + nitrite. While these results were not always statistically significant, they point to Gordon Slough as a contributor of many pollutants to Cache Creek. The CCAP should consider some targeted water quality sampling in Gordon Slough to attempt to determine source location(s) of these contaminants. Control of pollution coming from Gordon Slough could have the greatest single positive impact on water quality in Cache Creek within the CCRMP area.

- ***The surface water quality monitoring program has demonstrated that continued evaluation of the number of analytes and frequency of sampling is warranted.***

  There are no significant trends over time of water quality increasing or decreasing, and most individual analytes that formed the initial monitoring program have not been detected, most notable trace organics.

- ***Data from aggregate producers is valuable in determining potential impacts of mining on groundwater.***

  Review of all the data from wells at off-channel mining facilities shows that most contaminants are rarely detected. However, ongoing monitoring ensures that spikes in concentrations of a particular contaminant, which has occurred over the course of the program, are transient and not the result of increasing contamination.

- ***Mercury continues to be a concern for Cache Creek and its surrounding areas, but CCAP and mining activities do not seem to be exacerbating mercury impacts.***

  Cache Creek has long been known to be impacted by mercury from historical upstream mining practices, and methyl mercury production in natural water bodies can exacerbate its impact on biota. Data from the Cache Creek surface water monitoring program, the aggregate producer's facilities, and studies on bioaccumulation (Slotton and Ayers 2016) show no apparent increasing temporal or spatial trends, or that CCAP or mining activities are increasing the impacts of mercury on the Cache Creek ecosystem.

2.3.3 Hydrology Results and Discussion

Data Availability 1996-2016

Surface Water

For the analyses that follow, flow data from the USGS Cache Creek at Yolo station (11452500) and the CDEC Cache Creek at Rumsey Bridge station (RUM) were reviewed. These stations were chosen because they have the nearest upstream and downstream gages to the CCRMP area with the longest, most complete flow records. The Yolo gage has the longest record of the two (111 years versus 19 at Rumsey) and therefore this analysis focuses on the Yolo gage. A USGS stream gage existed at a slightly different location near Rumsey between 1961 and 1986 (USGS # 11451760) but due to the age of data it was excluded from this analysis. Peak flows at the Yolo gage, immediately downstream of the CCRMP area, were used to develop a frequency analysis for Cache Creek. Additionally, 15-minute flow data were used to select significant storm events that occurred during the period of interest (1996–2016) and to analyze flow hydrographs. Rumsey gage data are not continuously available and contain periods with gaps prior to 2010, particularly during the peak of flow events. These gaps result in missing hydrographs for several important flows events. As a result, the use of Rumsey gage data was limited, and a flow frequency analysis was not performed at this location.

Groundwater

The Water Resources Information Database (WRID) provided CCRMP-area data on groundwater elevations from 1931 to 2016. For this report groundwater sites that were within 1 mile of the CCRMP area were evaluated and classified by reach according to the closest lateral distance from Cache Creek. In addition, monitoring reports from gravel producers (Cemex, Granite, Teichert, and Syar) provided groundwater level and quality data.

Surface Water Hydrology

Flood Frequency Analysis

Table 2.1 presents a flood frequency analysis performed with the U.S. Army Corps of Engineers Statistical Software Package (HEC-SSP) embedded bulletin 17B flow frequency analysis tool for Cache Creek using the 111-year peak flow record at Yolo stream gage.

TABLE 2.1: CACHE CREEK FLOW FREQUENCY ANALYSIS.

Return Interval (yr.)	Annual % Chance of Exceedance	Cache Creek at Yolo (1903-2014)		
		Computed Flow (cfs)	Confidence Limits	
			0.05	0.95
100	1	44,761	58,772	35,475
50	2	41,529	54,156	33,078
20	5	35,843	46,138	28,818
10	10	30,187	38,304	24,516
5	20	23,097	28,722	19,015
2	50	11,185	13,408	9,383

The dates and magnitudes of peak flows from 1995 through 2015 are presented in Table 2.2 along with corresponding DWR water year type classifications recorded for the Sacramento Valley.

TABLE 2.2: CACHE CREEK PEAK FLOWS AND SACRAMENTO VALLEY WATER YEAR TYPE CLASSIFICATION.

Water Year	Cache at Yolo		Water Year Type [1]
	Peak Flow (cfs)	Date of Peak	
1996	17,400	2/4/1996	W
1997	28,700	1/1/1997	W
1998	34,600	2/3/1998	W
1999	9,830	2/9/1999	W
2000	5,740	2/14/2000	AN
2001	9,270	3/5/2001	D
2002	12,400	1/2/2002	D
2003	22,300	12/16/2002	AN
2004	14,900	2/26/2004	BN
2005	5,100	3/22/2005	AN
2006	29,900	12/31/2005	W
2007	1,770	2/11/2007	D
2008	13,900	1/26/2008	C
2009	3,150	3/3/2009	D
2010	9,890	1/21/2010	BN
2011	15,900	3/20/2011	W
2012	2,380	3/28/2012	BN
2013	10,900	12/24/2012	D
2014	325	3/1/2014	C
2015[2]	16,500	12/12/2014	C
2016[2]	4,790	3/6/2016	C

1 DWR water year type classification for the Sacramento Valley based on hydrologic classification indices (http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST)
2 Peak flow from 15-minute USGS data at Yolo gage

Significant Flow Events

In the 2006 Status and Trends Report (Yolo County 2006), 20,000 cfs was cited as the threshold for a large event on Cache Creek. Such an annual peak flow occurred at Yolo in four years during 1996 to 2015 – in 1997, 1998, 2003, and 2006. In some cases in these years, more than a single event produced a flow at Yolo in excess of 20,000 cfs. During one of these annual peak events (December 16, 2002), instantaneous flow data were not collected by the Yolo gage and therefore a hydrograph is not available.

Five individual events are described in detail below. Because Rumsey data are either not available or do not contain peak of hydrograph information in the 1990's events, the December 2014 event that peaked at 16,500 at Yolo is also discussed.

In general, the data indicate reductions in the intensity of flow hydrographs (i.e., lower peaks and longer durations) as they propagate from upstream (Rumsey) to downstream (Yolo). Lag time between peaks at the two gages ranged from 10 to 15 hours. Details of each event are described below.

February 4, 1996

The first of these occurred on February 4, 1996 and peaked at 17,400 cfs according to the Yolo gage (Figure 2.1). The duration of the storm hydrograph lasted approximately two days. The Rumsey gage did not have data available for this date.

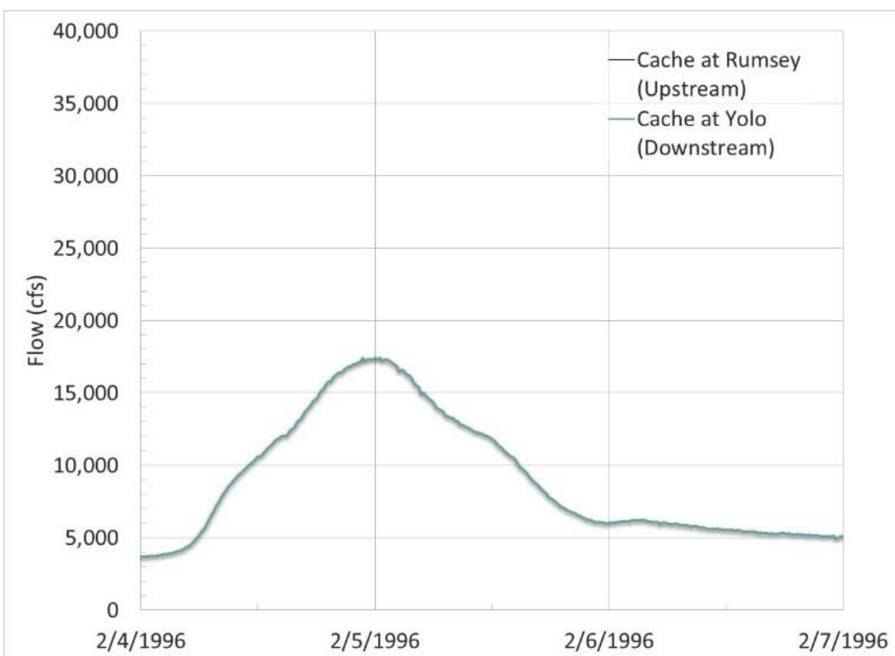

FIGURE 2.1: CACHE CREEK HYDROGRAPH AT YOLO, FEBRUARY 1996.

January 1, 1997

The 1997 event peaked at 28,700 cfs on January 1, 1997 and lasted for approximately one day according to the Yolo gage (Figure 2.2). Although the peak flow at the Rumsey gage was not reported for this day, the rising and falling limbs indicate that the peak was likely greater and the duration shorter as compared to the downstream Yolo gage.

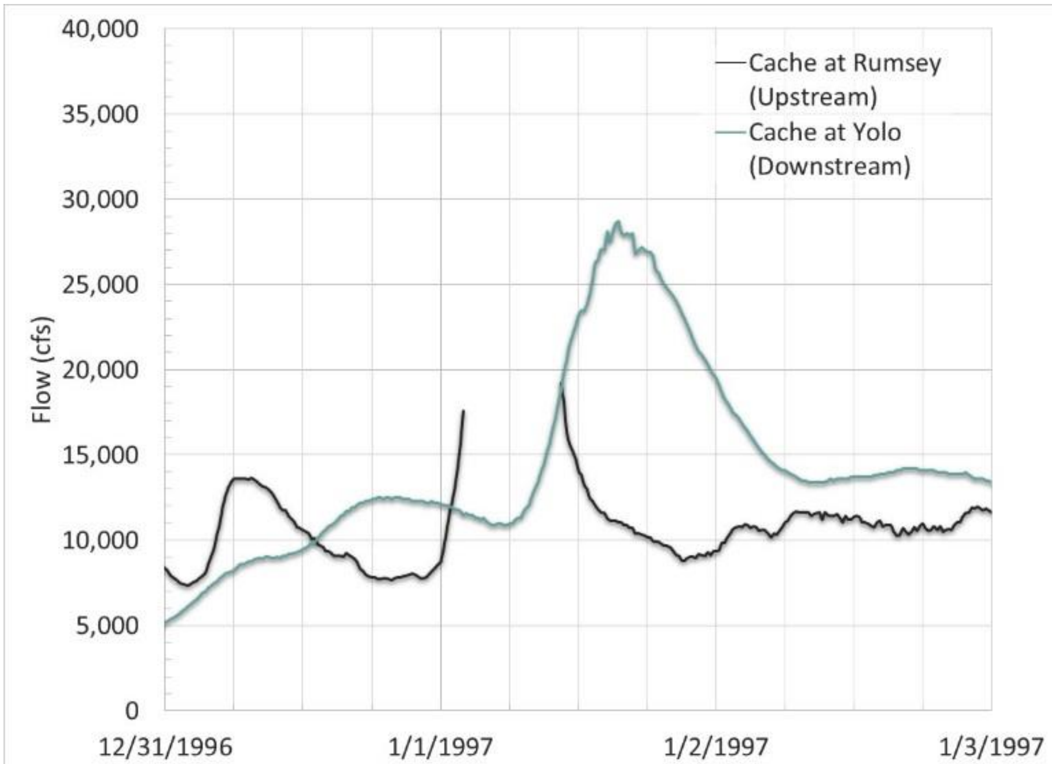

FIGURE 2.2: CACHE CREEK HYDROGRAPH AT RUMSEY AND YOLO, JANUARY 1997.

February 3, 1998

The 1998 peak event was the largest even during the period 1996-2015. It occurred on February 3rd and peaked at 34,600 cfs according to the Yolo gage (Figure 2.3). During this event, flows remained above 34,000 cfs for close to 6 hours, distinguishing it from others reported in this section, which generally peaked and began to recede more quickly. The peak at the Rumsey gage was not reported for this event, as with the 1997 event. However, the data that are available indicate that the peak was likely higher and the duration shorter at Rumsey as compared to Yolo.

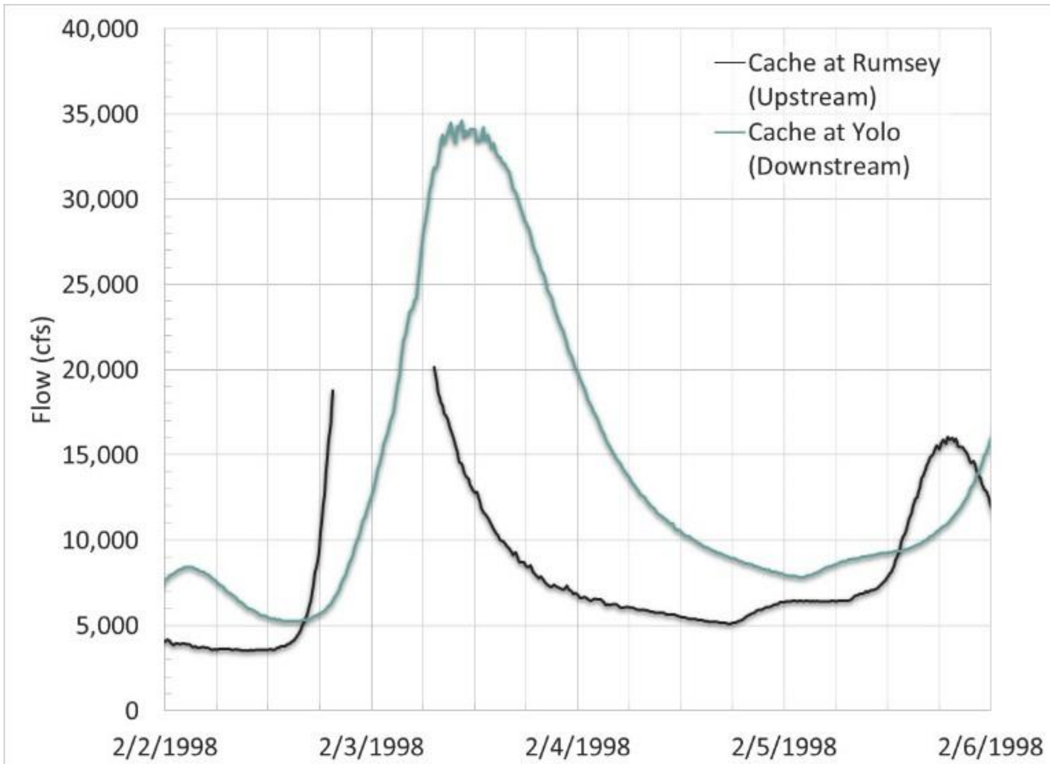

FIGURE 2.3: CACHE CREEK HYDROGRAPH AT RUMSEY AND YOLO, FEBRUARY 1998.

December 31, 2005

The December 31, 2005 event is the first in this list for which the full hydrographs at both Rumsey and Yolo were reported (Figure 2.4). The comparison of the two shows the evolution of the hydrograph as the flow propagates downstream—from a sharper, narrower spike peaking at 35,263 cfs to a flatter, reduced peak at Yolo of 29,900 cfs. The lag time between the peaks at these two gages was approximately 12 hours.

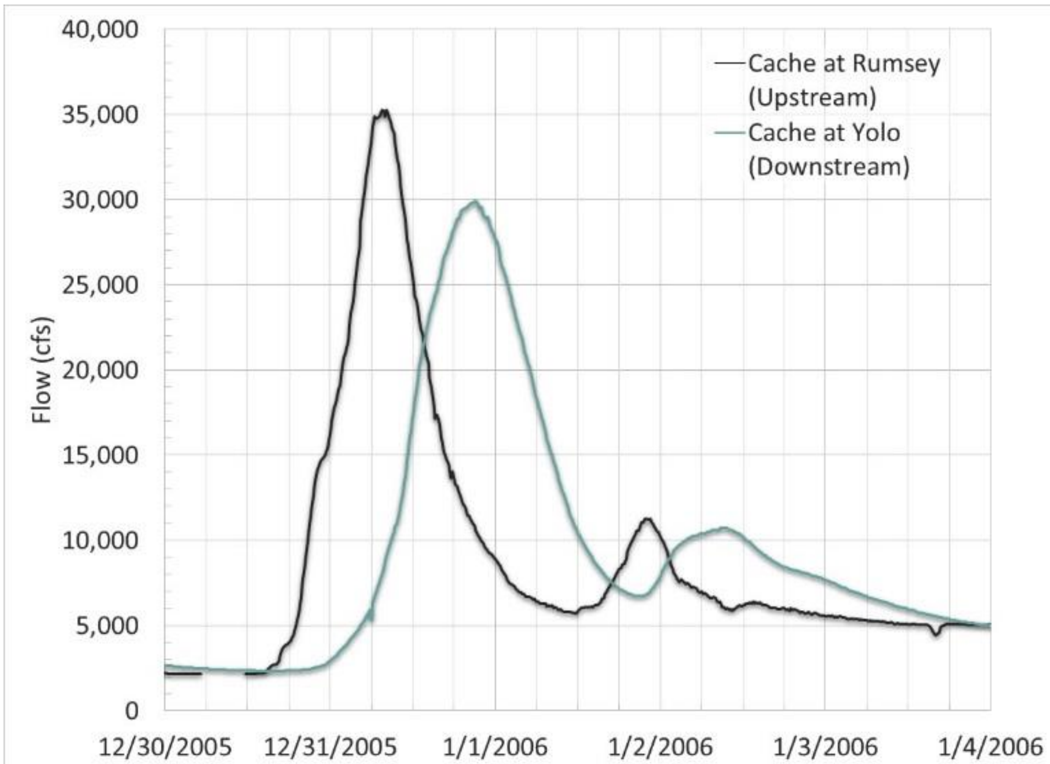

FIGURE 2.4: CACHE CREEK HYDROGRAPH AT RUMSEY AND YOLO, DECEMBER 2005.

December 11, 2014

The 2015 event peaked at 21,400 cfs on 12/11/2014 at Rumsey and lasted for approximately 18 hours (Figure 2.5). The peak flow at Yolo was reported as 16,500 cfs on 12/12/2014 and lasted for about a day. The lag time between the two events was approximately 15 hours.

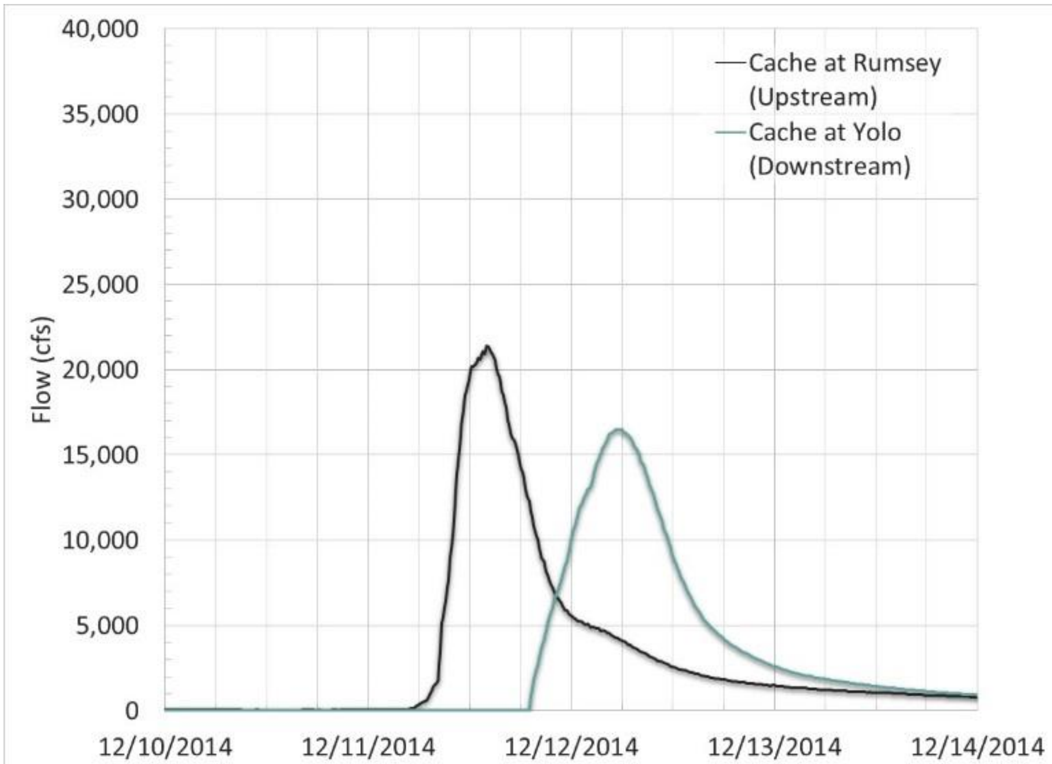

FIGURE 2.5: CACHE CREEK HYDROGRAPH AT RUMSEY AND YOLO, DECEMBER 2014.

Flood Hazards

The December 31, 2005 flood event described above was the last time that Cache Creek exceeded flood stage (81.0 feet at Yolo). During that event, the creek peaked at a stage of 83.22 feet at Yolo. While bank erosion has occurred at various locations within the CCRMP area since 2005, significant flood damage has not occurred, and based on recent TAC Annual Reports no major structures on the creek (with the exception of the damaged Capay Dam energy dissipation structures) have been impacted by high flows.

The TAC is currently developing a new 2-dimensional hydraulics model of Cache Creek that will take advantage of the best available topographic, vegetation cover, and hydrology data and provide a more accurate analysis of flood risk along Cache Creek than has ever been available before. As part of that analysis, an assessment of potential flood hazard by reach will be performed. This work will be completed in 2016. Preliminary results have informed revision of the 2017 Channel Form Template (formerly the Test 3 Line) and the Streamway Influence Boundary.

Groundwater Hydrology

Figure 2.6 displays reach-averaged, seasonal groundwater levels near Cache Creek from well data from the CASGEM (DWR 2016) database. Wells within one mile of Cache Creek were included in this analysis. Water levels were reported at various times throughout the year and were seasonally (winter, spring, summer, and fall) averaged. As expected due to topography, groundwater elevations drop from upstream (Capay) to downstream (Rio Jesus Maria). The three most downstream reaches (Dunnigan Hills, Hoppin, and Rio Jesus Maria) show the clearest seasonal variation due to groundwater pumping. The impacts of three dry to critical water years in the Sacramento Valley between 2007 and 2009 are visible in the 2009–2010 data while the impacts of the 2012-2015 drought are dramatically evident. The data between 2011 and 2012 do show the ability of the aquifer to recharge after a short period of depletion if a wet year (as in 2011) occurs. A brief discussion of groundwater conditions by reach follows, while Figure 2.7 presents a comparison of average groundwater elevations between 1996-2016 by reach against Cache Creek channel bed elevation.

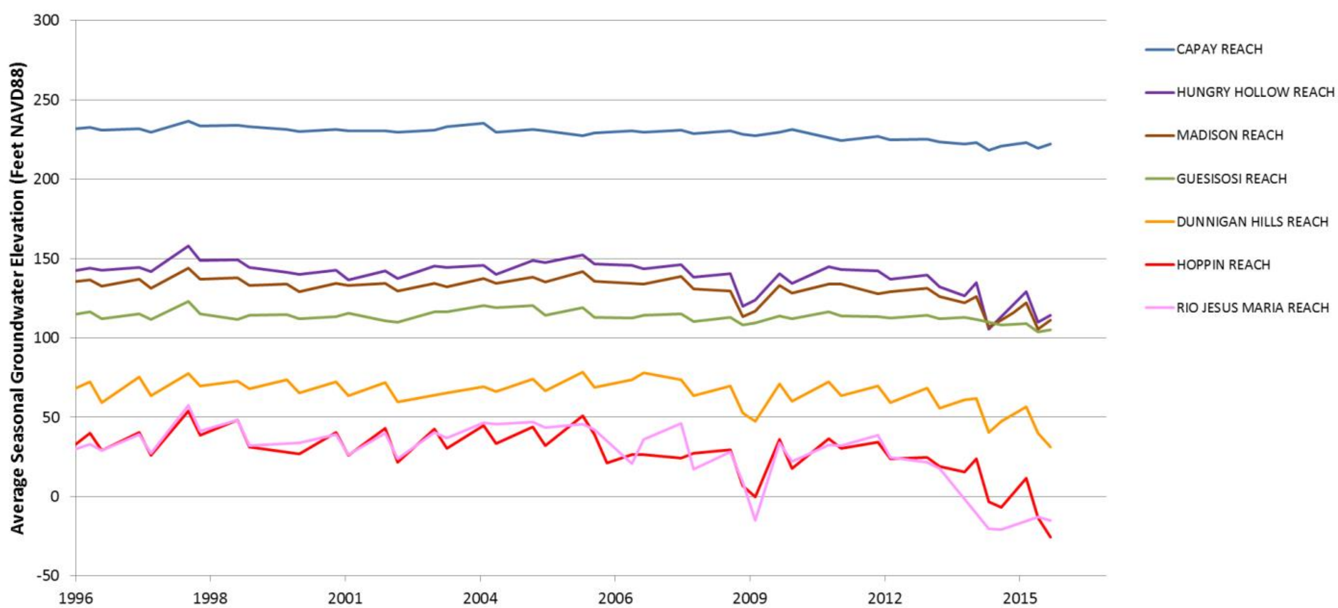

FIGURE 2.6: GROUNDWATER ELEVATIONS BY REACH NEAR CACHE CREEK.

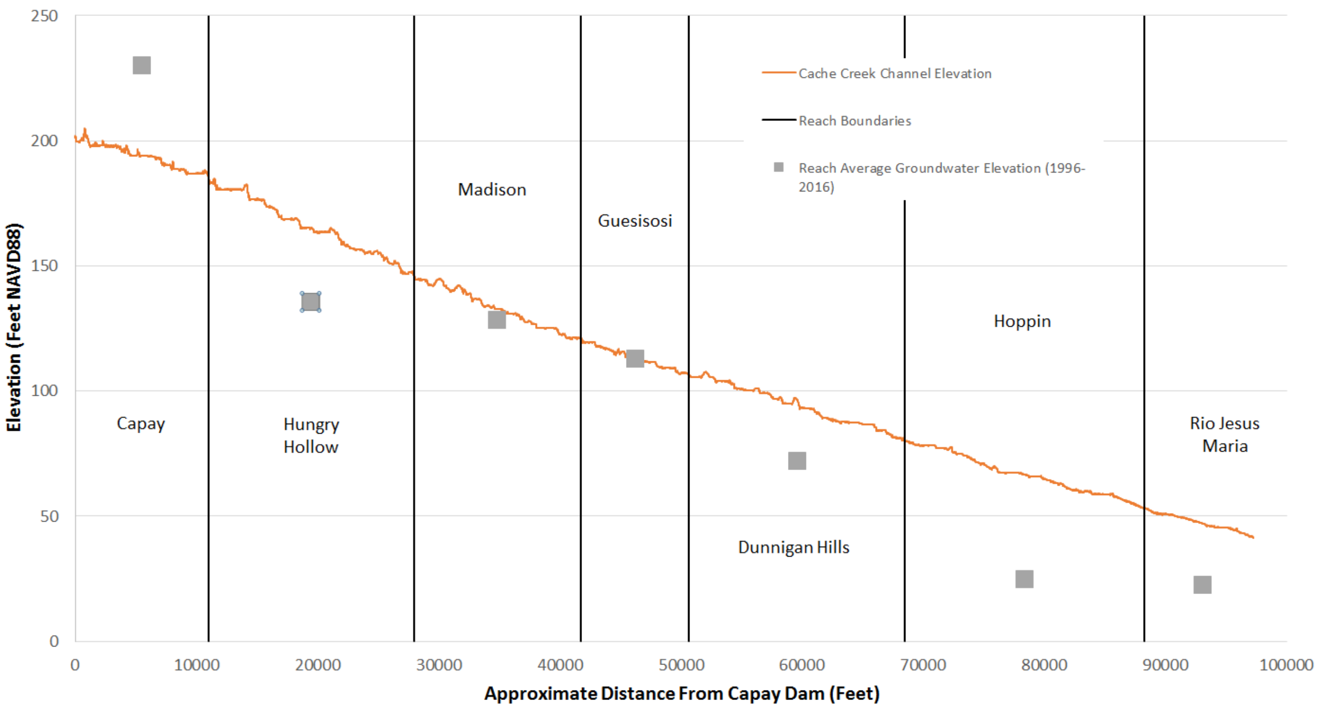

FIGURE 2.7: COMPARISON OF REACH AVERAGE GROUNDWATER ELEVATIONS (1996-2016) VS CACHE CREEK CHANNEL BED ELEVATION.

Capay Reach

The Capay Reach extends from Capay Dam to the Capay Bridge (Road 85). The Capay Reach is formed predominantly on fine-grained bedrock of the Capay and Tehama formations. This reach is generally considered to be a gaining reach, meaning that groundwater drains into the creek during low-flow periods. The data presented in Figure 2.7 support this, showing that average groundwater elevations between 1996-2016 were approximately 230 feet, or about 30-40 feet about typical channel bed elevations.

Hungry Hollow Reach

The Hungry Hollow reach extends from the Capay Bridge to below the Esparto Bridge. The channel lies on a varied geology of bedrock and alluvium within the reach. This is generally considered a losing reach of Cache Creek, where groundwater levels are generally below the channel bed and the channel is dry in the summer and fall seasons. The data in Figure 2.7 confirm this, showing that average groundwater levels over the past twenty years have been approximately 10 – 40 feet below the channel bed.

Both Granite and Syar current perform off-channel mining in the reach, and monitor groundwater levels in wells at their plant. We reviewed these monitoring data and compared them against the seasonal averages for the reach presented in Figure 2.6. This comparison is shown in Figure 2.8. Because Granite's plant is in the upstream portion of the reach, its groundwater wells exhibit levels higher than the reach-averaged levels from CASGEM wells. Meanwhile, Syar's plant is in the most downstream end of the reach, and therefore its groundwater levels are slightly lower than the average levels for the reach. Both mining plant's groundwater data generally follow the annual and seasonal patterns of the CASGEM wells, however.

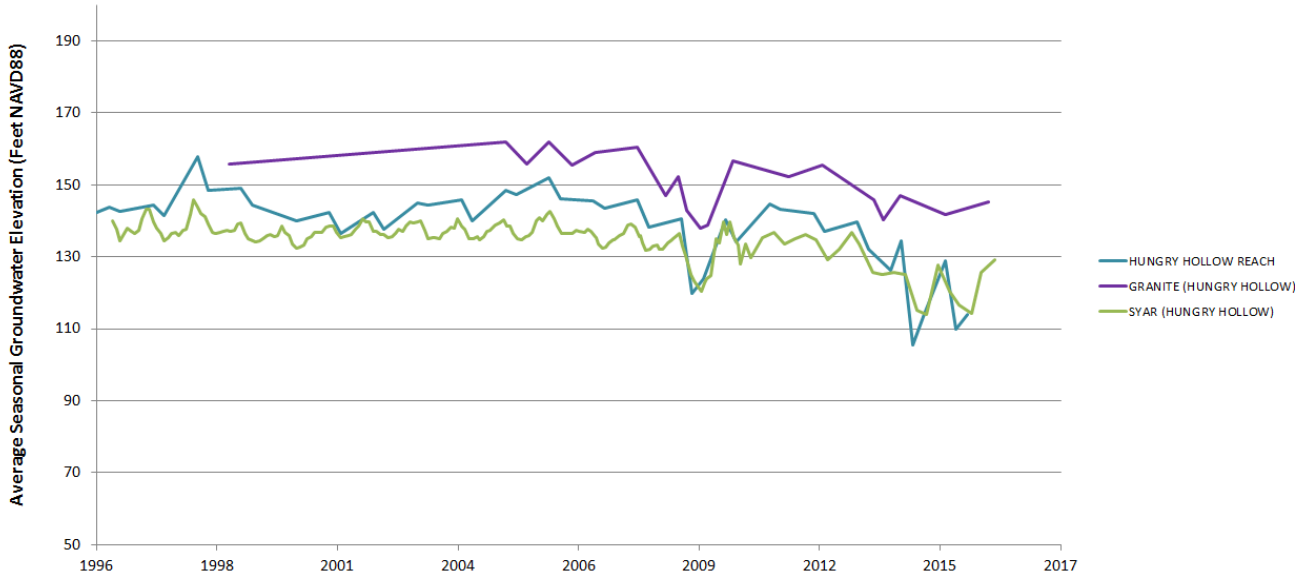

FIGURE 2.8: COMPARISON OF GRANITE AND SYAR GROUNDWATER MONITORING DATA AGAINST HUNGRY HOLLOW REACH AVERAGES, (1996-2016).

Madison Reach

The Madison reach extends from Hungry Hollow to the Highway I-505 Bridge. The reach is entirely on alluvial sediments and as such is a continuation of the losing stretch of Cache Creek found in the Hungry Hollow Reach, although towards the downstream end of the reach it is known begin transitioning to a gaining reach. The data in Figure 2.7 support this, showing that average groundwater levels in the reach between 1996 and 2016 were about seven feet lower than the channel bed at the upstream end and about four feet higher than the channel bed at the downstream end.

Teichert currently performs off-channel mining in the reach, and monitors groundwater levels in wells at their plant. Figure 2.9 shows that Teichert's groundwater elevation data closely match reach-averaged levels in CASGEM wells, although the Teichert levels are slightly higher (which is to be expected since the Teichert plant is in the upstream end of the reach).

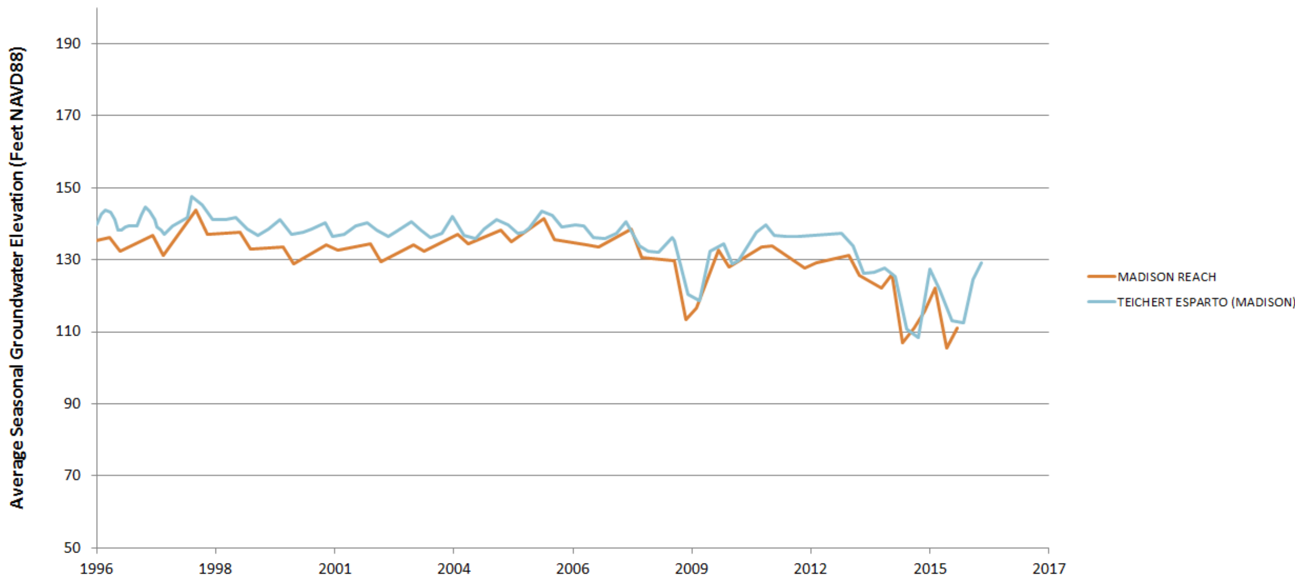

FIGURE 2.9: COMPARISON OF TEICHERT GROUNDWATER MONITORING DATA AGAINST MADISON REACH AVERAGES, (1996-2016).

Guesisosi Reach

The Guesisosi Reach extends from the Highway 505 Bridge and extends for about 2.2 miles downstream. This reach marks is a gaining reach, in which the groundwater table is comparatively high due to the presence of a bedrock constriction along the Dunnigan Hills-Plainfield Ridge lineament. The data in Figure 2.7 support this, showing that average groundwater levels between 1996 and 2016 were approximately equal to the average channel bed elevation.

Cemex currently performs off-channel mining in the Guesisosi Reach, and Figure 2.10 shows their groundwater elevation data. The data closely match reach-averaged levels in CASGEM wells.

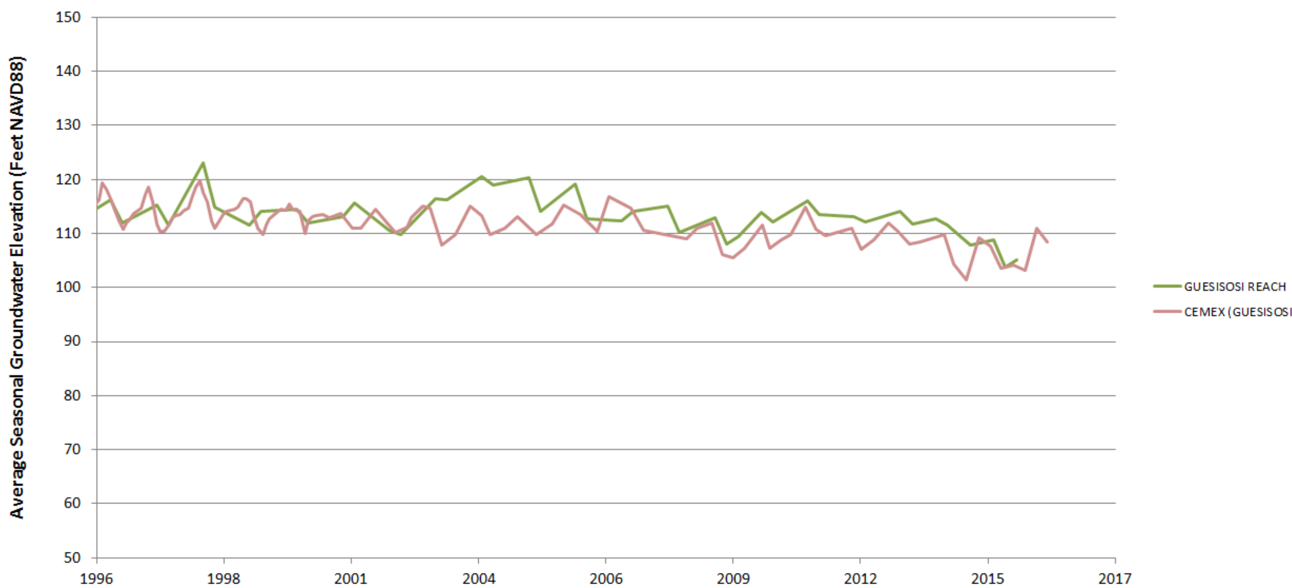

FIGURE 2.10: COMPARISON OF CEMEX GROUNDWATER MONITORING DATA AGAINST GUESISOSI REACH AVERAGES, (1996-2016).

Dunnigan Hills Reach

The Dunnigan Hills Reach extends downstream from the Guesisosi Reach to just above the Road 94B (Stevens Bridge). Average groundwater elevations confirm that this is a losing reach (Figure 2.7) – during 1996-2016 they were 10 – 25 feet lower than the channel bed elevation.

Teichert currently performs off-channel mining in the Dunnigan Hills Reach, and Figure 2.11 shows their groundwater elevation data from wells within the reach. The data indicate that groundwater in Teichert's wells is generally higher than the data from the CASGEM wells in the same reach, and that Teichert's groundwater levels did not depress during the 2012-2015 California drought to the same extent as other wells in the area. The reasons for these discrepancies are not known. However, off all reaches of Cache Creek, Dunnigan Hills contained the fewest available well records near the channel and the reach-averaged data shown in Figure 2.11 may not be as representative as the other reaches.

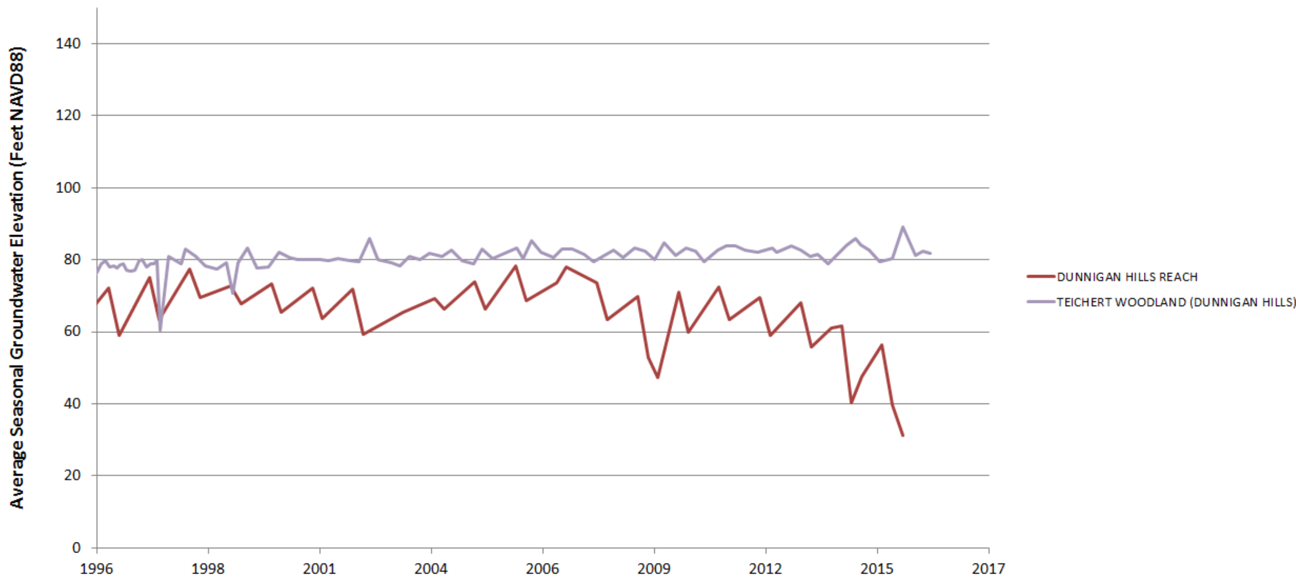

FIGURE 2.11: COMPARISON OF TEICHERT GROUNDWATER MONITORING DATA AGAINST DUNNIGAN HILLS REACH AVERAGES, (1996-2016).

Hoppin Reach

The Hoppin Reach extends approximately 3.2 miles downstream of Stephens Bridge. It continues the losing character of the Dunnigan Hills Reach, and the 1996-2016 groundwater data show that average levels were the deepest (30-50 feet below the channel bed) of all reaches.

Teichert also operates in the Hoppin Reach, and Figure 2.12 shows groundwater elevation data from wells within this reach. Like with the Dunnigan Hills reach, the data indicate that groundwater in Teichert's wells is generally higher than the data from the CASGEM wells and the typical depression of groundwater levels during the 2012-2015 California drought are not evident. As with the Teichert data in the Dunnigan Hills Reach, the reasons for these discrepancies with reach-averaged data are not known.

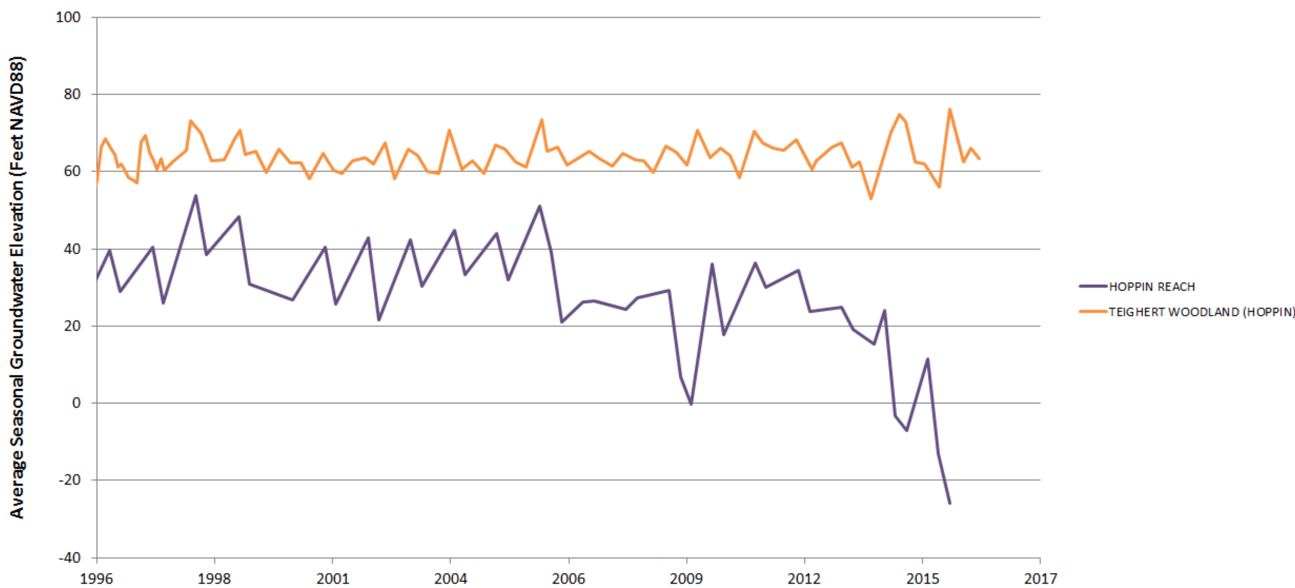

FIGURE 2.12: COMPARISON OF TEICHERT GROUNDWATER MONITORING DATA AGAINST HOPPIN REACH AVERAGES, (1996-2016).

Rio Jesus Maria Reach

The Rio Jesus Maria Reach extends from the Hoppin Reach to the settling basin, but only a small portion is within the CCRMP boundary. Like the Dunnigan Hills and Hoppin Reaches, it is a losing reach with average groundwater elevations between 1996 and 2016 approximately 20-30 feet below the channel bed.

No off-channel mining occurs in the Rio Jesus Maria Reach and therefore no aggregate producer groundwater elevation data were available.

2.3.4 Water Quality Results and Discussion

CCAP Monitoring Requirements

The CCRMP requires water quality sampling (CCRMP Section 3.4-3), at least once per year, at the upstream and downstream ends of the CCRMP area during the "first flush" flow event. Constituents tested should include, but not be limited to: pH, total dissolved solids, temperature, turbidity, total and fecal coliform, mercury, total petroleum hydrocarbons, dissolved oxygen, nitrogen, phosphorus, herbicides, and pesticides, suspended and floating matter, odor, and color. Additional testing is also required (CCRMP Section 3.4-3) near any projects prior to, during, and after construction (i.e., at first high-flow inundation) for the purpose of detecting any potential non-compliance with Regional Water Quality Control Board (RWQCB) Water Quality Objectives and adaptation of future projects as a response to non-compliance.

In addition, the OCMP requires mining operators (OCMP Section 3.4-3) to monitor wells on their plants for both groundwater level and groundwater quality.

Regulatory Context

According to the Sacramento and San Joaquin Rivers Basin Plan (CVRWQCB 2015), Cache Creek beneficial uses (from Clearlake to Yolo Bypass) include Municipal Domestic Supply (MUN), Agriculture (AGR), Industry (PROC, IND), Recreation (REC-1, REC-2), Freshwater habitat (WARM), Spawning (SPWN), and Wildlife Habitat (WILD). Lower Cache Creek (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass) is impaired for boron, mercury, and unknown toxicity according to the most recent Clean Water Act Section 303 (d) list (SWRCB 2010). Although elevated sources of mercury in Cache Creek are attributed to resource extraction from abandoned mines, sources of boron and toxicity are listed as “unknown” by the State Water Resources Control Board (SWRCB 2010). According to previous studies conducted by Yolo County, elevated concentrations of boron in Cache Creek are derived from mineralized waters of the North Fork Cache Creek and Bear Creek tributaries (NHC 1995, Yolo County 2006).

Water Quality Monitoring Summary and Data Availability

Surface Water

The surface water quality sampling program began in water year 2000 at 4 locations along the mainstem of Cache Creek—Capay Bridge (CC10), Upstream of Gordon Slough (CC11), Stevens Bridge (CC13), and 1-5 Bridge (CC14)—and was later expanded to include a fifth off-creek location in Gordon Slough (CC12). The locations Upstream of Gordon Slough, Gordon Slough, and Stevens Bridge were selected to capture any influence Gordon Slough has on Cache Creek water quality. Most analyses are performed in an analytical lab (“analytical results”), while temperature, pH, dissolved oxygen, electrical conductivity, and turbidity are measured in the field (“field results”) by Yolo County or Yolo County Flood Control and Water Conservation District staff.

During water years 2000 to 2011, samples were generally collected 3 times per year to capture the first flush, wet conditions, and dry season conditions (Table 2.3). However, the number and locations of sample events has fluctuated since the beginning of the program, due to a combination of hydrologic conditions and annual recommendations from TAC members. The most recent substantial change occurred in 2012 when the TAC recommended a reduction in the scope of the water quality sampling protocol to three sites (Capay Bridge, Gordon Slough, and I-5 Bridge) and one event per year unless additional events were warranted based on water quality results and the opinion of the TAC Hydraulic Engineer. In 2015, the TAC further recommended a reduction in contaminants analyzed at each annual sampling event (Yolo County 2015).

In 2013, turbidity was not measured during sampling events due to the instrument not being available. In subsequent years, the field data collection worksheet omitted turbidity as a sampling parameter.

TABLE 2.3: NUMBER OF SAMPLING EVENTS BY LOCATION (2000–2016).

Water Year	Capay Bridge (CC10)	Upstream of Gordon Slough (CC11)	Gordon Slough (CC12)	Stephens Bridge (CC13)	I-5 Bridge (CC14)
2000 [a]	3	3		3	3
2001 [a]	3	3		3	2
2002 [b]	2	2		2	1
2003 [b]	2	2		2	2
2004 [c]	1	1	1		1
2005 [a]	3	3	3		3
2006 [a]	3	3	3		3
2007 [c]	1	1	1	1	1
2008 [b]	2	2	2	2	1
2009 [a]	3	3	3	3	2
2010 [d]	2	2	2	2	2
2011 [a]	4	4	4	4	4
2012 [d]	1	1	1	1	1
2013 [d]	1	1	1	1	1
2014 [e]	1		1		1
2015 [d]	1		2		1
2016 [f]	1	1	1		1

a. Water quality samples collected during winter, spring, and summer
b. Water quality samples collected in winter and summer
c. Water quality samples collected during the summer only
d. Water quality samples collected during winter only
e. Water quality samples collected during spring only
f. Water quality samples collected during winter and spring

The resulting data from the surface water quality monitoring program have been inconsistently managed. The TAC Hydraulic Engineer has maintained a summary spreadsheet ("TAC summary spreadsheet") cataloging water quality monitoring data for all field data and a subset of analytical data for all years. All analytical data since 2006 have been uploaded to the Water Resources Information Database (WRID), a shared resource that is managed by the Yolo County Flood Control and Water Conservation District. Since 2012, the TAC Hydraulic Engineer has maintained not only the TAC summary spreadsheet, but also the original laboratory analytical reports and field data collection sheets for each sampling event.

Review of the surface water quality data showed that management and organization have not been consistent over the lifetime of the monitoring program. Specifically:

- field-collected data (pH, turbidity, DO, electrical conductivity) have not been entered into the WRID,
- all laboratory analysis reports are not available from all years of the program,
- water quality data from laboratory analyses have only been entered into the WRID from 2006 onward

- entry of data into the WRID has been inconsistent; for example, non-detect values or values reported that exceeded quantification limits (e.g. >1600 MPN/mL for fecal coliforms) were often entered into the WRID as blanks, and
- Water quality data have not been collected at in-channel projects as specified in Section 3.4-3 of the CCRMP.

Groundwater

Groundwater quality data exist for some wells throughout Yolo County for calendar years 1953 to 2007 in the WRID. For this analysis, only data from wells within a mile of Cache Creek were reviewed. The resulting data set contained samples from between 2004 and 2007 and only for pH, boron, nitrate, and nitrite.

Groundwater quality monitoring data were also available from Teichert, Syar, Cemex, and Granite for each of their mining plants. Generally, these data included general minerals and nutrients, heavy metals, and hydrocarbons.

Water Quality Analysis and Trends

Surface Water

The available record of analytical data from the surface water quality monitoring program was used to calculate the percent of total samples that were listed as “non-detected” by constituent. The results are contained in Appendix 2.B. For the purpose of calculating statistics in this report, samples with a non-detected result were considered to have a zero value, because in some cases, method detection limits were not available.

Appendix 2.B illustrates that the overwhelming majority of contaminants (>85%) have never been detected in the CCRMP water quality monitoring program. For those that were detected only limited spatial or temporal trends were observed:

- Some parameters were found to have increased within the CCRMP area over time. These include fecal coliform (starting in water year 2005), boron (starting in water year 2009), and orthophosphate (starting in water year 2010).
- Other parameters showed variability in concentrations that cannot be explained by factors such as hydrology or land use (which has not changed dramatically since the start of water quality monitoring). These included:
    - Mercury (both total and dissolved) spiked in water years 2004 and 2015.
    - TKN spiked in water year 2015 and to a lesser degree in water year 2008.
- TPH as diesel was detected during water years 2005–2011, but has since been below the method detection limit.

Gordon Slough often differed from the mainstem Cache Creek sample locations (CC10, CC11, CC13, and CC14). Gordon Slough showed the lowest average DO, pH, boron, and mercury compared to the other sites. On the other hand, Gordon Slough also showed higher TKN, orthophosphate, turbidity, and fecal coliforms than other sampling locations.

Sampling at Upstream of Gordon Slough, Gordon Slough, and Stevens Bridge was intended to capture the influence of Gordon Slough on Cache Creek water quality. On several occasions in the past, water quality samples were collected at these sites on different days (or not at all at Stevens Bridge from water years 2004–2006), prohibiting the fulfillment of this objective. If sampling at these sites is to continue in the future, samples should be collected on the same day. In addition, the data suggest that mixing of Gordon Slough input with Cache Creek is not occurring by Stevens Bridge, and consideration should be given to moving this sampling location further downstream.

Concentrations of few parameters were found to be distinctly increasing or decreasing through the CCRMP area. Most of the time, downstream changes in concentration were either difficult to recognize or changed depending on the year. However, the data showed a strong increase in total mineral nitrogen (nitrate + nitrite) between the Capay Bridge and Upstream of Gordon Slough sites. In most years, turbidity either increased or remained constant through the CCRMP area.

Correlation between Water Quality and Hydrology

The temporal variability in water quality was compared against several metrics of hydrology – Sacramento River water year type (Table 2.1), Cache Creek peak flow, and mean daily flow on Cache Creek at Yolo. No clear correlation was found between water quality and hydrology.

Turbidity was the only water quality parameter that showed a meaningful trend as compared to mean daily flows measured at the Yolo gage (Figure 2.13). Turbidity caused by suspended sediment would be expected to increase with flow due to erosion and transport of fine sediment, as depicted in the dotted line on Figure 2.13 which represents the linear regression of the data correlation.

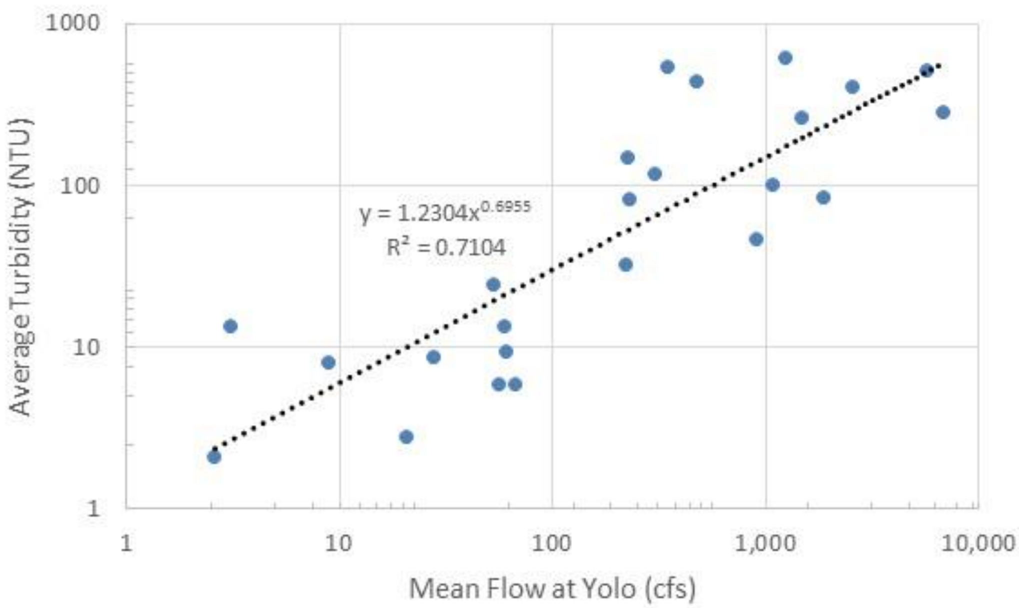

FIGURE 2.13: CORRELATION BETWEEN TURBIDITY AND MEAN DAILY FLOW.

Groundwater

Groundwater quality data are collected by aggregate producers in groundwater wells at each active plant along Cache Creek. These data are reported annually by each producer. A review of the data showed that few contaminants have ever been detected at levels exceeding regulatory guidelines, and those detections that have occurred have generally been isolated incidents. The following specific groundwater quality concerns were found:

- In 2009, Monitoring Well 2 (MW-2) at the Granite Capay plant showed very high levels of several metals. Such readings have not been seen at any other time.
- Nitrate is generally elevated (>45 mg/L as NO_3) in groundwater at the Cemex Madison plant.
- The Syar Madison plant has occasional elevated levels of Arsenic in some of its wells, and Arsenic is always present in elevated levels in ponds at the plant.

2.4 Recommendations

2.4.1 Recommendations on Plan Documents

Off-Channel Mining Program (OCMP)

The Streamway Influence Boundary and Test 3 Line referenced in the OCMP should be updated based on the latest available data and analyses. Other than this update and references to these boundaries, there are no recommendations for changes to the OCMP.

Cache Creek Resources Management Plan (CCRMP)

The CCRMP should be revised to reflect the following:

Section	Recommendation
Section 1.2	Update discussion of CCRMP channel boundary based on 2016 technical analyses.
Section 2.4	Revise outdated modeling-related language to reflect latest available data, models, and other tools to evaluate Creek conditions and plan for projects.
Section 2.5-9	Delete references to stream routing parameters and stream routing analyses. These are outside the scope of CCAP/CCRMP.
Section 3.4-1	Remove requirement of herbicide water quality study, which is beyond the intended scope of the CCRMP.
Section 3.4-3	Revise language describing guidance for water quality monitoring on in-channel projects. Meeting RWQCB requirements should be the responsibility of the entity implementing the project, not the County under the CCRMP. Additionally, while the County Resource Management Coordinator should be responsible for data collection, management, and distribution (as this Section is written), all data management activities should be coordinated through the appropriate TAC member for formatting, storage, and quality control.
Sections 6.5-6 through 6.5-8	These sections provide guidance on the way in-channel excavations should be performed for the purpose of improving channel stability and habitat. It is recommended that these be revised. As written, they provide a prescriptive approach that does not take into account the state of the Creek at the time a project is implemented. Rather than provide guidelines of channel slopes, cross sectional forms, and setbacks, the TAC should be engaged to provide guidance and approval of an in-channel aggregate removal designs to ensure that the designs best serve the needs of the Creek at the time of the project and in the future.
Section 6.5-12	This section should be revised to be consistent with revisions of the In-Channel Mining Ordinance, which duplicates this language.

Cache Creek Improvement Program (CCIP)

The CCIP should be revised to reflect the following:

Section	Recommendation
Section 2.2	The TAC Hydraulic Engineer role description should be revised to include the requirement that the selected individual have expertise in environmental water quality analyses.
Section 3.4	The “Test 3” concept should be renamed to be more descriptive of what the concept represents. The Test 3 Line should be revised to reflect current conditions in Cache Creek. The TAC Hydraulic Engineer and Geomorphologist recommend adoption of the 2017 Channel Form Template to replace the Test 3 Line.
Section 3.5	This sections states that the TAC should coordinate design of treatments of bridge transitions. This should be revised to reflect the technical advisory role of the TAC, rather than a design coordination role.
Section 3.6	Generalized sketches of proposed bridge transition projects should be reviewed to determine whether they are still relevant.
Section 4.2	The portion of this section regarding Maintenance of a Defined Low Flow Channel is outdated and should be revised or removed.
Section 6.3	Yolo County Flood Control and Water Conservation District (YCFCWCD) currently operate a real-time stream gage at Capay Dam, but the data are not publicly available. Better coordination between Yolo County Natural Resources staff, the TAC, and YCFCWCD should be developed so that the TAC has on-demand access to data from this gage.
Section 6.3	The CCIP stipulates that field crews should be mobilized an average of five times per year to measure flow and sediment transport at three locations. This monitoring has not been regularly occurring. If funding allows for this sampling to occur, it should be started to comply with the CCIP. Otherwise, the CCIP should be revised to exclude this requirement.
Section 6.3	The CCIP should add a trigger for a relatively high flow (10,000 cfs or higher is recommended) at which a longitudinal water surface profile should be surveyed for the purpose of (re)calibrating the program’s hydraulic model.
Section 6.3	The discussion of topographic surveys should be updated to reflect modern survey methods and topography analyses.
Section 6.3	Data storage, management, and quality control for the CCIP should be done in coordination with the appropriate TAC member to ensure that all collected data are appropriately formatted and entered into County databases for consistency throughout the lifetime of the CCAP.

2.4.2 Recommendations on Ordinances

Off-Channel Mining Ordinance

No changes to this ordinance are recommended.

Reclamation Ordinance

No changes to this ordinance are recommended.

In-Channel Mining Ordinance

The ordinance language (Section 10-3.406) describing allowable excavations, in particular gravel bar skimming, is confusing and difficult to interpret when designing a bar skimming project. This occurred during 2015 when a bar skimming project was developed in the Hungry Hollow Reach. This language should be revised to clarify which portions of gravel bars and what quantities of aggregate can be removed.

2.4.3 Other Recommendations

This retrospective analysis of CCAP has resulted in recommendations for program changes outside of the ordinances and plans that make up CCAP. These are described below.

Entry of water quality data from the CCRMP program into the WRID should be directly coordinated with or reviewed by the TAC Hydraulic Engineer. CCRMP water quality data already in the WRID should be updated and corrected to eliminate errors and inconsistencies.

During review of the WRID water quality data and comparison against TAC records, several data quality issues and inconsistencies were discovered in the WRID database. Coordination and review with the TAC Hydraulic Engineer to make sure that water quality results are appropriately entered into the WRID will benefit the program.

The CCRMP water quality monitoring program should be further streamlined.

Many contaminants, particularly trace organic molecules (such as pesticides) have been rarely, if ever, detected. The TAC Hydraulic Engineer recommends removing the Herbicides and Semi-Volatile Organics Analysis (SVOA) components from the program.

Dissolved oxygen concentrations should be recorded during sampling events.

In recent years (2012 to 2016), dissolved oxygen measurements have been recorded as a percent saturation. This should be changed back to a measurement of the concentration of dissolved oxygen, as percent saturation cannot be compared against historical data or regulatory criteria.

Turbidity should be measured during sampling events.

Beginning in 2014, turbidity data were no longer collected in the field during sampling events. This should be resumed per Section 3.4-3 of the CCRMP.

Status of Recommendations from the 2006 Status and Trends Report

In the 2006 Status and Trends Report (Yolo County 2006), the TAC Hydraulic Engineer had several recommendations. They are repeated in Section 4.1.1 with a discussion of the current status of implementation of the recommendation.

Status of Recommendations from 1998-2015 TAC Annual Reports

The status of recommendations related to water quality, hydrology, and hydraulics are summarized in Section 4.2.

2.5 References

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CHAPTER 2

APPENDICES

APPENDIX 2.A – DETAILED SURFACE WATER QUALITY ANALYSIS

SURFACE WATER QUALITY

Dissolved Oxygen

According to the Basin Plan, dissolved oxygen concentrations shall remain above 5.0 mg/L for waters designated for freshwater habitat (WARM) beneficial uses and 7.0 mg/L for spawning (SPWN) (CVRWQCB 2015). On average, dissolved oxygen concentrations at the Cache Creek sample locations (CC10, CC11, CC13, and CC14) ranged from 9.6 mg/L to 10.2 mg/L and did not change significantly from Capay Bridge to I-5 Bridge (Figure 2.14). Data from Gordon Slough show a lower average dissolved oxygen concentration of 7.6 mg/L. However, the difference may not be statistically significant as it is within the estimated standard deviation of the samples at other sites. The 2006 Status and Trends Report (County of Yolo 2006) also concluded that DO concentrations at the Cache Creek sites were similar, but Gordon Slough concentrations appeared to be "significantly lower." However, the report also stated that limited data at Gordon Slough precluded the confirmation of a significant difference.

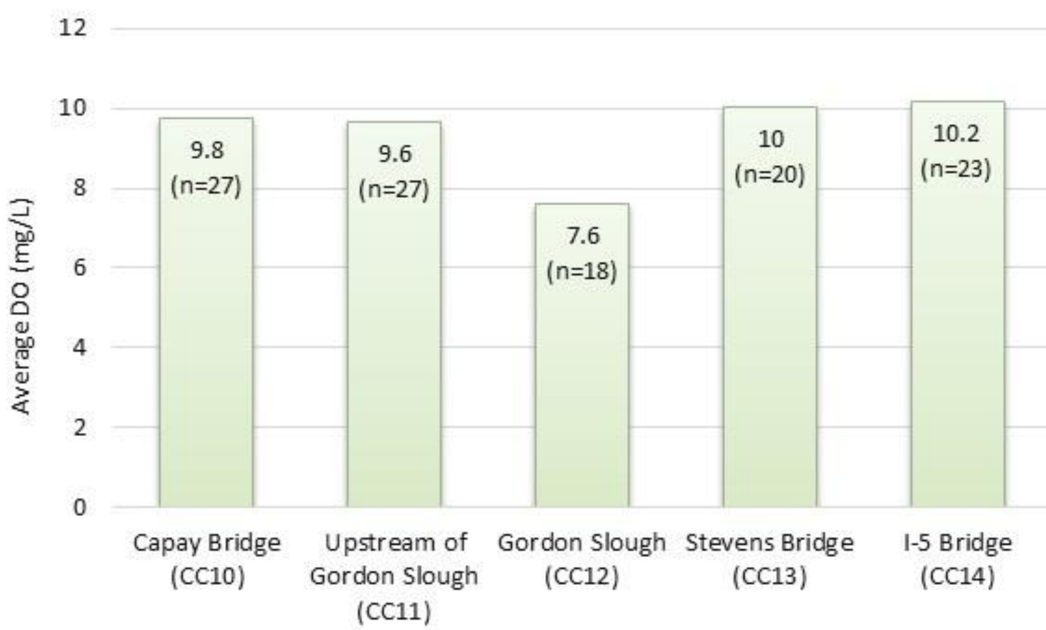

FIGURE 2.14: CACHE CREEK AVERAGE DISSOLVED OXYGEN BY SAMPLE LOCATION.

Most dissolved oxygen measurements have been above the Basin Plan minimum of 7.0 mg/L, especially prior to the 2003 water year (Figure 2.15). However, Gordon Slough has regularly been below that criteria, and along with Upstream of Gordon Slough, had some of the lowest recorded values on record. During water years 2012, 2013, 2015, dissolved oxygen was either not recorded or was measured as a percent of saturation rather than a concentration. Of all the values recorded, the lowest dissolved oxygen concentrations occurred in March 2016 at the site Upstream of Gordon Slough (3.1 mg/L) and in Gordon Slough (3.0 mg/L).

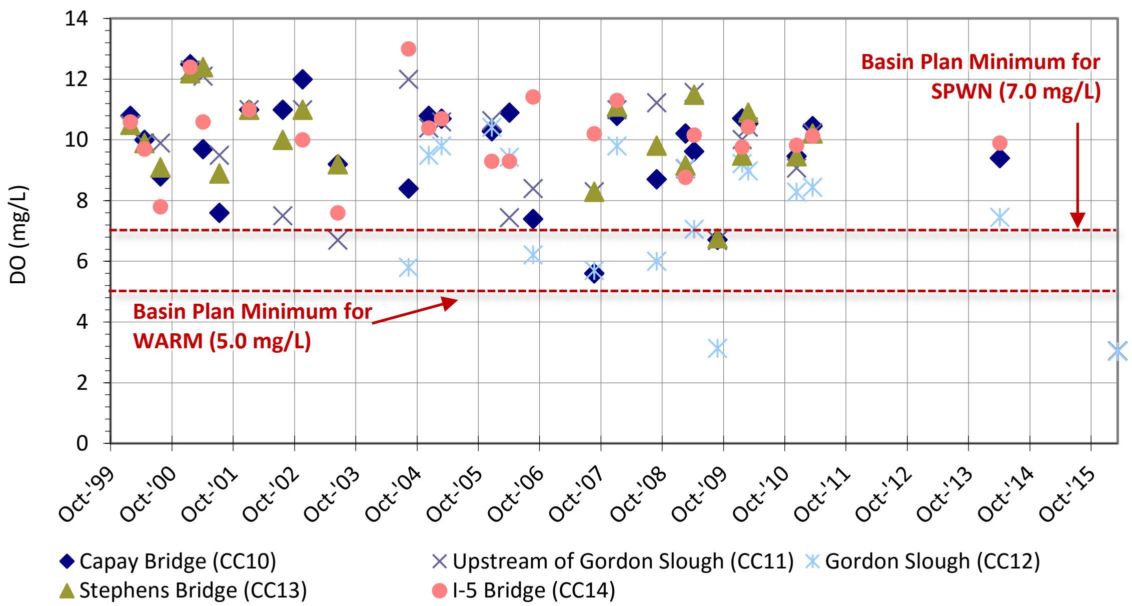

FIGURE 2.15: CACHE CREEK DISSOLVED OXYGEN (WATER YEARS 2000–2016).

pH

Surface Water

Average pH at all CCRMP monitoring locations ranged from 7.8 to 8.2, and did not change significantly from one site to the next (Figure 2.16). The 2006 Status and Trends Report (County of Yolo 2006) also concluded that pH at the Cache Creek sites were similar. However, the report also stated that Gordon Slough pH appeared to be "significantly lower," but limited data at precluded the confirmation of a significant difference.

FIGURE 2.16: CACHE CREEK AVERAGE PH BY SAMPLE LOCATION.

The Basin Plan (CVRWQCB 2015) states that pH shall remain in the range of 6.5 to 8.5 at all times. Measured pH values in Cache Creek were generally within this range with a few exceptions (Figure 2.17). The lowest value (5.3 pH units) was recorded in August 2005 at the I-5 Bridge. On the upper end of the range, exceedances of Basin Plan criteria occurred in water years 2006 at the I-5 Bridge (5.3 and 8.7 S.U.), in 2007 at the I-5 Bridge (8.6 S.U.), in 2010 at Capay Bridge (8.6 S.U.), and most recently in 2016 at Capay Bridge (8.8 S.U.), Stevens Bridge (8.7 S.U.), and I-5 Bridge (8.7 S.U.).

During water years 2000 to 2003, intra-site variation in pH was generally low. This trend started to change in water year 2004, as pH variability increased and Gordon Slough was added to the sites sampled. Other than the increase in pH variability observed after 2003, no other trends in pH over time are evident.

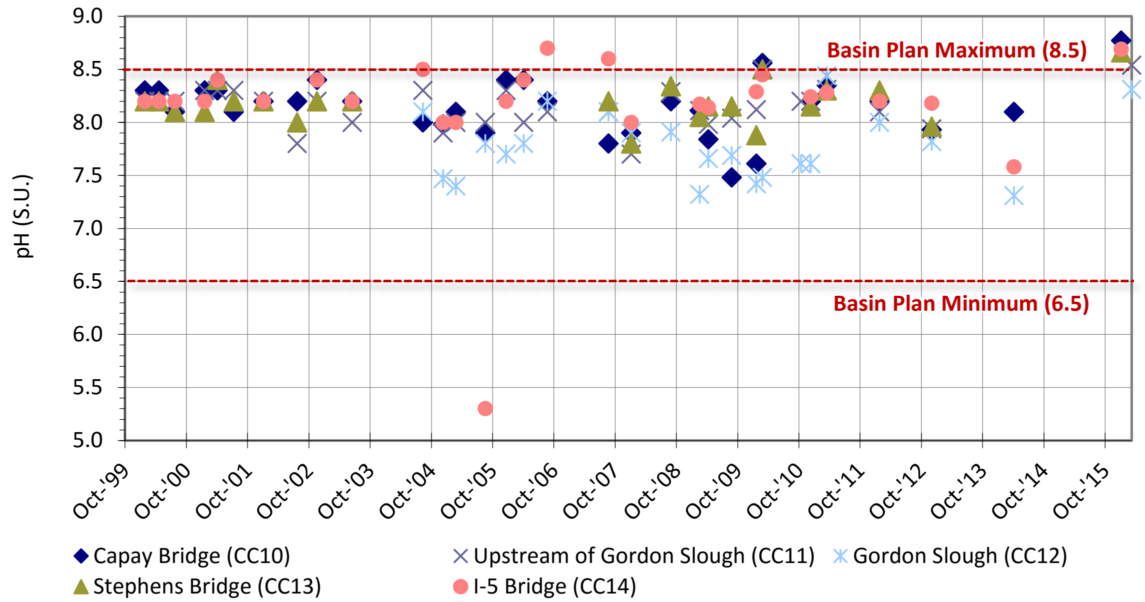

FIGURE 2.17: CACHE CREEK PH (WATER YEARS 2000–2016).

Groundwater

Limited pH data in groundwater wells were available. Figure 2.18 shows that available groundwater pH measurements are within the same range as surface water.

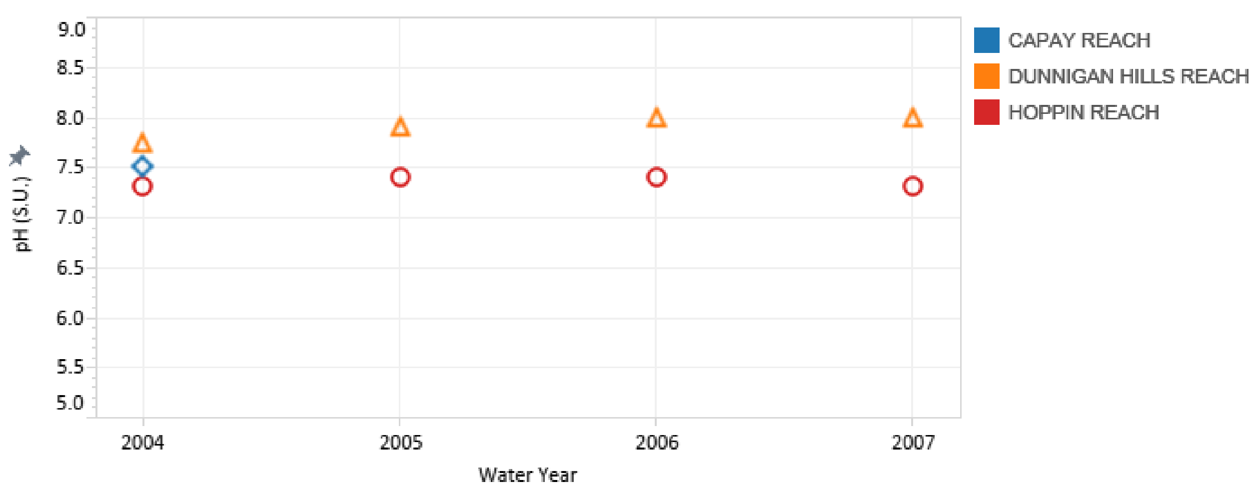

FIGURE 2.18: GROUNDWATER PH IN CCRMP AREA.

Turbidity

Turbidity is the measure of relative clarity of a liquid. Material that causes water to be turbid includes clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, and plankton and other microscopic organisms. In the Cache Creek CCRMP area, average turbidity ranged from 115–177 NTU (Figure 2.19). Gordon Slough and the I-5 Bridge were the two sites with the highest average turbidity (177 NTU and 170 NTU, respectively) due to some relatively high values recorded at I-5 Bridge in 2002 (780 NTU), at Gordon Slough and I-5 Bridge in 2008 (392 NTU and 677 NTU, respectively), and at Gordon Slough in 2013 (440 NTU, Figure 2.). In most years, turbidity either increased or remained constant through the CCRMP area. The 2006 Status and Trends Report (County of Yolo 2006) pointed to a possible increasing trend in turbidity through the CCRMP area and the highest value at Gordon Slough. However, the report also stated that Gordon Slough limited data were available and true significance could not be established. Additionally, the turbidity figure in the report (Figure 2.20) shows a flat to slightly decreasing trend from Capay Bridge to I-5 Bridge.

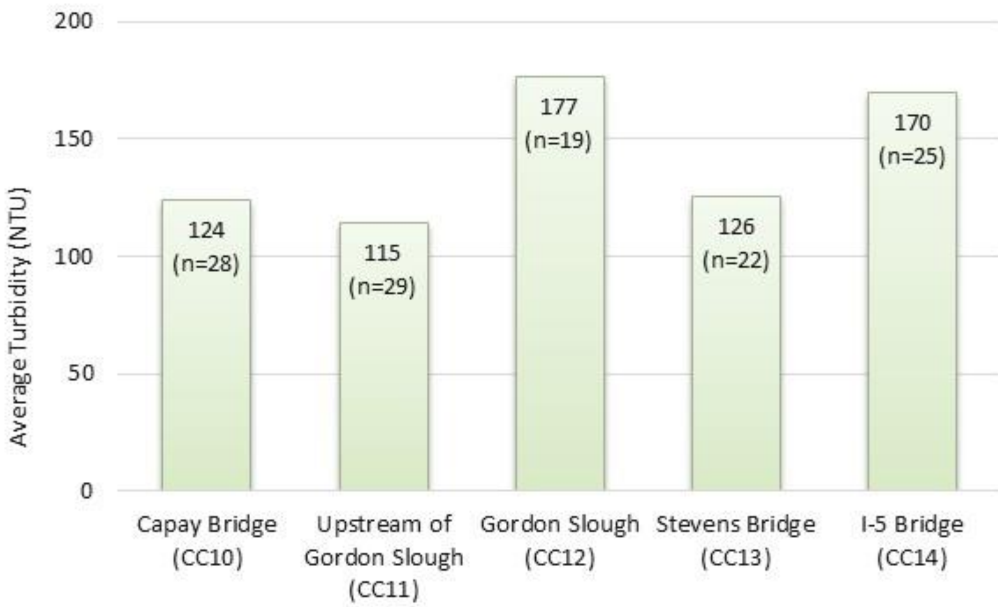

FIGURE 2.19: CACHE CREEK AVERAGE TURBIDITY BY SAMPLE LOCATION.

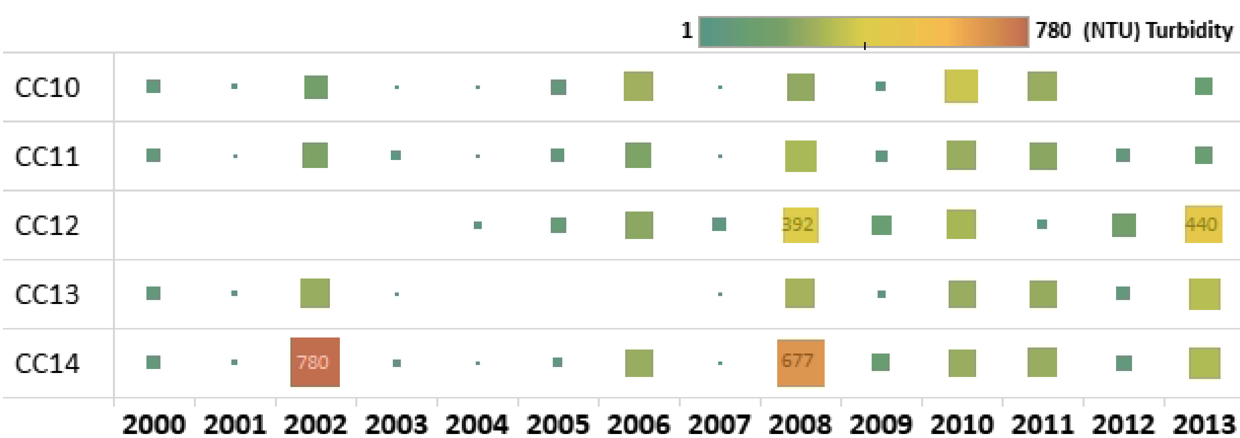

FIGURE 2.20: CACHE CREEK AVERAGE TURBIDITY TRENDS BY WATER YEAR (2000–2013).
Relative size and color of square indicate value. Number labels are shown for the 4 highest average turbidity values.

Elevated turbidity appears to be correlated with elevated flow recorded at the Yolo stream gage just upstream of the I-5 Bridge (USGS 11452500, Figure 2.21). This is most likely due to fine sediment transport during higher flows. Turbidity measurements were not taken in water years 2014 to 2016.

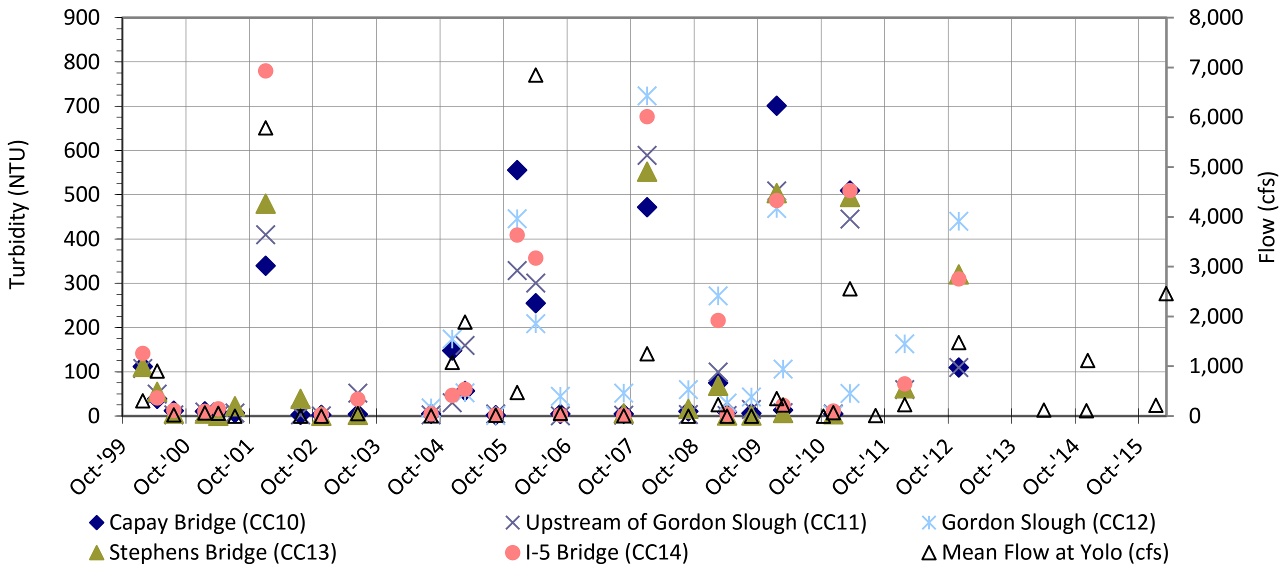

FIGURE 2.21: CACHE CREEK TURBIDITY (WATER YEARS 2000–2016).

Laboratory Analytical Measurements

Boron

Surface Water

As mentioned previously, Cache Creek is listed as impaired for Boron (a naturally occurring contaminant in the watershed), and a TMDL is due for this constituent by 2021 (SWRCB 2010). Currently, the Basin Plan sets the maximum concentration levels (MCLs) at 2.6 mg/L for any single sample and 1.0 mg/L (1.3 mg/L during critically dry years) for any monthly mean taken during the period from September 16th through March 14th of any year (CVRWQCB 2015). The 2006 Status and Trends Report (County of Yolo 2006) cites a program limit of 0.6 mg/L for Boron.

Average boron concentrations at all Cache Creek sample locations (CC10, CC11, CC13, and CC14) were below the 2.6 mg/L criteria, but above 1.0 mg/L monthly mean MCL and the program 0.6 mg/L criterion (Figure 2.22). Overall, average boron varied slightly through the CCRMP area, but concentrations did not change significantly from Capay Bridge to I-5 Bridge. Gordon Slough exhibited a significantly lower average Boron concentration from the other sites (0.92 mg/L, 0.72 mg/L during Sept 16th through Mar 14th). The 2006 Status and Trends Report (County of Yolo

2006) concluded that there were no discernible intra-site trends in boron. The report mentioned that Gordon Slough had lower concentrations, but not significantly so.

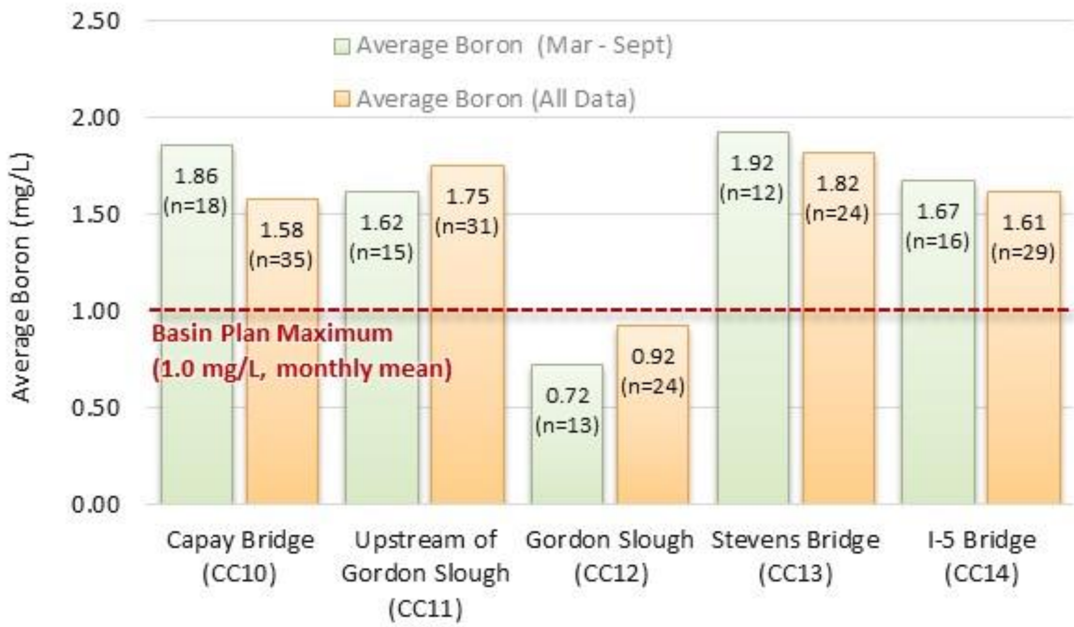

FIGURE 2.22: CACHE CREEK AVERAGE BORON BY SAMPLE LOCATION.

When looking at changes in boron over the years (Figure 2.23), there appears to have been an increase in average boron concentration starting with water year 2009. This is corroborated by the fact that all 9 exceedances of the 2.6 mg/L single-sample threshold occurred after the beginning of water year 2009. These exceedances occurred in February 2009 at Capay Bridge (3.5 mg/L); in January 2010 Upstream of Gordon Slough (3.2 mg/L), at Stevens Bridge (2.8 mg/L), and at I-5 Bridge (3.3 mg/L); in December 2010 at I-5 Bridge (2.7 mg/L); in April 2014 at Capay Bridge (2.7 mg/L) and Gordon Slough (2.9 mg/L); and in December 2014 at Capay Bridge (3.1 and 2.7 mg/L).

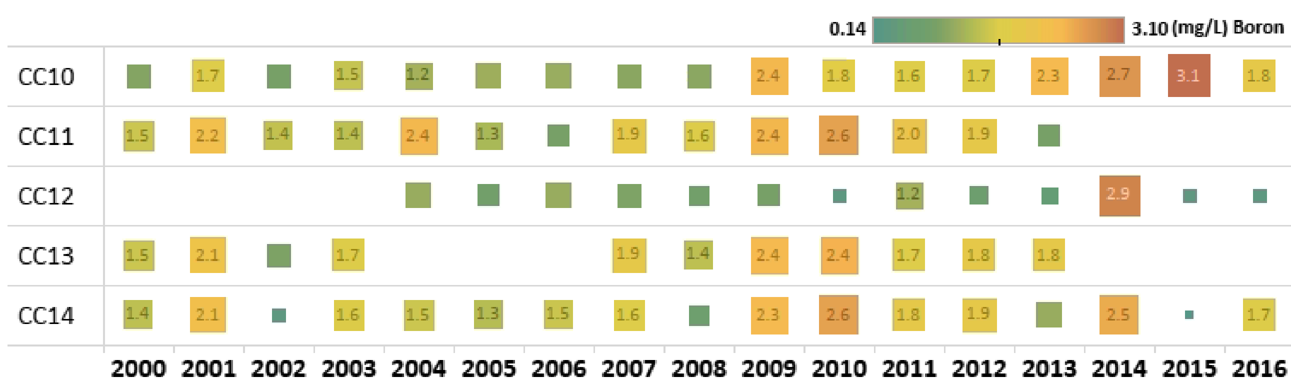

FIGURE 2.23: CACHE CREEK AVERAGE BORON TRENDS BY WATER YEAR (2000–2016).
Relative size and color of square indicate value. Number labels are shown for boron averages that exceed 1.0 mg/L (Basin Plan monthly average criteria)

Groundwater

A query of the WRID resulted in a total of 9 boron measurements from 3 wells within 1-mile of the CCRMP area. The one boron measurement from Capay reach was very high (9.5 mg/L). Boron at the other 2 reaches were below 2.6 mg/L single-sample threshold, with the exception of one measurement at Hoppin reach in water year 2007 (2.8 mg/L).

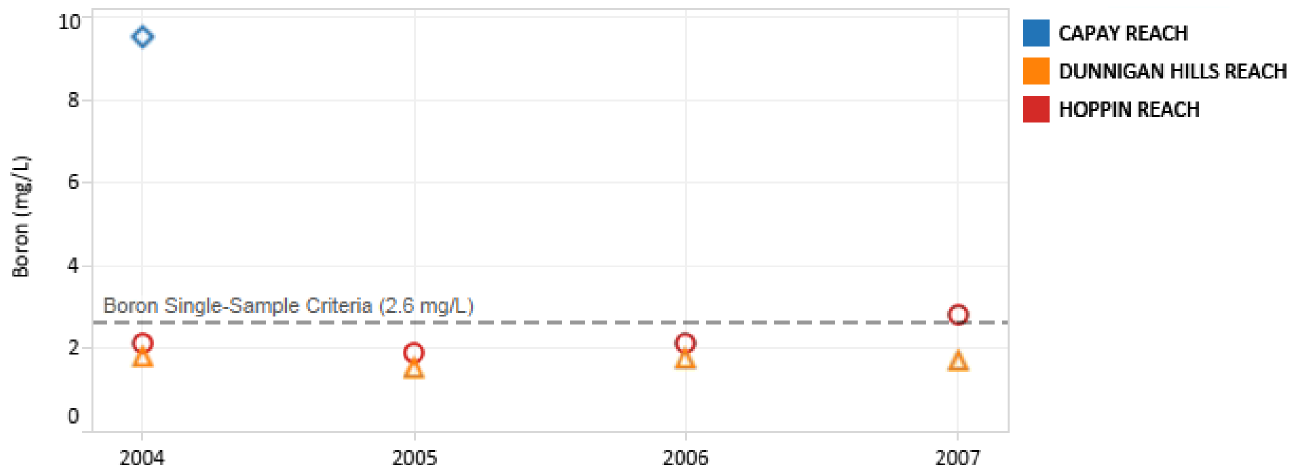

FIGURE 2.24: BORON IN GROUNDWATER BY REACH (WATER YEARS 2004–2007).

Mercury

Cache Creek is currently listed as impaired for mercury from past mining activities, initiating the creation and adoption of Cache Creek watershed methylmercury and total mercury implementation program. The program applies to Cache Creek, from Clear Lake to the Settling Basin outflow and North Fork Cache Creek from Indian Valley Reservoir Dam to the main stem Cache Creek. Basin Plan (CVRWQCB 2015) maximum limits are based on methylmercury fish tissue concentrations rather than concentrations of total mercury in surface water. However, separate from the Basin Plan, the California Toxics Rule (CTR) established a total mercury water concentration threshold of 0.05 µg/L for the protection of human health in all California waters.

The TAC summary spreadsheet data show an apparent decrease in the method detection limit (from 0.250 µg/L to 0.002 µg/L) starting with water year 2010 (Figure 2.25 and Figure 2.26). The lower detection limit allows for greater resolution in annual and inter-annual mercury trends as well as comparison against the CTR threshold (0.05 µg/L). However, this change also clarified that samples from 2000 to 2009 were likely providing a false sense of the state of mercury levels in Cache Creek. During this period, the majority (i.e., 96%) of samples did not contain detectible levels of mercury, but this was likely due to the high method detection limit rather than low levels of mercury in samples. Due to this issue the pre-2010 and 2010–2016 periods are discussed separately.

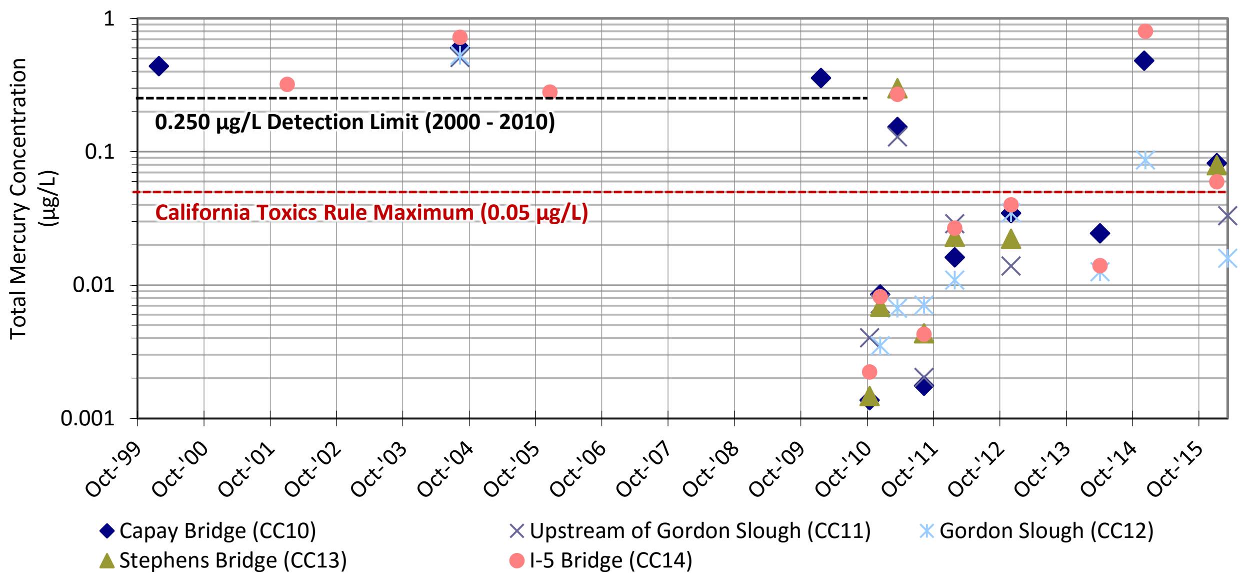

FIGURE 2.25: CACHE CREEK TOTAL MERCURY (WATER YEARS 2000–2016).

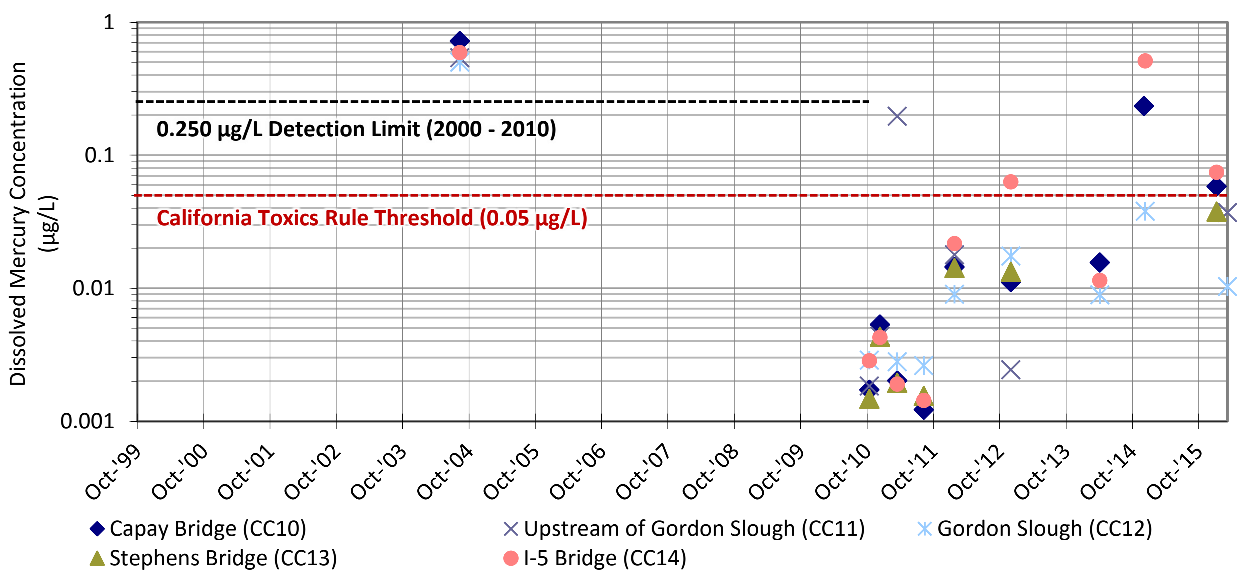

FIGURE 2.26: CACHE CREEK DISSOLVED MERCURY (WATER YEARS 2000–2016).

Average total mercury concentrations from 2010–2016 were above the CTR threshold at Capay Bridge (0.089 µg/L), Stevens Bridge (0.062 µg/L), and I-5 Bridge (0.136 µg/L, Figure 2.27). Based on average values, concentrations of both total and dissolved mercury were higher at the downstream end of the CCRMP area as compared to Capay Bridge. However, drawing conclusions about intra-site trends from mean values proves dubious in this case since the sample sizes were small (between 7 and 9 data points per site), and the differences in concentration were within the estimated standard deviations by site. This observation is similar to that of the 2006 Status and Trends Report (County of Yolo 2006), which was based on a smaller dataset.

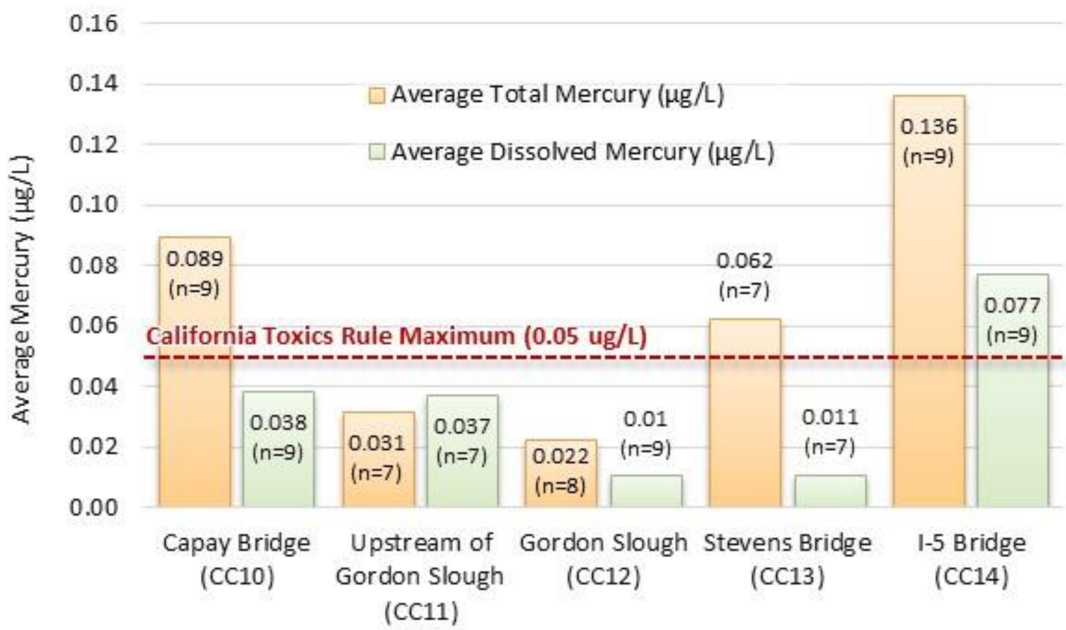

FIGURE 2.27: CACHE CREEK AVERAGE TOTAL AND DISSOLVED MERCURY BY SAMPLE LOCATION (2010–2016).

On an annual basis, average total mercury concentrations tended to increase through the CCRMP area in water years 2002, 2004, 2006, and 2015 (Figure 2.28). In contrast, average concentrations in water years 2000 and 2010 appeared to decrease with measurable values at Capay Bridge and non-detects at all other sites.

During the period from 2000 through 2009, the majority of total mercury concentrations were below the detection limit leading to low average total mercury during most years and at most sites (Figure 2.28). The exceptions to this occurred in water year 2000 at Capay Bridge (0.15 µg/L); in water year 2002 at I-5 Bridge (0.32 µg/L); in water year 2004 at Capay Bridge (0.60 µg/L), Upstream of Gordon Slough (0.51 µg/L), Gordon Slough (0.53 µg/L), and I-5 Bridge (0.72 µg/L); and in water year 2006 at I-5 Bridge (0.09 µg/L). Water year 2004 stands out in the record as having the highest average mercury concentrations, which were collected in August 2004. Since 2010, average total mercury has regularly exceeded the CTR threshold (Figure 2.28). In water year 2015, average total mercury was the highest recorded since 2004 at both Capay Bridge (0.48 µg/L) and I-5 Bridge (0.80 µg/L).

Because mercury transport can be strongly linked to sediment transport, possible linkages between total suspended solids concentrations and water years with relatively high total mercury concentrations were evaluated. In water year 2004, samples were collected in the summer and total suspended solids concentrations were very low (Figure 2.33) and most of the mercury was in the dissolved form (Figure 2.29). However, relatively higher total suspended solids concentrations were correlated with higher total mercury concentrations in other water years (e.g., 2000, 2002, 2011, 2015, and 2016), especially in 2015 when the highest total suspended sediment concentration at I-5 Bridge (6,900 mg/L) corresponded with the highest total mercury concentration (0.80 µg/L). However, it is not clear whether a definitive conclusion about mercury association with sediment can be drawn from these limited data, since dissolved mercury accounted for the majority of the total mercury found in these samples.

FIGURE 2.28: CACHE CREEK AVERAGE TOTAL MERCURY TRENDS BY WATER YEAR (2000–2016).
Relative size and color of square indicate value. Number labels are shown for total mercury averages that exceeded 0.05 µg/L (CTR human health criteria)

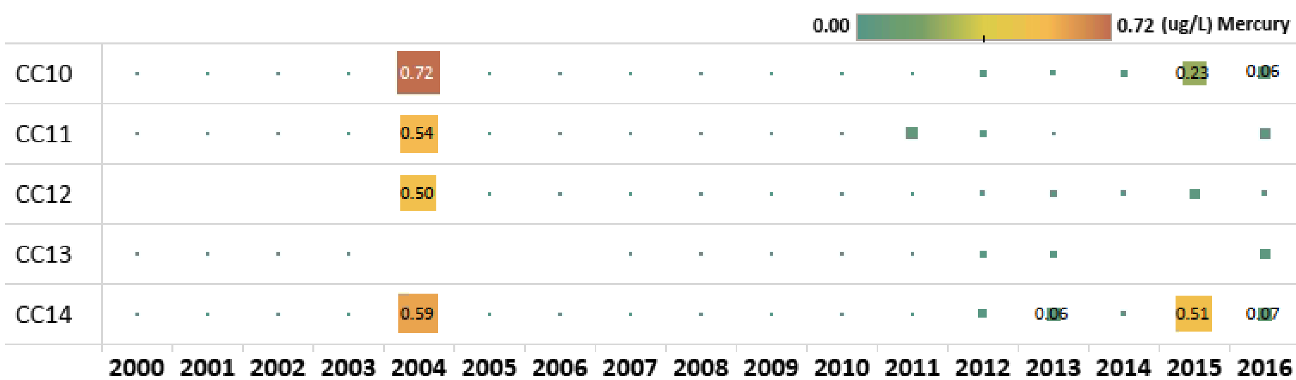

FIGURE 2.29: CACHE CREEK AVERAGE DISSOLVED MERCURY TRENDS BY WATER YEAR (2000–2016).
Relative size and color of square indicate value. Number labels are shown for dissolved mercury averages that exceeded 0.05 µg/L (CTR human health criteria)

Fecal Coliforms

According to the Basin Plan (CVRWQCB 2015), waters designated for contact recreation (REC-1) shall not contain fecal coliform in excess of 200/100 mL based on a geometric mean of not less than five samples for any 30-day period, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 mL. Even though the CCRMP sampling protocol collects samples at a much lower frequency and number, these criteria provide a useful reference.

All fecal coliform measurements were above the minimum detection limit. However, the data collected from 2000 to 2004 and 2011 to 2016 showed that a laboratory maximum detection limit of 1,600 MPN/100mL was used, meaning that the laboratory could not detect fecal coliforms above this number. This was not a problem in early years (2000–2004) because concentrations were consistently below 1,600 MPN/100 mL, but later imposed a maximum value as concentrations rose dramatically since 2004.

The lowest average fecal coliform concentration was found at Capay Bridge (Figure 2.30). Gordon Slough was a major source of fecal coliforms with an average concentration at more than double the Basin Plan criterion. However, average fecal coliforms recorded just downstream of Gordon Slough, at Stevens Bridge, were similar in concentration to those at Capay Bridge and Upstream of Gordon Slough (Figure 2.30). Concentrations at I-5 Bridge were higher than any other location in the mainstem of Cache Creek, which indicates there was either an additional source of fecal coliform between Stevens Bridge and I-5 Bridge or the influence of Gordon Slough on Cache Creek was not captured by sampling at Stevens Bridge (i.e., the two creeks were not fully mixed at that location). The 2006 Status and Trends Report (County of Yolo 2006) concluded that fecal coliform concentrations Upstream of Gordon Slough were considerably higher than all other sites, although the data provided in the report (Figure 2.31) do not show such a trend.

FIGURE 2.30: CACHE CREEK GEOMETRIC MEAN OF FECAL COLIFORM BY SAMPLE LOCATION.

Overall, fecal coliform concentrations appear to be increasing in the CCRMP area. Prior to 2004, concentrations at all sites were consistently below 1,600 MPN/100 mL, the maximum detectable concentration during 2000 to 2004 (Figure 2.31, shown as a dotted line). It appears that the maximum detectable concentration limit was increased following December 2004 (the first time concentrations rose above that value); and concentrations hit the new maximum (>160,000 MPN/100 mL) in Gordon Slough in water year 2010. Starting in water year 2011, the maximum detectable concentration limit was reduced back down to 1,600 MPN/100 mL. Since then, concentrations have regularly hit this upper limit and reduced the ability to evaluate trends beyond that concentration.

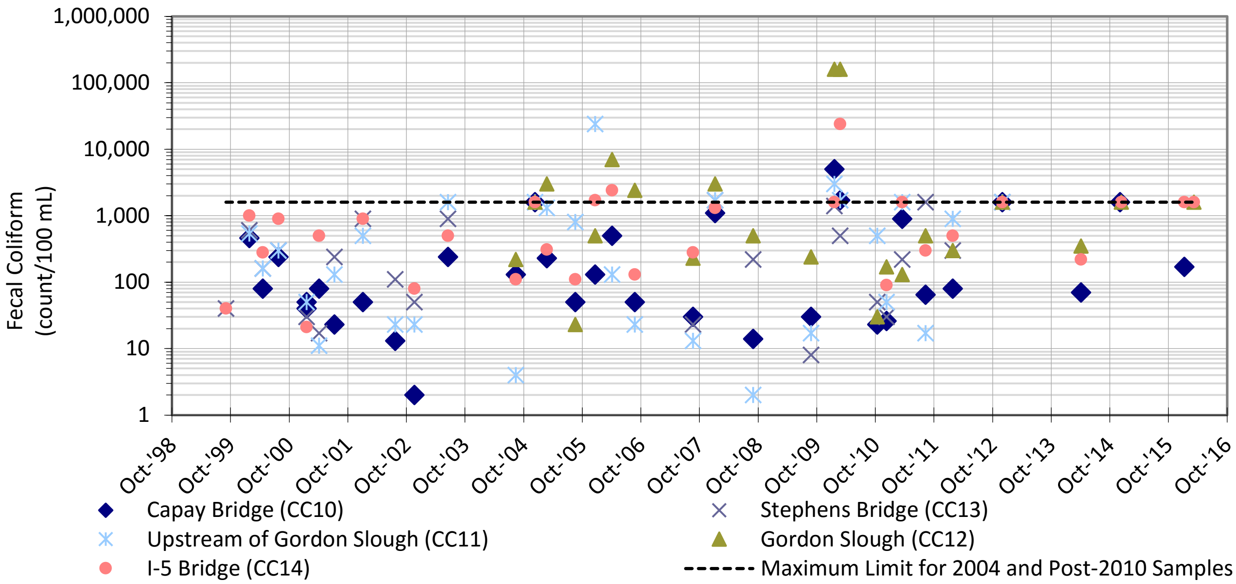

FIGURE 2.31: CACHE CREEK FECAL COLIFORM (WATER YEARS 2000–2016).

Total Suspended Solids

Total suspended solids (TSS) measures the concentration of both organic particles (e.g., algae) and inorganic particles (e.g., silt) larger than 2 microns found in the water column. Since the beginning of the program, 23% of the total samples collected (n=145) were below the method detection limit. On average, TSS remained relatively constant in Cache Creek until the concentration suddenly increased between Stevens Bridge and the I-5 Bridge (Figure 2.32). However, average TSS concentration at I-5 Bridge (486 mg/L) was skewed by an unusually high concentration recorded on December 2014 (6,900 mg/L). The cause of this high value is unknown. However, when this outlier was removed, the average TSS concentration at the I-5 Bridge dropped by 49% to 248 mg/L (shown as dashed line on Figure 2.32). As a result, average TSS concentrations remained relatively consistent, and no significant trends could be determined through the CCRMP area from Capay Bridge to the I-5 Bridge. The 2006 Status and Trends Report (County of Yolo 2006) proposed a possible increasing trend between creek sites, especially between Stevens Bridge and I-5 Bridge. The report also suggested Gordon Slough may have significantly higher TSS as compared to other sites, but also stated that limited data were available to establish true significance.

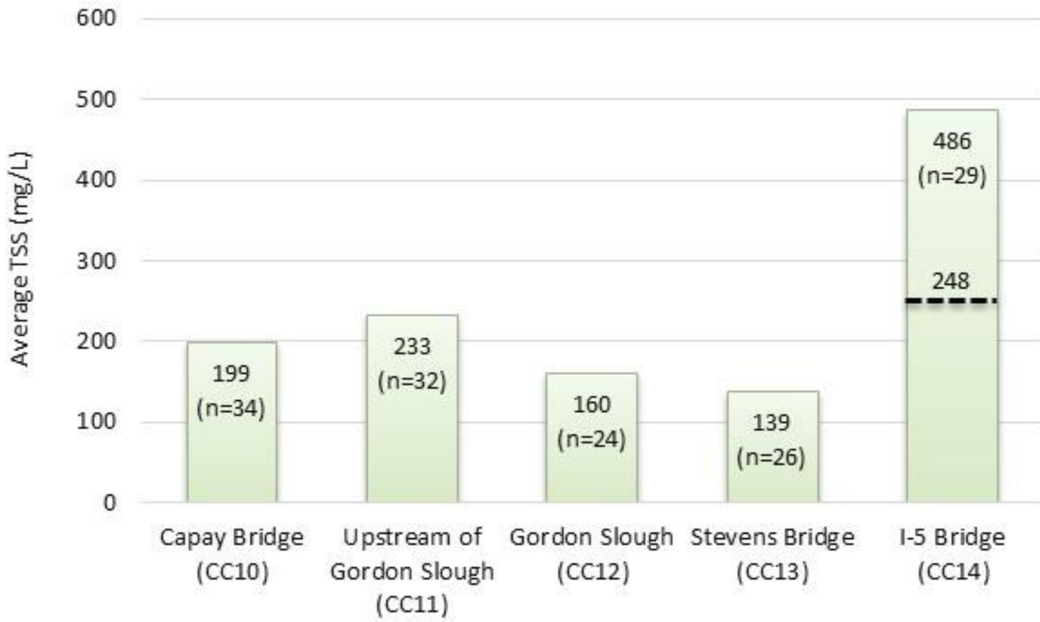

FIGURE 2.32: CACHE CREEK AVERAGE TOTAL SUSPENDED SOLIDS BY SAMPLE LOCATION.
Dotted line represents average TSS concentration if December 2014 outlier is removed.

Analysis of average TSS concentrations by water year showed that TSS may be increasing. Five out of the eight highest average concentrations (>500 mg/L) occurred in water years 2015 (1,600 mg/L at Capay Bridge, 750 mg/L at Gordon Slough, and 6,900 mg/L at I-5 Bridge) and 2016 (2,600 mg/L at Upstream of Gordon Slough and 620 mg/L at I-5 Bridge, Figure 2.). The other three occurred in water years 2002 at I-5 Bridge (940 mg/L), 2005 at I-5 Bridge (510 mg/L), and 2010 at Capay Bridge (680 mg/L). At an annual perspective, inter-site changes in average TSS have either increased or remained consistent through the CCRMP area depending on the water year. During half of the water years, TSS has remained consistent from Capay Bridge to I-5 Bridge, and TSS increased during the other half. The 2006 report indicated a “possible increasing trend [in TSS] between sites”, but this trend that has not predominated when looking at the entire record.

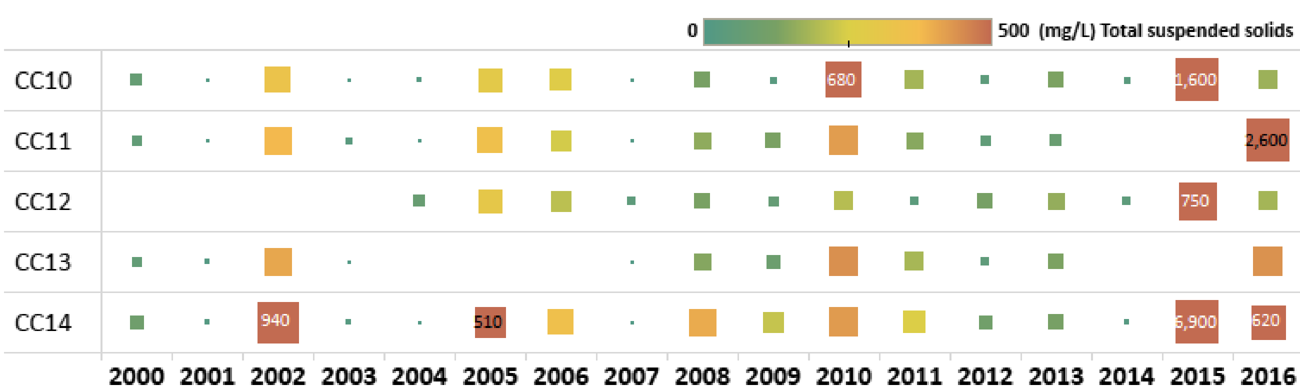

FIGURE 2.33: CACHE CREEK AVERAGE TOTAL SUSPENDED SOLIDS TRENDS (WATER YEARS 2000–2016).
Relative size and color of square indicate value. Number labels are shown for average TSS concentrations greater than 500 mg/L

Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) measures the total concentration of organic nitrogen, ammonia, and ammonium. Since the beginning of the program, 36% of the total samples collected (n=144) were below the method detection limit. When looking at average values over the entire sampling period, TKN concentrations fluctuated within the CCRMP area, but remained comparable at Capay Bridge (1.08 mg/L) and the I-5 Bridge (1.14 mg/L, Figure 2.34). Although Gordon Slough has the highest average TKN concentration compared to all sites, the difference does not appear to be statistically significant. The 2006 Status and Trends Report (County of Yolo 2006) observed the same general trends with similar concentrations at Capay Bridge, Upstream of Gordon Slough, and I-5 Bridge; higher concentrations in Gordon Slough; and lower concentrations at Stevens Bridge.

FIGURE 2.34: CACHE CREEK AVERAGE TOTAL KJELDAHL NITROGEN BY SAMPLE LOCATION.

Annual average TKN concentrations have generally increased at all locations beginning in water year 2004 (Figure 2.35). This observation was also documented in the 2006 Status and Trends Report (County of Yolo 2006). Water year 2015 marked the highest average TKN concentrations observed since the CCRMP water quality sampling program began. Concentrations at Gordon Slough (7.7 mg/L) and I-5 Bridge (8.3 mg/L) were measured at more than double any of the preceding years. Other generally high TKN years included water year 2008 and 2013. The lowest average TKN concentrations occurred in 2001, 2003, 2009, and 2014. No other temporal trends were observed. When looking at spatial trends through the CCRMP area, no consistent pattern emerges from the annual data.

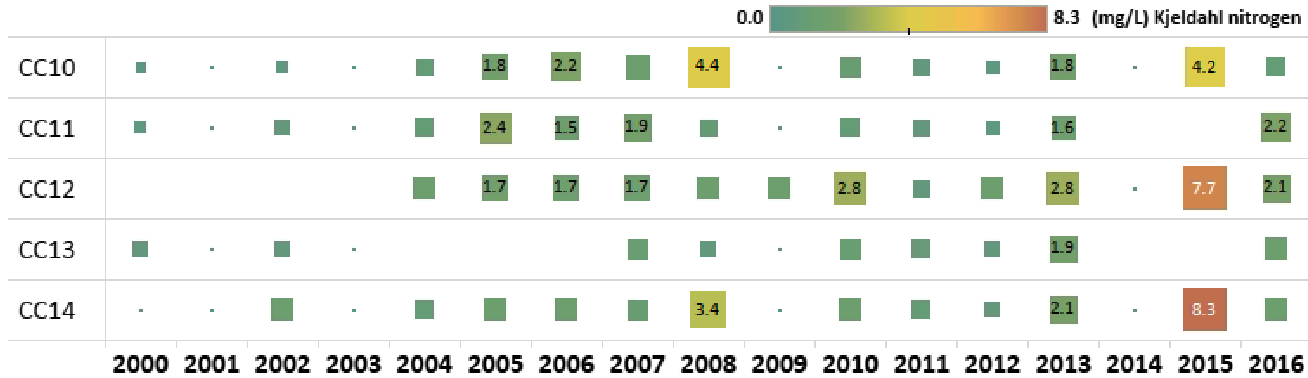

FIGURE 2.35: CACHE CREEK AVERAGE TOTAL KJELDAHL NITROGEN TRENDS (WATER YEARS 2000–2016).
Relative size and color of square indicate value. Number labels are shown for average TKN concentrations greater than 1.5 mg/L

Nitrate and Nitrite

In the sections that follow, nitrate and nitrite are aggregated as total mineral nitrogen. Nitrate is a highly soluble, stable nitrogen species that is easily transported in streams and groundwater. Plankton, algae, and aquatic plants utilize this nutrient as an energy source. On the other hand, Nitrite is relatively short-lived in water because it is often quickly converted to nitrate by bacteria. Because of this, nitrite often contributes a very small amount to the total mineral nitrogen as compared to nitrate. However, there are some exceptions to this (described below).

Surface Water

Since the beginning of the program, 88% of nitrite samples and 14% of nitrate samples were below the method detection limit. On average, mineral nitrogen in Cache Creek increased sharply through the CCRMP area from upstream at Capay Bridge (0.51 mg/L) to downstream at I-5 Bridge (1.71 mg/L, Figure 2.36). The most significant increase occurred between Capay Bridge (0.51 mg/L) and Upstream of Gordon Slough (2.28 mg/L), the location with the highest average mineral nitrogen concentration. From Upstream of Gordon Slough to the I-5 Bridge, average mineral nitrogen concentrations decreased gradually. This same trend was documented in the 2006 Status and Trends Report (County of Yolo 2006). However, the 2006 report also concluded that Gordon Slough had the highest mineral nitrogen concentrations—a trend not observed in this report.

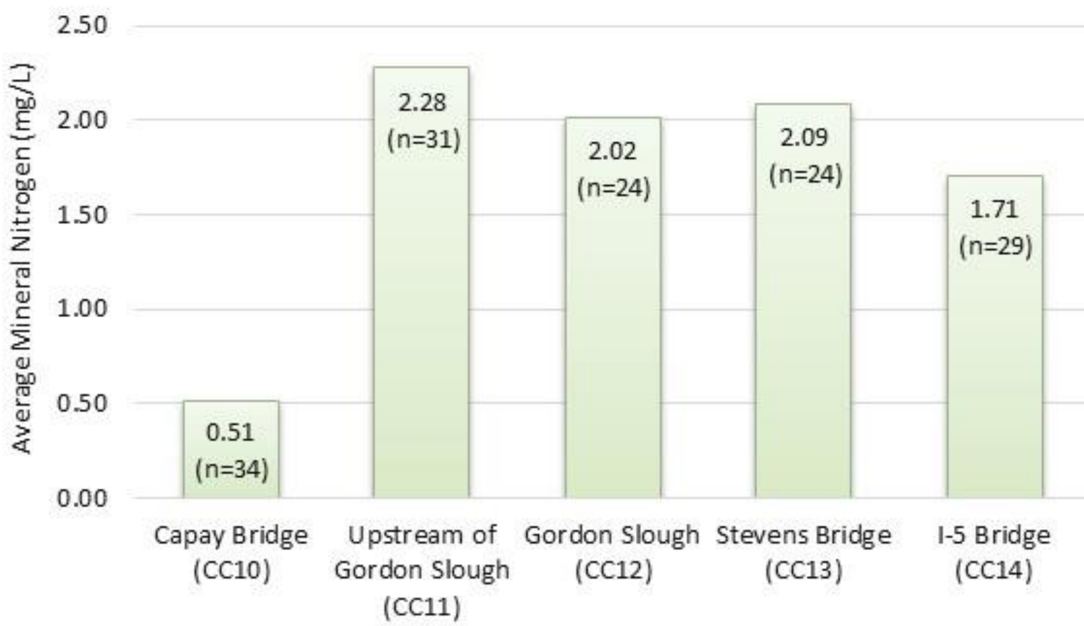

FIGURE 2.36: CACHE CREEK AVERAGE MINERAL NITROGEN BY LOCATION.

During most years, nitrite concentrations did not contribute significantly to the total mineral nitrogen concentration. Water year 2006 is the only exception. During December 2005, nitrite concentrations were 1.25 mg/L at Capay Bridge, 2.35 mg/L at Gordon Slough, and 2.66 mg/L at I-5 Bridge. When looking at averages by water year, no clear temporal pattern in nitrate prevailed over the course of the study period (Figure 2.37). The highest values were recorded in water year 2005 at Gordon Slough (5.7 mg/L) and Upstream of Gordon Slough in water year 2004 (5.2 mg/L). During most years, nitrate was lowest at Capay Bridge and increased significantly at Upstream of Gordon Slough.

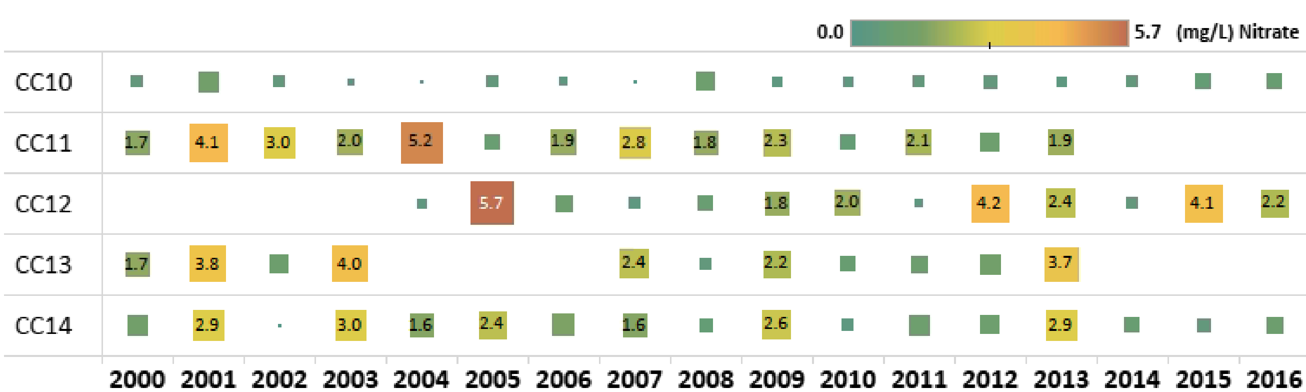

FIGURE 2.37: CACHE CREEK AVERAGE NITRATE TRENDS (WATER YEARS 2000–2016).
Relative size and color of square indicate value. Number labels are shown for average Nitrate concentrations greater than 1.5 mg/L.

Groundwater

Limited nitrogen data were available for groundwater wells and are shown in Figure 2.38. The Hoppin Reach shows elevated nitrogen levels that increased during the available period of record.

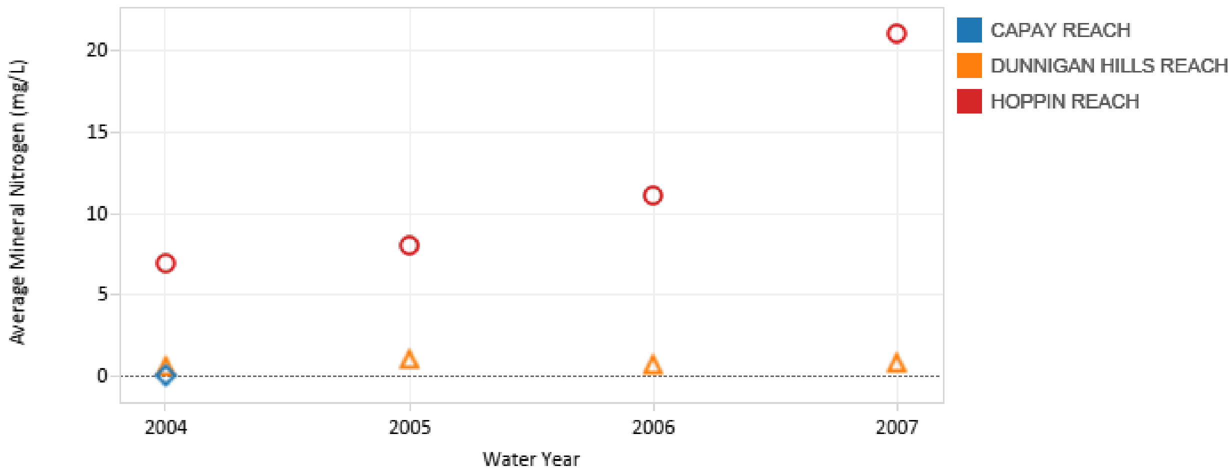

FIGURE 2.38: GROUNDWATER MINERAL NITROGEN IN CCRMP AREA.

Orthophosphate

Since the beginning of the program, the majority (87%) of orthophosphate concentrations have been below the method detection limit. This resulted in very low average concentrations as most data points were zero. Average orthophosphate concentrations in Cache Creek remained consistent from the Capay Bridge to the I-5 Bridge (Figure 2.39). Gordon Slough had the highest average orthophosphate concentration, but the spread of the data indicated this difference is not statistically significant when compared to averages at other sites. The 2006 Status and Trends Report (County of Yolo 2006) did not include any detectable concentrations of orthophosphate.

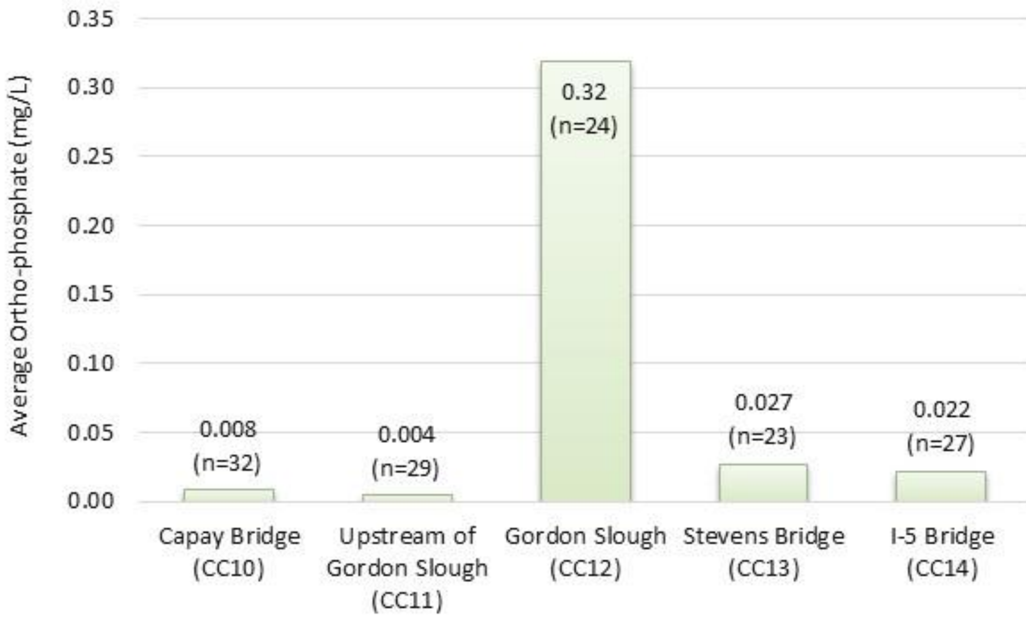

FIGURE 2.39: CACHE CREEK AVERAGE ORTHO-PHOSPHATE BY LOCATION.

During most years and across all sites, orthophosphate concentrations have been below detection limits (Figure 2.40). The first detection occurred Upstream of Gordon Slough in water year 2007 (1.1 mg/L), and the highest average orthophosphate concentration observed since the program began occurred in Gordon Slough during water year 2010 (2.5 mg/L). Orthophosphate may be on the rise as more values have been detected since water year 2010, especially at Gordon Slough.

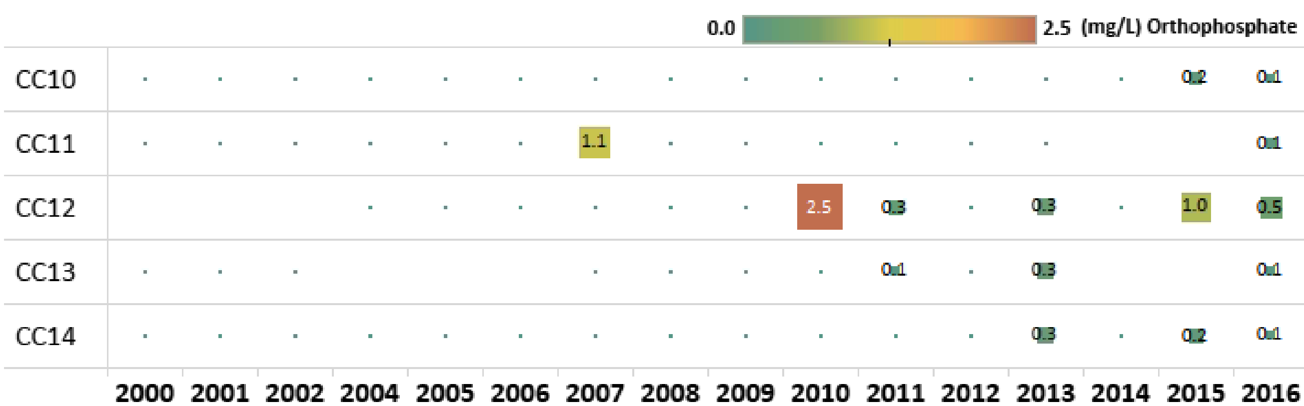

FIGURE 2.40: CACHE CREEK AVERAGE ORTHOPHOSPHATE TRENDS (WATER YEARS 2000–2016).
Relative size and color of square indicate value. Number labels are shown for average Orthophosphate concentrations greater than zero.

TPH as Diesel

The majority (79%) of TPH as diesel results have been below the method detection limit since the beginning of the program. On average, TPH as diesel concentrations have remained consistent from the upstream extent of the CCRMP area at Capay Bridge (14 µg/L) to the downstream extent at I-5 Bridge (29 µg/L, Figure 2.41). The highest average TPH as diesel concentration occurred at Gordon Slough (52 µg/L) as compared to all other sites. However, the spread of the data indicates this difference is not statistically significant.

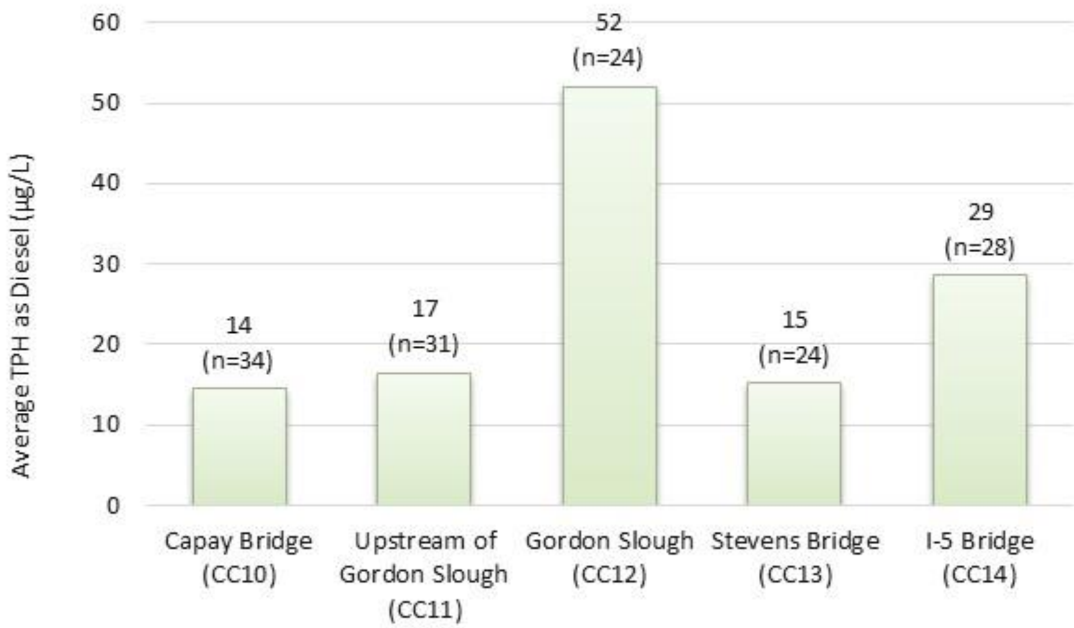

FIGURE 2.41: CACHE CREEK AVERAGE TPH AS DIESEL BY LOCATION.

More informative is the analysis of temporal trends in TPH as diesel (Figure 2.42). Prior to water year 2005, all TPH as diesel concentrations were below detection limits. In February 2005, TPH as diesel concentrations were detected for the first time at Capay Bridge (43 µg/L), Gordon Slough (21 µg/L), and I-5 Bridge (41 µg/L). These same observations were made in the 2006 Status and Trends Report (County of Yolo 2006). Average concentrations increased at all sites from 2005 through 2007. Average concentrations in 2007 indicated the source may have been between Capay Bridge and Upstream of Gordon Slough, or perhaps in Gordon Slough (Figure 2.). Concentrations dropped off again in 2008 to below detection limits at all sites except Gordon slough. In 2009, TPH as diesel concentrations were again detected at all locations, this time with increasing average concentration at each site from Capay Bridge (24 µg/L) through I-5 Bridge (97 µg/L). This trend changed a bit in 2010 as Gordon Slough exhibited the highest average concentration, 265 µg/L. Beginning in 2011 and extending to 2012, TPH as diesel concentrations dropped to below detection limits at all sites, where they have remained.

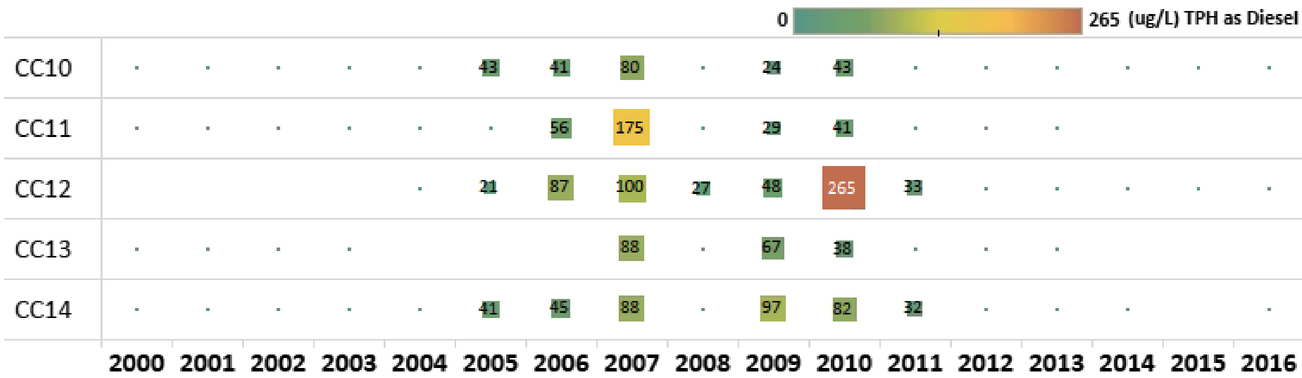

FIGURE 2.42: CACHE CREEK AVERAGE TPH AS DIESEL TRENDS (WATER YEARS 2000–2016).

Relative size and color of square indicate value. Number labels are shown for average TPH as Diesel concentrations greater than zero.

APPENDIX 2.B – SURFACE WATER QUALITY MONITORING PROGRAM STATISTICS

	Entire Record (2006-2016)		Recent Record (2014-2016)	
Analyte	**No. of Samples**	**% Non-Detects**	**No. of Samples**	**% Non-Detects**
2,4,5-T	73	100%	4	100%
2,4,5-TP (SILVEX)	73	100%	4	100%
2,4-D	73	99%	4	100%
2,4-DB	73	100%	4	100%
2,4-Dichlorophenylacetic acid	43	16%	-	N/A
3,5-Dichlorobenzoic acid	29	100%	-	N/A
4-Nitrophenol	29	100%	-	N/A
Acifluorfen	33	100%	-	N/A
Ammonia	75	55%	6	100%
AMPA	22	0%	-	N/A
Azinphos-ethyl	27	100%	4	100%
Azinphos-methyl	73	100%	4	100%
Bentazon	38	100%	-	N/A
Bolstar	73	100%	4	100%
Boron	74	0%	5	0%
Chloramben	33	100%	-	N/A
Chlorobenzene	46	0%	-	N/A
Chlorpyrifos	27	100%	4	100%
Color	68	0%	4	0%
Color (A.P.H.A)	5	40%	-	N/A
Coumaphos	73	100%	4	100%
Dalapon	65	100%	4	100%
DCAA	27	0%	4	0%
DCPA	33	100%	-	N/A
DCPAA	8	0%	-	N/A
Demeton	46	100%	-	N/A
Demeton-o	27	100%	4	100%
Demeton-s	27	100%	4	100%
Diazinon	73	100%	4	100%
Dicamba	65	100%	4	100%
Dichloroprop	46	100%	-	N/A
Dichlorprop	27	100%	4	100%
Dichlorvos	73	100%	4	100%
Dimethoate	65	100%	4	100%
Dinoseb	73	100%	4	100%
Disulfoton	73	100%	4	100%

	Entire Record (2006-2016)		Recent Record (2014-2016)	
Analyte	No. of Samples	% Non-Detects	No. of Samples	% Non-Detects
Dursban (Chlorpyrifos)	46	100%	-	N/A
EPN	65	100%	4	100%
Ethion	27	100%	4	100%
Ethoprop	73	100%	4	100%
Famphur	27	100%	4	100%
Fecal Coliform	69	6%	5	80%
Fensulfothion	73	100%	4	100%
Fenthion	73	100%	4	100%
Gardona (Stirophos)	46	100%	-	N/A
Gasoline Range Hydrocarbons	46	100%	-	N/A
Glyphosate	73	100%	4	100%
Malathion	73	100%	4	100%
MCPA	65	100%	4	100%
MCPP	65	100%	4	100%
Mercury	65	69%	6	0%
Mercury, dissolved	60	68%	6	0%
Merphos	46	100%	-	N/A
Methyl Parathion	8	100%	-	N/A
Mevinphos	73	100%	4	100%
Monocrotophos	38	100%	-	N/A
Naled	46	100%	-	N/A
Nitrate as N	74	11%	5	0%
Nitrite as N	74	96%	5	60%
Odor	73	26%	4	0%
Orthophosphate as P	75	83%	6	0%
Parathion	65	100%	4	100%
Parathion-methyl	65	100%	4	100%
Pentachlorophenol	65	100%	4	100%
Phorate	73	100%	4	100%
Picloram	65	100%	4	100%
Ronnel	73	100%	4	100%
Simazine	27	100%	4	100%
Stirofos	27	100%	4	100%
Sulfotep	38	100%	-	N/A
TEPP	38	100%	-	N/A
Tetratetracontane	27	0%	4	0%
Thionazin	27	100%	4	100%
Tokuthion	73	100%	4	100%
Toluene-d8	28	0%	5	0%

	Entire Record (2006-2016)		Recent Record (2014-2016)	
Analyte	**No. of Samples**	**% Non-Detects**	**No. of Samples**	**% Non-Detects**
Total Coliform	69	12%	5	100%
Total Dissolved Solids	74	0%	5	0%
Total Kjeldahl Nitrogen	75	28%	6	0%
Total Suspended Solids	75	25%	6	0%
TPH as Diesel	73	70%	4	100%
TPH as Gasoline	28	100%	5	100%
Tributyl phosphate	49	0%	4	0%
Trichloronate	73	100%	4	100%
Triphenyl phosphate	61	0%	4	0%
Turbidity	46	0%	-	N/A

CHAPTER 3

LOWER CACHE CREEK BIOLOGICAL RESOURCES STUDY (1995–2016)

3.1 INTRODUCTION

This report summarizes the results of a retrospective analysis of biological resources on lower Cache Creek (Yolo County, CA) conducted in 2016 by the Consulting Biologist in support of the 10-year update of the Cache Creek Area Plan (CCAP), which includes the Cache Creek Resource Management Plan (CCRMP) and the Off-channel Mining Plan (OCMP), as well as various ordinances. Within the CCAP framework, biological resources include native vegetation, wildlife (amphibians, reptiles, mammals, and birds), invertebrates, and fish. Nonnative species in each of these categories were also be considered due to their direct and indirect impacts on native species and ecological processes. The goals of this retrospective analysis were to (1) document the current state of biological resources within the CCAP area along lower Cache Creek, (2) assess changes and trends in biological resources relative to the baseline 1995 Technical Studies, and (3) inform the update of foundational plan documents and ordinances and the ongoing adaptive management of biological resources on lower Cache Creek.

Quantitative data were available to assess changes and trends in vegetation, while both qualitative and quantitative assessments were made regarding changes and trends in wildlife, invertebrates, and fish. Particular attention was given to special-status native species, which include those listed or proposed for listing as threatened or endangered by the California Department of Fish and Wildlife (CDFW) and/or the U.S. Fish and Wildlife Service (USFWS), most species that are candidates for either state or federal listing, and species designated as "fully protected" or "species of special concern" by CDFW. Historical recommendations regarding biological resources were also evaluated, and refined recommendations are presented to enhance data collection, evaluation of changes and trends in biological resources, and implementation of the CCAP. Results and recommendations are evaluated in terms of long-term goals of the CCAP regarding biological resources.

3.2 METHODS AND ASSUMPTIONS

This study integrated review, reanalysis, and synthesis of historical data on biological resources in addition to collection and analysis of new data on native vegetation, wildlife, and other biological resource elements. For detailed description of methods used, see Appendix 3.A.

Beginning with the 1995 Technical Studies (NHC 1995), numerous historical (1995–2015) reports and datasets related biological resources were reviewed, and both quantitative and qualitative data were extracted, compiled, and analyzed. Source material included CCTAC annual reports, Biological Assessments (BAs) and Environmental Impact Reports (EIRs) associated with past CCAP projects, aerial photography, published research, historical maps, and biological databases (e.g., California Natural Diversity Data Bank, or CNDBB).

New data on biological resources were collected for this study to further assess changes and trends in native and nonnative vegetation, including reclassification of 1995 and 2005 vegetation from existing maps and aerial photography, new classification of 2010 and 2015 vegetation from aerial photography, mapping of all present-day (2015–2016) blue elderberry (*Sambucus nigra* spp. *caerulea*) shrubs within the CCRMP area, mapping of 25 priority nonnative and invasive plant species within the CCRMP area in 2016, and incidental observations of native and nonnative plant species made during field activities.

Incidental observations of native and nonnative wildlife, invertebrates, and fish were also made during 2015 and 2016 Creek Walks, and during elderberry and invasive plant mapping efforts. A focused Valley elderberry longhorn beetle (VELB; *Desmocerus californicus dimorphus*) survey was performed by the Consulting Biologist in June 2015 on a small portion of the CCRMP scoped for a proposed bar-skimming project. Additional wildlife data were generated through interviews conducted in 2016 with landowners, land managers, and gravel operators during public meetings and the annual Creek Walk.

3.3 RESULTS AND DISCUSSION

Substantial changes and specific trends in both native and nonnative vegetation were revealed through integrated analyses of existing and newly-collected qualitative and quantitative data. Changes and trends were also observed for the other categories of biological resources, although they were more qualitative in nature due to the nature of the organisms and limitations on data availability. For amphibians, reptiles, mammals, birds, invertebrates, and fish, it is important to recognize that statistically-rigorous surveys for these biological resource elements have not been performed systematically across all CCAP reaches for any year from 1995–2016, with the exception of Swainson's hawk (*Buteo swainsoni*) surveys in 2010 (Cahill 2014). Two large-scale fish surveys undertaken in 1997 (Moyle and Marcheti 1998) and 2008 (Stillwater Sciences 2009) spanned lower Cache Creek, but sampling locations were not aligned within all reaches. Similarly, camera surveys for mammalian carnivores and other species were conducted by University of California Davis researchers within the CCAP area from 2015–2016, but sampling locations were not located in all reaches (B.N. Sacks, University of California Davis, unpublished data). Given these data gaps, and the more than 200 common or special-status native wildlife and invertebrate species that could potentially be present, it is imperative that lack of occurrence data for any native species in a particular reach or location not be interpreted as proof of absence. Instead, if the species has been observed within or near the CCAP in the past, and if suitable habitat exists within the CCAP, the assumption should be that the species could be present unless specific information suggests otherwise.

Syntheses of changes and trends (1995–2016) for each category of biological resources are provided below; see Appendix 3.B for detailed results and summary tables for observations of amphibians, reptiles, mammals, birds, invertebrates, and fish.

3.3.1 VEGETATION

Data Collection and Analysis

At the time of the 1995 baseline Technical Studies, riparian vegetation had been heavily impacted by aggregate mining and little mature riparian forest remained. Remaining mature riparian forests were largely hydrologically abandoned by degradation of the topographic level of the creek channel bed, thus endangering regeneration of the canopy and understory characteristic of riparian forest.

Remaining vegetation was dominated by herbaceous vegetation and early-successional willow scrub, indicative of a high level of disturbance, as well as invasive tamarisk (*Tamarix ramossissima*) and giant reed (*Arundo donax*) that were widespread along lower Cache Creek (NHC 1995). The negative ecological effects of both of these species was well-described, and included high rate of evapotranspiration leading to water competition with native species, displacement of native species, concentration of salts in soil by tamarisk, reduction in flow capacity, and substantial reductions of wildlife habitat value. Two additional invasive species, yellow starthistle (*Centaurea solstitialis*) and tree tobacco (*Nicotiana glauca*), were noted as being already present at the Cache Creek Nature Preserve (Jones & Stokes Associates 1995).

Riparian vegetation within the CCAP area was initially mapped in 1995 from aerial photography as a component of the Technical Studies (see Appendix 1 for details). Four vegetation classes were used: *riparian forest, oak woodland, willow scrub,* and *herbaceous* (non-woody vegetation) (Fig. 3.1). The 1995 Technical Studies estimated that only approximately 200 ac. of riparian forest remained within the CCAP area. However, reanalysis of the 1995 vegetation map in 2016 using current GIS-based methods resulted in substantially higher estimates of all four vegetation classes than originally reported in the Technical Studies (Fig. 3.2, Table 3.1). At the scale of the CCAP area, a total of 616.35 ac of riparian forest, 625.14 ac. of oak woodland, 861.12 ac. of willow scrub, and 331.68 ac. of herbaceous vegetation was estimated in the reanalysis (see Table 3.1 for results for CCRMP area, OCMP area, and by reach).

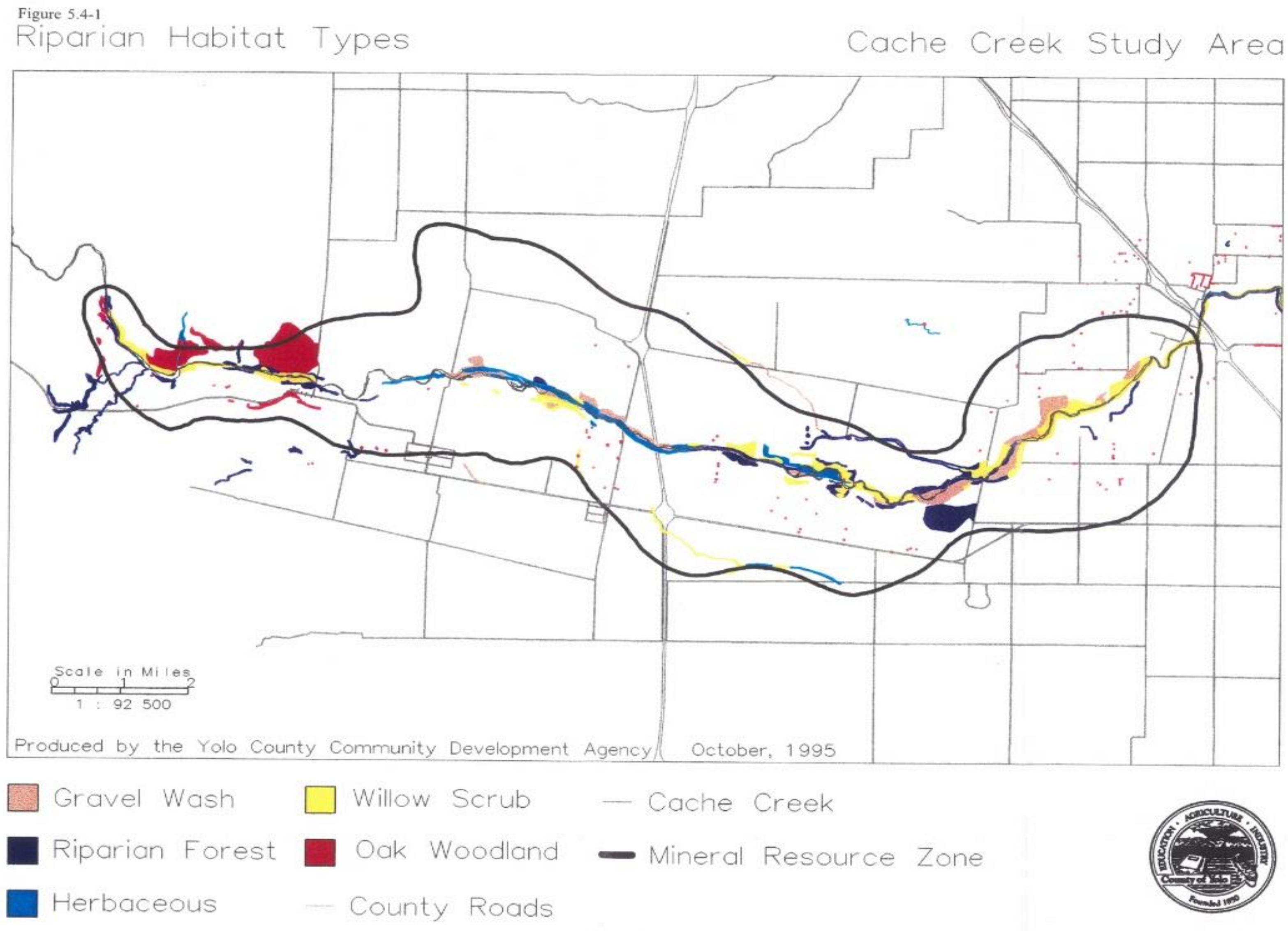

FIGURE 3.1: ORIGINAL BASELINE VEGETATION MAP CREATED AS A COMPONENT OF THE 1995 TECHNICAL STUDIES.

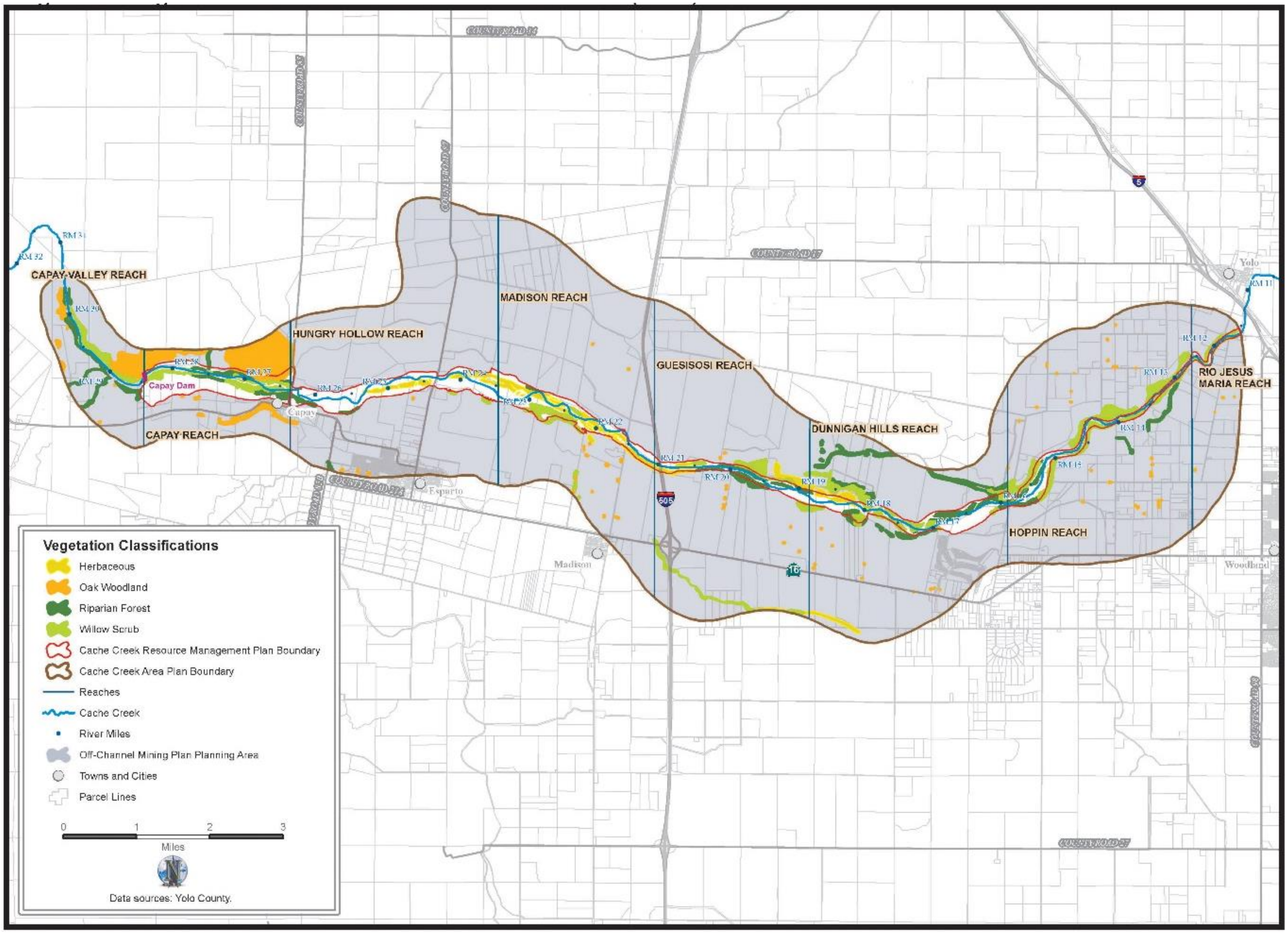

FIGURE 3.2: 1995 VEGETATION WITHIN CCAP AREA REPRODUCED FROM THE 1995 TECHNICAL STUDIES AND REANALYZED IN 2016.
See Table 3.1 for vegetation by reach and planning area.

TABLE 3.1: ACREAGE OF VEGETATION (RIPARIAN FOREST, OAK WOODLAND, WILLOW SCRUB, HERBACEOUS) FOR EACH REACH AS OF 1995 BASED ON REANALYSIS OF VEGETATION DATA FROM 1995 TECHNICAL STUDIES.

Reach	Area	Acreage Per Vegetation Class (1995)			
		Riparian Forest	Oak Woodland	Willow Scrub	Herbaceous
Capay Valley[1]	CCRMP	NA	NA	NA	NA
	OCMP	93.95	121.71	69.00	1.51
	Total	*93.95*	*121.71*	*69.00*	*1.51*
Capay	CCRMP	65.53	36.13	94.67	0.00
	OCMP	7.83	370.61	0.00	1.74
	Total	*73.36*	*406.74*	*94.67*	*1.74*
Hungry Hollow	CCRMP	31.03	0.00	0.79	53.86
	OCMP	10.29	24.85	8.62	0.00
	Total	*41.32*	*24.85*	*9.41*	*53.86*
Madison	CCRMP	5.06	0.00	51.16	117.82
	OCMP	0.00	20.61	28.91	14.88
	Total	*5.06*	*20.61*	*80.07*	*132.70*
Guesisosi	CCRMP	52.23	0.00	15.20	24.14
	OCMP	23.98	11.25	116.61	48.65
	Total	*76.21*	*11.25*	*131.81*	*72.79*
Dunnigan Hills	CCRMP	74.76	0.00	79.77	22.35
	OCMP	176.30	9.26	80.43	46.72
	Total	*251.06*	*9.26*	*160.20*	*69.07*
Hoppin	CCRMP	33.94	0.00	75.52	0.00
	OCMP	41.45	27.36	206.93	0.00
	Total	*75.39*	*27.36*	*282.45*	*0.00*
Rio Jesus Maria	CCRMP	0.00	0.00	14.16	0.00
	OCMP	0.00	3.36	19.35	0.00
	Total	*0.00*	*3.36*	*33.51*	*0.00*
CCRMP Total by Class		**262.56**	**36.13**	**331.28**	**218.17**
OCMP Total by Class		**353.80**	**589.01**	**529.85**	**113.51**
CCAP Total by Class		**616.35**	**625.14**	**861.12**	**331.68**

[1]Capay Valley reach is upstream of Capay Dam, outside CCRMP area but within OCMP area

Results are summarized for CCRMP, OCMP, and the total CCAP area. See Fig. 2 for vegetation map, and Fig. 1 for original vegetation map.

1996–2006

Reports and observations from 1996–2005 focused primarily on riparian vegetation and included little data on wildlife, invertebrates or fish. Remnant patches of high-quality riparian forest were described in the Dunnigan Hills reach, a gaining reach in which relatively shallow groundwater contributed to the persistence of native woody vegetation, as well as in other locations (Yolo County 1998; Truan 2004a). Both increases and decreases in woody riparian vegetation were noted during this period, both due to natural riverine processes. Recruitment of cottonwoods and willows along the low-flow channel was noted in the 1998 Annual Report, likely as a result of flooding in 1995 as well as sustained summer flows (Yolo County 1998). A storm event in February 1998 led to the establishment of hundreds of cottonwood, willow, and also tamarisk seedlings in scattered locations along the creek (Yolo County 1999). Conversely, approximately 2 ac. of young riparian forest were lost in the Dunnigan Hills reach between 1996–1998 when a meander formed and directed the low-flow channel into a riparian terrace (Yolo County 1998).

Management actions also contributed to changes in vegetation during this period. Some small plantings of willows and mulefat were noted as establishing well in the Madison and Guesisosi reaches (Yolo County 1998). Previously planted willows were still successfully establishing in the Hungry Hollow, Madison, and Guesisosi reaches in 1999 (Yolo County 1999). The establishment of summer base flows was identified as a factor that could positively impact native plant species recruitment and active restoration projects along the channel (Yolo County 1998, 1999). Some native vegetation was lost when a fire set by Yolo County Flood Control and Water Conservation District to control tamarisk apparently spread to native trees and brush in the Capay Reach (Yolo County 1999). The Cache Creek Nature Preserve was also established early in this period, with the purpose of protecting habitat and providing environmental education (Yolo County 1999). In the early 2000s, the Preserve was observed to have the highest diversity of native plants and wildlife of all surveyed sites along longer Cache Creek (Truan 2004a). Invasive arundo and tamarisk continued to be of concern during this period, although treatment efforts began to ramp up towards the end of this period (Yolo County 1998, Yolo County 2006). Analysis of tamarisk distribution via aerial imagery begun in 1998 continued in 1999, with the largest areas observed in the Hoppin and Madison reaches (Yolo County 1999).

Some estimation of vegetative cover was performed for most of the CCRMP in 1999, but no methodology was described and a single cover class (tree/shrub only) was used. It was estimated that roughly 12.9% of the land area was covered by woody vegetation (Yolo County 1999). A 10-year, GIS-based analysis was undertaken by the Cache Creek TAC in 2006 to evaluate changes and trends in vegetation within the CCRMP portion of the CCAP area from 1996-2005 (Yolo County 2006). Vegetation was classified from black and white, high-resolution orthophotos taken in 2004. Unlike the baseline vegetation classification in the 1995 Technical Studies in which four vegetation classes were used, a single class (‘mature woody vegetation’) was used to lump together all woody vegetation greater than approximately 12-15 ft. in height. Stands of invasive giant reed and tamarisk were included, since the degree of intermixing with native vegetation made separation impractical. The rationale for this approach was well-described in the report; however, the methodology had several limitations that complicated assessment of changes in native vegetation (see Appendix 1).

It was originally estimated that over 350 ac. of mature woody riparian vegetation was present within the CCRMP area in 2005 (Yolo County 2006). Reanalysis using 2004 and 2006 aerial photography was conducted in 2016 using five vegetation classes: *herbaceous*, *scattered scrub*, *dense scrub*, *riparian forest*, and *oak woodland* (see Appendix 1 for detailed descriptions of vegetation classes and characteristics). The scattered scrub and dense scrub classes represented an expansion of the original willow scrub class used in the 1995 Technical Studies, and reflected observations made during this study that both types of vegetation occurred in distinct patches throughout the CCAP area. Supplementary data (e.g., LiDAR-derived elevation data) were used to assist with discrimination of dense scrub and riparian forest, which were often intermingled in mixed stands of vegetation.

The new estimate of vegetation in the CCRMP area produced in 2016 was 300.71 ac. of riparian forest, 2.5 ac. of oak woodland, 149.12 ac. of dense scrub, 184.79 ac. of scattered scrub, and 301.97 ac. of herbaceous vegetation, for a total of 939.06 ac. (Fig. 3.3; see Table 3.2 for results by reach). Most notably, riparian forest increased by almost 40 ac., likely due to the transition of some early-successional willow scrub vegetation to later-successional, mature riparian forest (Yolo County 2006).

TABLE 3.2: ACREAGE OF VEGETATION (RIPARIAN FOREST, OAK WOODLAND, DENSE SCRUB, SCATTERED SCRUB, HERBACEOUS) FOR EACH REACH IN 2005.

Reach	Area	Acreage Per Vegetation Class (2005)				
		Riparian Forest	Oak Woodland	Dense Scrub	Scattered Scrub	Herbaceous
Capay	CCRMP	63.16	1.11	26.23	33.05	81.79
Hungry Hollow	CCRMP	4.71	0	14.3	29.7	50.33
Madison	CCRMP	20.99	0	46.45	26.92	60.31
Guesisosi	CCRMP	35.15	1.36	6.62	10.73	29.63
Dunnigan Hills	CCRMP	119.91	0	31.33	29.85	37.98
Hoppin	CCRMP	50.77	0	16.67	48.04	36.99
Rio Jesus Maria	CCRMP	6.02	0	7.52	6.50	4.94
CCRMP Total by Class		**300.71**	**2.47**	**149.12**	**184.79**	**301.97**

Analysis conducted at scale of CCRMP area, not entire CCAP area. See Fig. 3 for vegetation map.

The 2006 study also included a comprehensive review of previously-implemented habitat improvement projects, which had mixed results. Generally, plantings closer to the creek had better results in terms of establishment and growth of native species. Post-implementation monitoring varied widely, and some projects had little or no monitoring data that could be used to evaluate project outcomes.

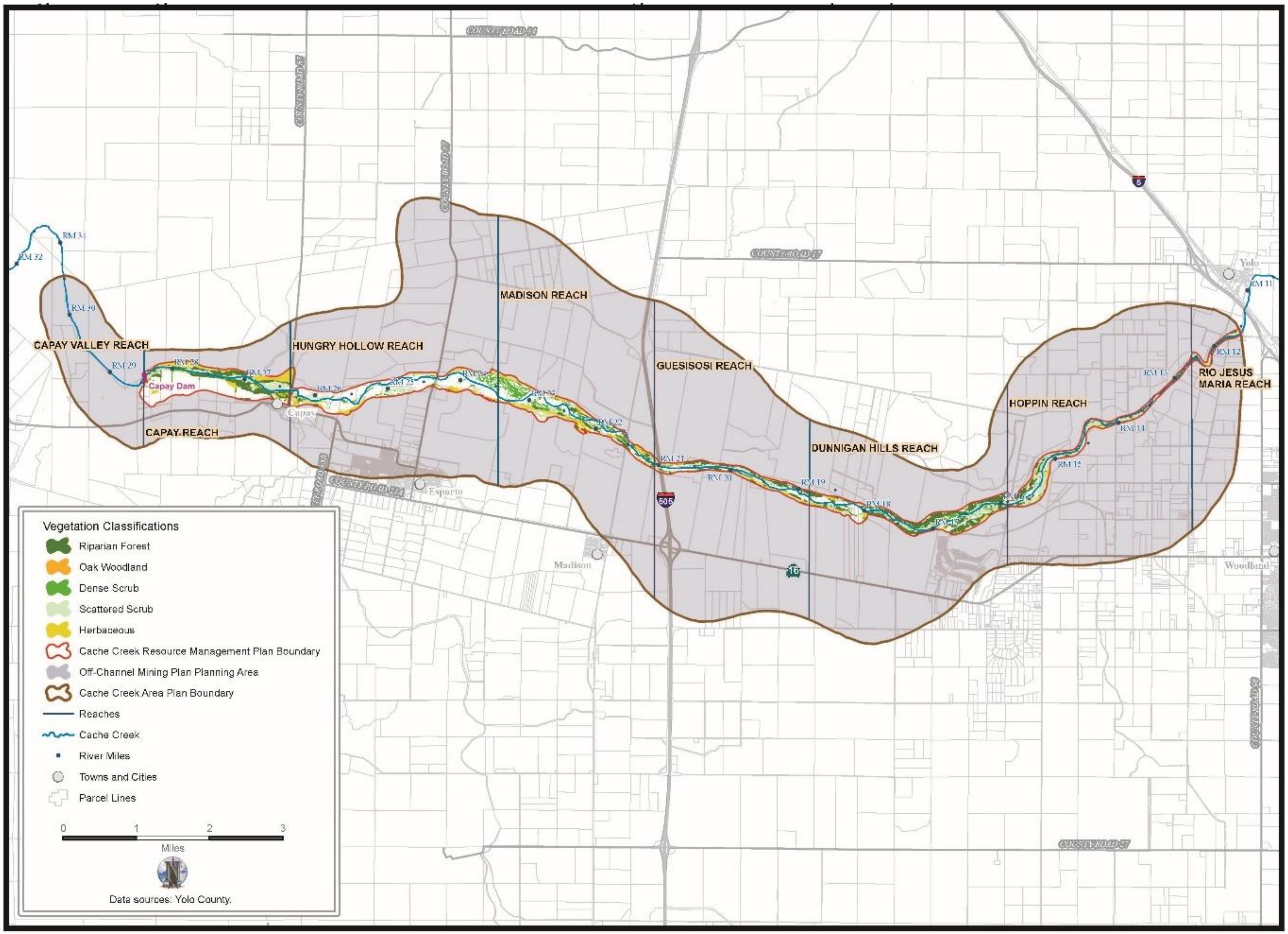

FIGURE 3.3: 2005 VEGETATION WITHIN CCRMP AREA CLASSIFIED FROM 2006 AERIAL PHOTOGRAPHY IN 2016.
See Table 3.2 for vegetation by reach.

2007-2015

Annual reports from 2007–2010 were incomplete or unavailable. The 2011 Annual Report describes significant loss of herbaceous and woody riparian vegetation occurred due to channel migration and erosion from 2010–2011 (Yolo County 2011). Damage to, and loss of, mature cottonwoods due to beaver (*Castor canadensis*) was called out for additional monitoring in 2013 and 2014 (Yolo County 2013, 2014). Some natural regeneration of woody vegetation was noted in 2011, such as in the Hoppin reach (Yolo County 2011). Without any meaningful creation of adverse conditions, native vegetation was observed to be increasing at several locations within the CCRMP area in 2015. For example, woody shrubs and other vegetation was observed to be increasing along the rock toe of Huff's corner in the Rio Jesus Maria reach and in-channel bars within the Hoppin and Dunnigan Hills reaches. Cattails, tules, and other herbaceous wetland species were observed to be spreading from channel banks in many locations within the Hoppin, Dunnigan Hills, and Guesisosi reaches. Native vegetation was also observed to have decreased due to scouring flows in Dec. 2014 in the Guesisosi reach, and due to dieback (presumably from drought on an in-channel bar in the Hoppin reach and on south banks in the Guesisosi reach (Yolo County 2015). Large patches of presumably remnant creeping wildrye (*Elymus triticoides*) were noted in 2015 as being present along the upper terraces on the south bank of the creek in the Hoppin reach and on upper north banks in the Capay reach (Yolo County 2015). The patches were identified as potential seed sources for future revegetation and restoration projects. A single remnant buckbrush (*Ceanothus cuneatus*) shrub, another candidate species for restoration projects, was found on the south edge of the Millsap property, on the north bank uplands in the Dunnigan Hills reach (Yolo County 2015).

Echoing earlier reports, recommendations were made throughout this period to explore opportunities to increase surface flows in lower Cache Creek to improve conditions for establishment and sustaining native freshwater marsh and riparian vegetation. The lack of available surface water was identified as a major limiting factor in some reaches, particularly losing reaches such as the Hungry Hollow, Rio Jesus Maria, and portions of the Madison and Guesisosi reaches.

Management actions and other human activities also contributed to changes in vegetation during this period. Some riparian vegetation was lost due to off-highway vehicle (OHV) use in several reaches in 2011 (Yolo County 2011). Regarding invasive species, significant progress was made controlling widespread invasive tamarisk, arundo, and Ravenna grass (*Saccharum ravennae*), which was mentioned for the first time as a priority invasive species in 2011 (Yolo County 2011–2015). Some re-establishment of tamarisk was noted in 2012, likely due to seed dispersal from untreated stands (Yolo County 2012a). Numerous new invasive species are described as having dramatically increased, including milk thistle (*Silybum marianum*), Italian thistle (*Carduus pycnocephalus*), yellow starthistle (*Centaurea solstitialis*), Himalayan blackberry (*Rubus armeniacus*), perennial pepperweed (*Lepidium latifolium*), and edible fig (*Ficus* spp.) (Yolo County 2011–2015). Additional invasive species were also noted in 2015, including purple loosestrife (*Lythrum salicaria*), tree tobacco (*Nicotiana glauca*), tree of heaven (*Ailanthus altissima*) barbed goatgrass (*Aegilops triuncialis*), and medusahead (*Elymus caput-medusae*) (Yolo County 2015). These reports contained recommendations for systematic mapping, prioritization, and treatment of these species, followed by revegetation with native species. Specific emphasis was placed on the need for GPS-based mapping framework to track previously treated and newly mapped invasive species. In terms of previous restoration and revegetation projects, plantings near the creek were generally observed to be flourishing in 2015 even under drought conditions, while more upland sites were observed to be in poor condition presumably as a result of drought conditions, invasive species, and a lack of long-term management. Restoration opportunities at Capay Open Space Park and the Millsap property were highlighted as priorities for grant funding (Yolo County 2015).

Analysis of 2010 vegetation within the CCRMP area was conducted in 2016 using a combination of 2010 and 2011 aerial photography and supplement data (see Appendix 3.A). A total of 944.29 ac. of vegetation was mapped in 2010, including 281.96 ac. of riparian forest, 2.68 ac. of oak woodland, 185.60 ac. of dense scrub, 113.97 ac. of scattered scrub and, and 360.08 ac. of herbaceous vegetation (Fig. 3.4; Table 3.3).

TABLE 3.3: ACREAGE OF VEGETATION (RIPARIAN FOREST, OAK WOODLAND, DENSE SCRUB, SCATTERED SCRUB, HERBACEOUS) FOR EACH REACH IN 2010.

Reach	Area	Acreage Per Vegetation Class (2010)				
		Riparian Forest	Oak Woodland	Dense Scrub	Scattered Scrub	Herbaceous
Capay	CCRMP	61.64	0.62	40.33	6.09	67.03
Hungry Hollow	CCRMP	4.59	0	12.72	18.9	64.81
Madison	CCRMP	15.88	0	47.65	18.82	78.84
Guesisosi	CCRMP	36.87	2.06	15.35	6.52	39.79
Dunnigan Hills	CCRMP	114.49	0	38.35	25.23	52.43
Hoppin	CCRMP	43.03	0	24.23	37.1	47.91
Rio Jesus Maria	CCRMP	5.46	0	6.97	1.31	9.27
CCRMP Total by Class		**281.96**	**2.68**	**185.60**	**113.97**	**360.08**

Analysis conducted at scale of CCRMP area, not entire CCAP area. See Fig. 3.4 for vegetation map.

2016

Substantial new vegetation data were collected from 2015–2016 and analyzed in 2016 for the purpose of conducting a detailed analysis of changes and trends in vegetation (1995–2016) at the scale of the CCAP area. 2015 vegetation within the entire CCAP area was classified from high-resolution aerial photography obtained via drones in 2015 (see Appendix 3.A). Classifications were opportunistically ground-truthed during 2015–2016 field work. At the scale of the CCAP area, a total of 4004.19 ac. of vegetation was mapped in 2015, including 624.21 ac. of riparian forest, 596.82 ac. of oak woodland, 370.86 ac. of dense scrub, 101.84 ac. of scattered scrub, and 2310.47 ac. of herbaceous vegetation (Fig. 3.5; see Table 3.4 for results for CCRMP area, OCMP area, and by reach). See Appendix 2 for detailed maps of 2015 vegetation for each reach.

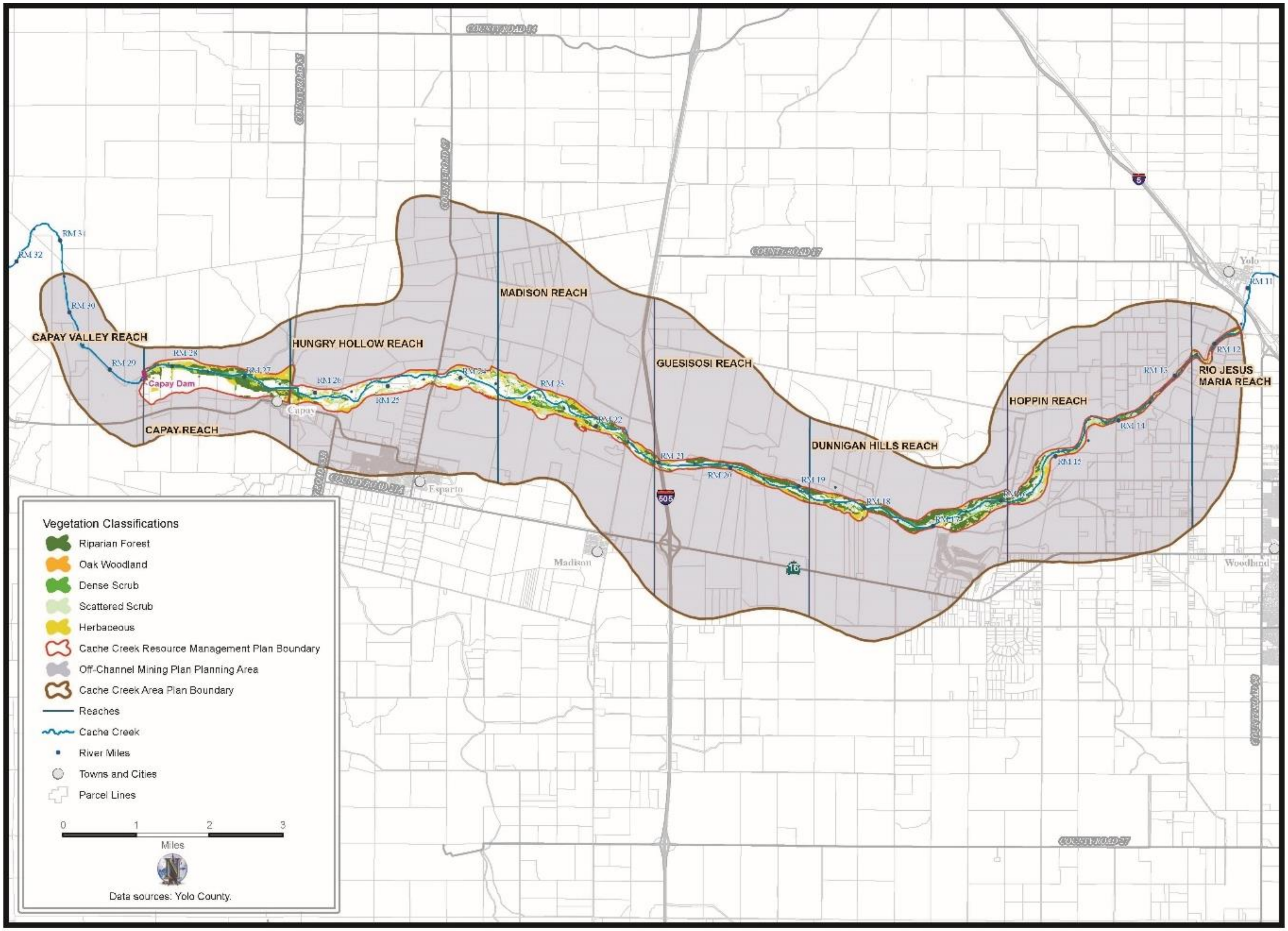

FIGURE 3.4: 2010 VEGETATION WITHIN CCAP AREA CLASSIFIED FROM 2010/2011 AERIAL PHOTOGRAPHY IN 2016.

See Table 3.3 for vegetation by reach.

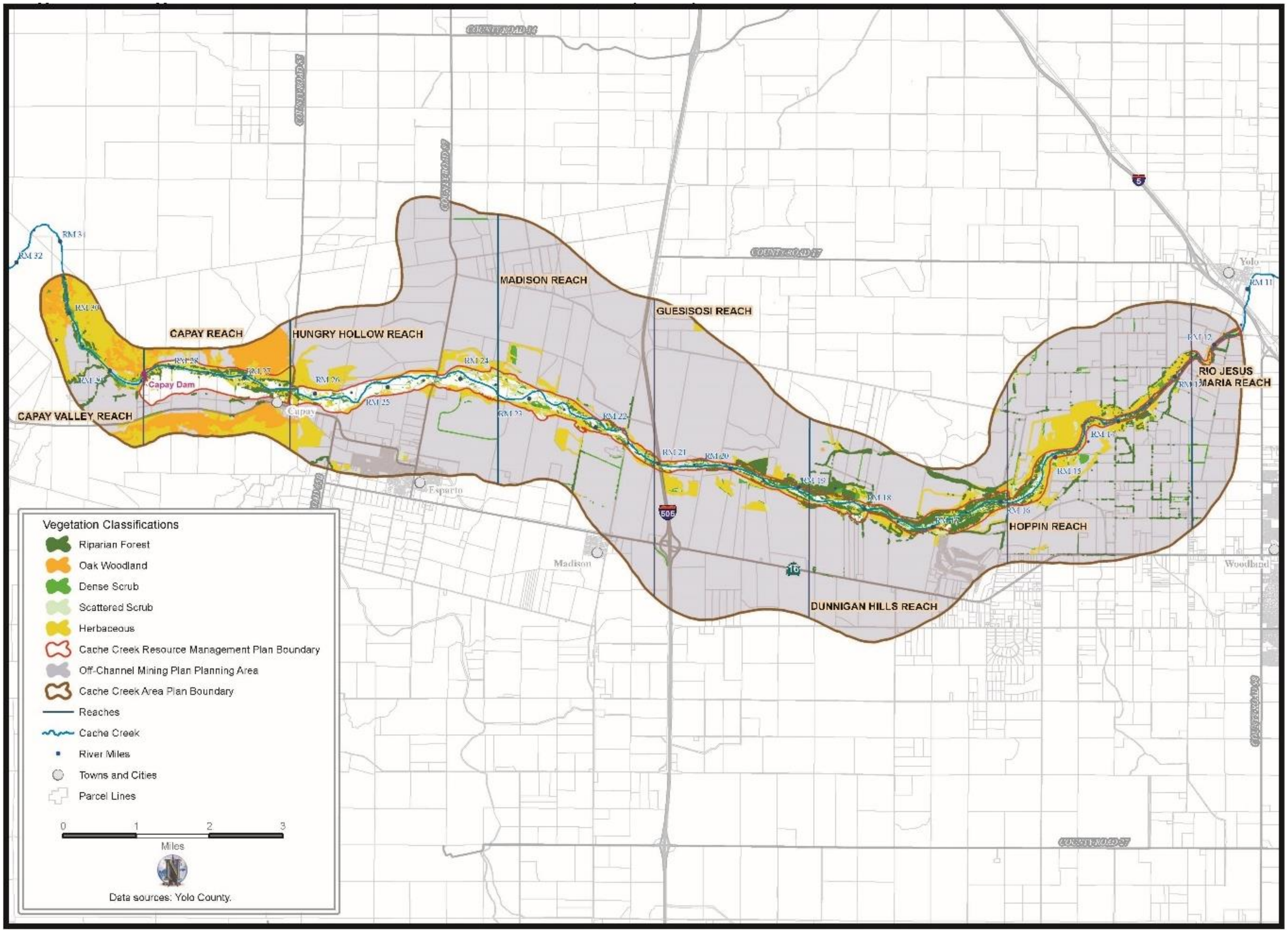

FIGURE 3.5: 2015 VEGETATION WITHIN CCAP AREA CLASSIFIED FROM 2015 HIGH-RESOLUTION IMAGERY IN 2016.

See Table 3.4 for vegetation by reach and planning area. See Appendix 2 for detailed maps by reach.

TABLE 3.4: ACREAGE OF VEGETATION (RIPARIAN FOREST, OAK WOODLAND, DENSE SCRUB, SCATTERED SCRUB, HERBACEOUS) FOR CCRMP AREA, OCMP AREA, AND TOTAL CCAP IN 2015.

Reach	Area	Acreage Per Vegetation Class (2015)				
		Riparian Forest	Oak Woodland	Dense Scrub	Scattered Scrub	Herbaceous
Capay Valley[1]	CCRMP	NA	NA	NA	NA	NA
	OCMP	45.34	152.62	46.36	2.25	502.48
	Total	*45.34*	*152.62*	*46.36*	*2.25*	*502.48*
Capay	CCRMP	43.32	0.54	13.18	3.88	96.42
	OCMP	7.08	431.39	1.22	0.00	288.00
	Total	*50.40*	*431.93*	*14.40*	*3.88*	*384.42*
Hungry Hollow	CCRMP	3.73	0	12.92	12.33	68.49
	OCMP	6.57	3.14	12.43	10.42	308.65
	Total	*10.30*	*3.14*	*25.35*	*22.75*	*377.14*
Madison	CCRMP	10.23	0	32.29	14.27	94.38
	OCMP	11.29	1.00	21.93	3.64	91.25
	Total	*21.52*	*1.00*	*54.22*	*17.91*	*185.63*
Guesisosi	CCRMP	28.66	2.35	18.17	5.08	48.17
	OCMP	42.46	0.00	16.75	6.51	124.83
	Total	*71.12*	*2.35*	*34.92*	*11.59*	*173.00*
Dunnigan Hills	CCRMP	121.99	0	48.23	8.25	77.36
	OCMP	159.08	5.78	28.05	12.25	117.90
	Total	*281.07*	*5.78*	*76.28*	*20.50*	*195.26*
Hoppin	CCRMP	37.79	0	34.01	5.15	78.27
	OCMP	90.80	0.00	74.27	17.45	396.82
	Total	*128.59*	*0.00*	*108.28*	*22.60*	*475.09*
Rio Jesus Maria	CCRMP	5.95	0.00	4.95	0.36	11.85
	OCMP	9.92	0.00	6.09	0.00	5.61
	Total	*15.87*	*0.00*	*11.04*	*0.36*	*17.46*
CCRMP Total by Class		**251.67**	**2.89**	**163.75**	**49.32**	**474.94**
OCMP Total by Class		**372.54**	**593.93**	**207.11**	**52.52**	**1835.53**
CCAP Total by Class		**624.21**	**596.82**	**370.86**	**101.84**	**2310.47**

[1]Capay Valley reach is upstream of Capay Dam, outside CCRMP area but within OCMP area

See Fig. 3.5 for vegetation map, and Appendix 2 for maps by reach.

Changes in vegetation (1995–2015) were qualitatively analyzed in the context of estimated locations of past in-channel mining locations (1984–1994). Mining was most extensive during this period, and mining locations encompassed almost all locations from previous time periods. These locations were concentrated in the Hungry Hollow, Madison, Guesisosi, and Dunnigan Hills reaches (Fig. 3.6).

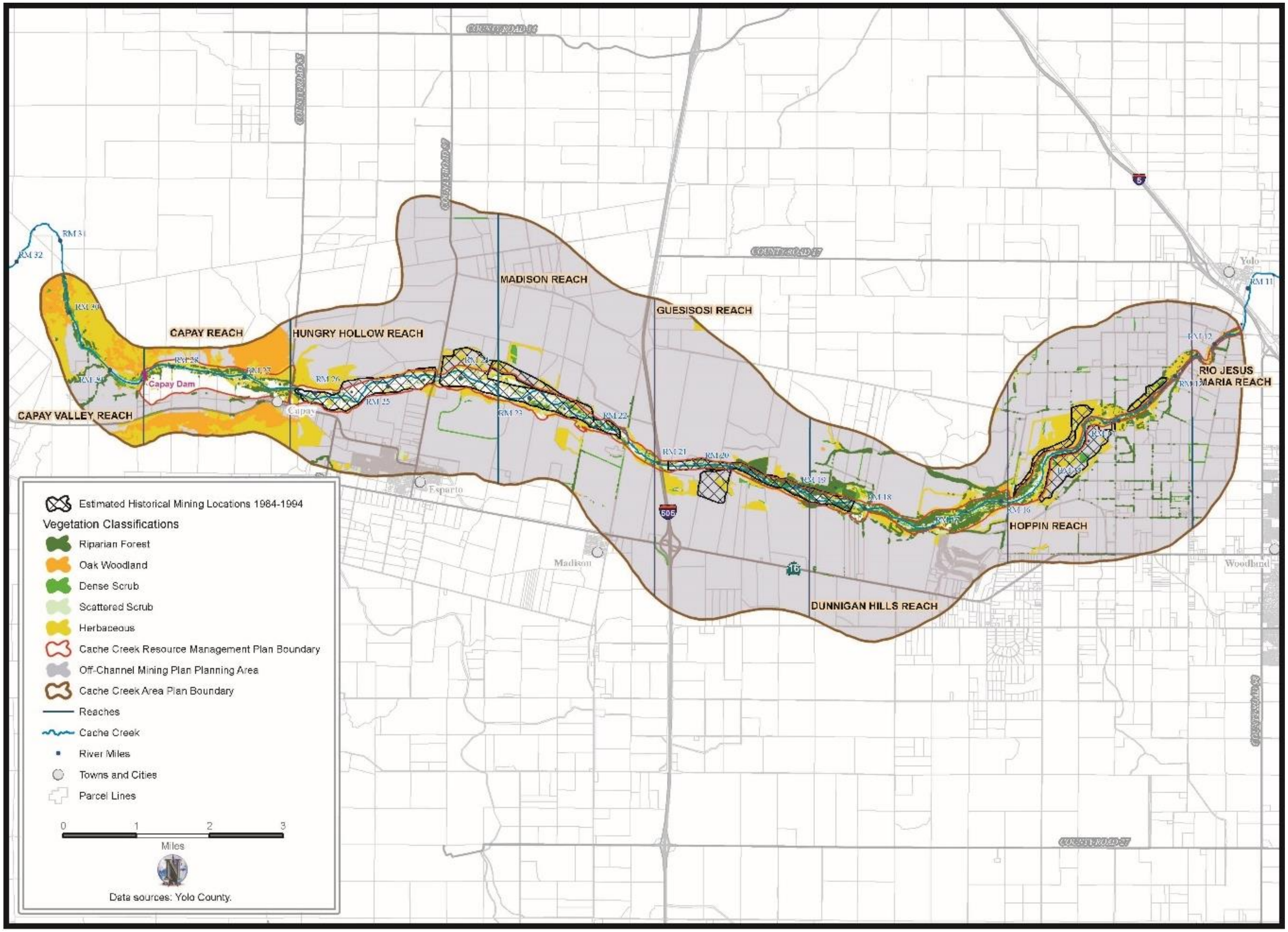

FIGURE 3.6: HISTORICAL IN-CHANNEL MINING LOCATIONS (1984–1994) OVERLAIN ON 2015 VEGETATION MAP.

In addition, extensive field surveys were conducted in 2015–2016 to map all native blue elderberry shrubs (*Sambucus nigra* ssp. *caerulea*) within the CCRMP area to develop a spatially-explicit, quantitative baseline for permitting and conservation planning (see Appendix 3.A and Rayburn 2016a for detailed methods). Blue elderberry is a drought-deciduous native shrub typically < 8 m in height that is a common component of cottonwood forests, mixed riparian forests, and associated open savannas in California's Central Valley (Vaghti and Greco 2007). A valuable resource for numerous species of native mammals, birds, and invertebrates, blue elderberry is most widely known as the sole host plant of the Valley elderberry longhorn beetle (VELB; *Desmocerus californicus dimorphus*), a federally-listed threatened insect species that occupies blue elderberry at all stages of its life cycle (USFWS 1980; Collinge et al. 2001).

Using GPS equipment, elderberry shrubs were mapped as individual points and as patches when discrete individuals could not be easily identified. Over 10,000 elderberry shrubs were mapped within the CCRMP area and included seedlings, resprouts, mature shrubs, and older tree-like plants (Figs. 3.7 and 3.8; see Rayburn 2016a for detailed results and maps). Most elderberry shrubs were found on benches and terraces, with only a few scattered shrubs on the channel floor. Numerous seedlings, often found under the canopies of larger elderberry shrubs, strongly suggested that the elderberry population is increasing due in part to CCAP implementation.

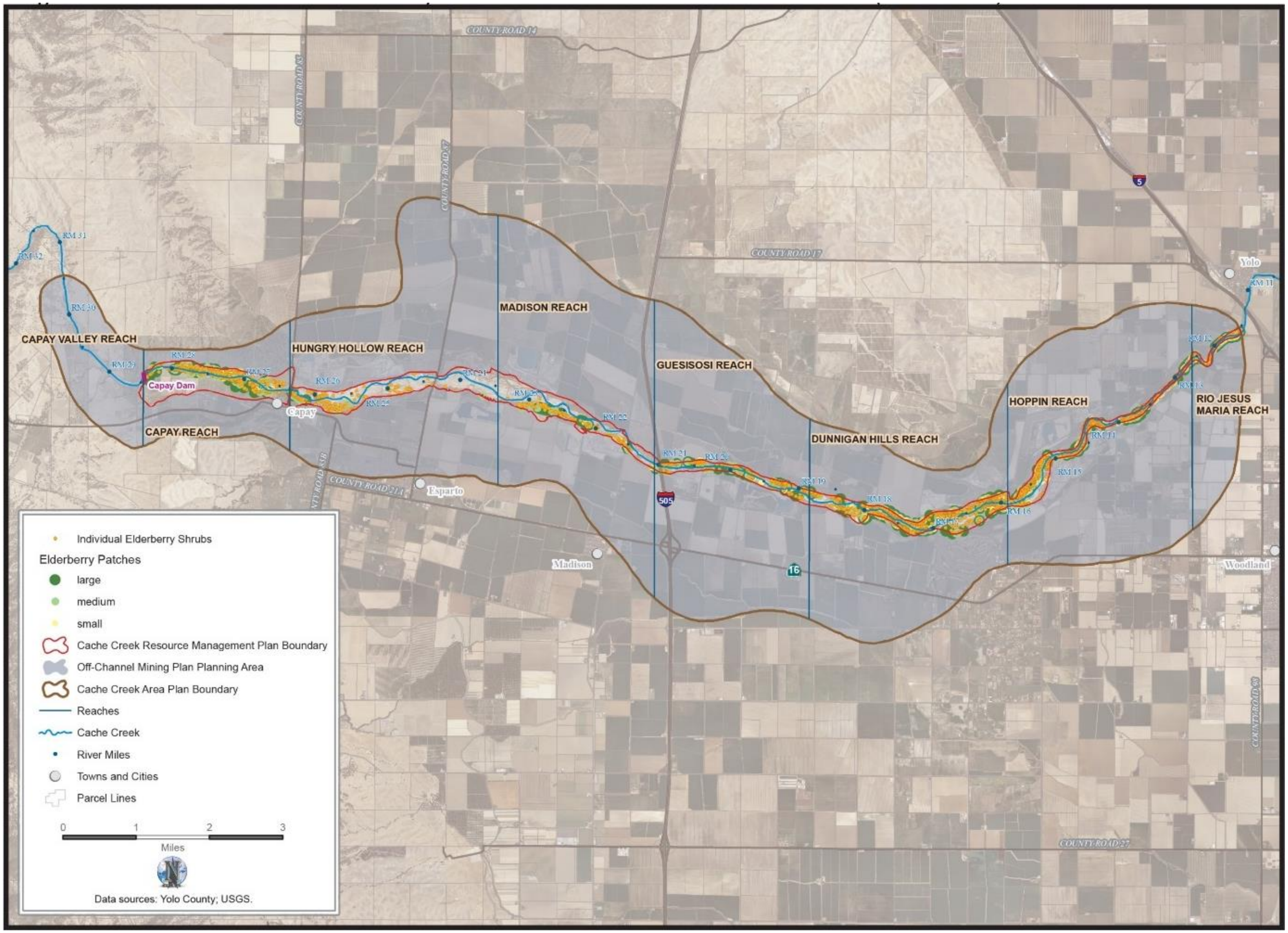

FIGURE 3.7: DISTRIBUTION OF BLUE ELDERBERRY PLANTS (POINTS) AND PATCHES WITHIN CCRMP AREA AS MAPPED DURING 2015–2016 SURVEY.

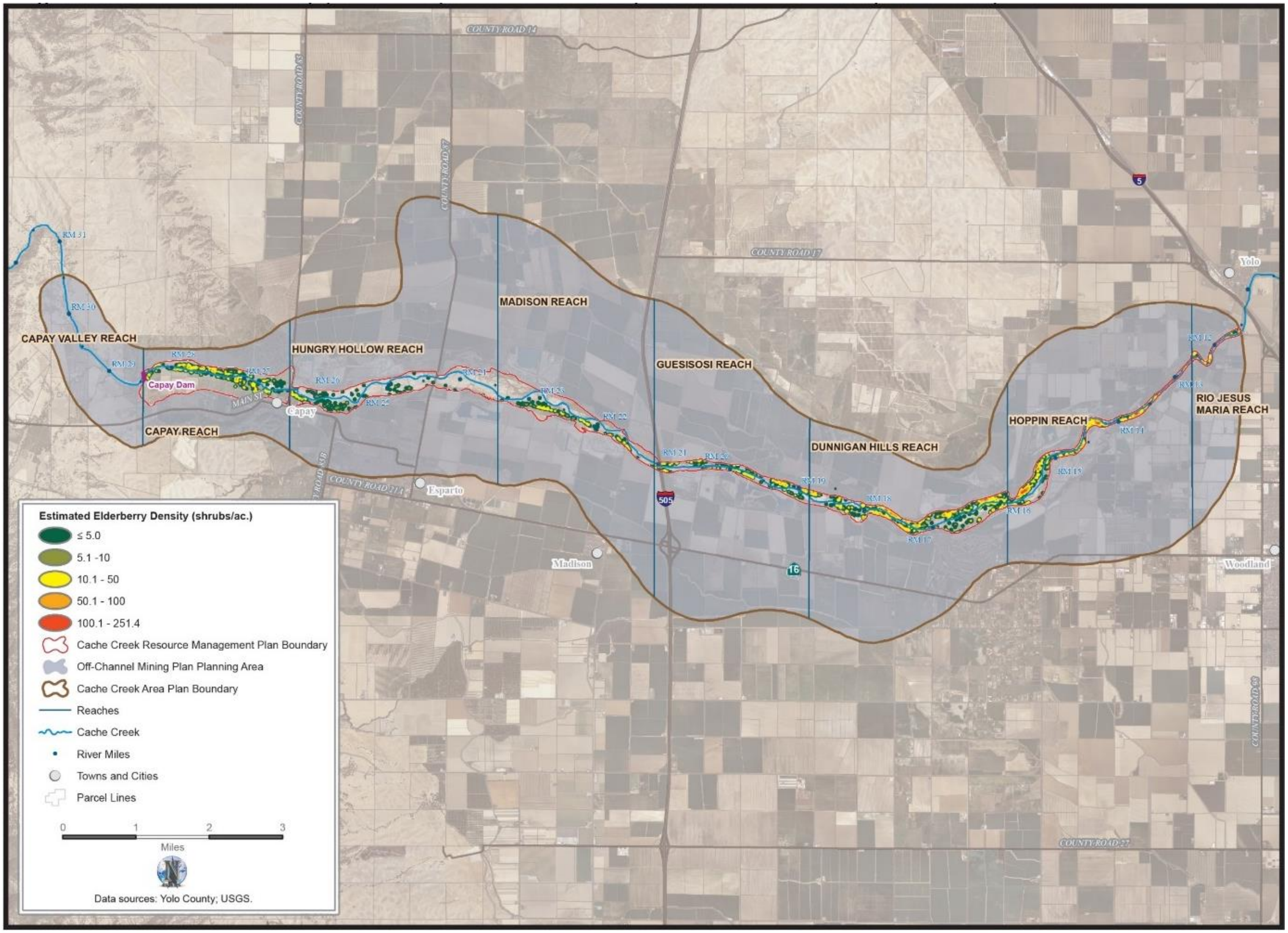

FIGURE 3.8: ESTIMATED DENSITY OF BLUE ELDERBERRY SHRUBS WITHIN CCRMP AREA.
Density estimate based on locations of plants (points) and patches; see Fig. 3.7.

Lastly, using similar methods as described above for mapping elderberry shrubs, the distribution of 25 priority invasive plant species (Table 3.5) was mapped across the CCRMP area from April–June 2016 (see Rayburn 2016b for detailed methods and results). The overarching goal was to comprehensively assess the distribution and status of a suite of invasive plant species within the CCRMP and six additional County-owned parcels to inform adaptive vegetation management (Rayburn 2016b).

TABLE 3.5: LIST OF PRIORITY INVASIVE SPECIES MAPPED WITHIN CCRMP AREA IN 2016.

Common Name	Scientific Name	Growth Form
Arundo	*Arundo donax*	Herbaceous
Bamboo	Various	Herbaceous
Barbed goatgrass	*Aegilops triuncialis*	Herbaceous
Common teasel	*Dipsacus fullonum*	Herbaceous
Edible fig	*Ficus carica*	Shrub/tree
Eucalyptus	*Eucalyptus* spp.	Tree
Fan palm	*Washingtonia robusta*	Shrub/tree
Fennel	*Foeniculum vulgare*	Herbaceous
Himalayan blackberry	*Rubus armeniacus*	Herbaceous
Medusahead	*Elymus caput-medusae*	Herbaceous
Oleander	*Nerium oleander*	Shrub
Pampas grass	*Cortaderia selloana*	Herbaceous
Perennial pepperweed	*Lepidium latifolium*	Herbaceous
Poison hemlock	*Conium maculatum*	Herbaceous
Purple loosestrife	*Lythrum salicaria*	Herbaceous
Ravenna grass	*Saccharum ravennae*	Herbaceous
Stinkwort	*Dittrichia graveolens*	Herbaceous
Tamarisk	*Tamarix* spp.	Shrub
Thistles (Italian, bull, milk)	*Carduus pycnocephalus* *Cirsium vulgare* *Silybum marianum*	Herbaceous
Tree of heaven	*Ailanthus altissima*	Tree
Tree tobacco	*Nicotiana glauca*	Shrub/tree
Yellow flag iris	*Iris pseudacorus*	Herbaceous
Yellow starthistle	*Centaurea solstitialis*	Herbaceous

Adapted from Rayburn (2016b).

The list of priority invasive species was developed in collaboration with County and Cache Creek Conservancy staff. Species included past priority species (arundo, Ravenna grass, and tamarisk), new invasive species highlighted in historical Annual Reports (perennial pepperweed, milk thistle, Italian thistle, tree tobacco, Himalayan blackberry, fig, yellow starthistle, purple loosestrife, barbed goatgrass, medusahead), and additional invasive species known to be in the area or that were observed in the field during the mapping effort: tree of heaven (*Ailanthus altissima*), common eucalyptus (*Eucalyptus globulus*), yellow-flagged iris (*Iris pseudacorus*), stinkwort (*Dittrichia graveolens*), common teasel (*Dipsacus fullonum*), fennel (*Foeniculum vulgare*), oleander (*Nerium oleander*), palms (e.g., Mexican fan palm; *Washingtonia robusta*), and poison hemlock (*Conium maculatum*). Surveys were conducted on foot, and species were mapped as points (individual plants) or patches (clusters of plants) including notes on approximate size classes. Acreages for each species were approximated using species-specific estimates for different size classes of individual plants in combination with areas of actual patches mapped in the field (Rayburn 2016b).

In general, invasive species were most common in the Capay, Dunnigan Hills, and Hoppin reaches. More than a decade of intensive control of arundo, Ravenna grass, and tamarisk has dramatically reduced these species within the CCRMP area, although many individual plants and small stands of these three species were still present, often in backwater channels or obscured under dense forest canopy (Table 3.6; Rayburn 2016b). Small seedlings of these three species were also commonly observed, which suggests these species were still recolonizing via seed and biomass dispersal by wind, water, and other vectors.

Additional invasive species were noted to have spread across the CCRMP, including perennial pepperweed, milk and Italian thistle, yellow starthistle, tree tobacco, and Himalayan blackberry (Table 3.6; Rayburn 2016b). Other invasive species, including fig, tree of heaven, common eucalyptus, yellow-flagged iris, common teasel, fennel, and poison hemlock, were present but less widespread (Table 3.6; Rayburn 2016b). As of 2016, it was estimated that over 95% of the understory vegetation on lower Cache Creek is nonnative, consisting of naturalized annual grasses and forbs in addition to perennial pepperweed, thistles, teasel, fennel, poison hemlock, and invasive grasses (Rayburn 2016b).

TABLE 3.6: ESTIMATED AREA OF PRIORITY INVASIVE SPECIES WITHIN EACH REACH OF LOWER CACHE CREEK WITHIN THE CCRMP AREA.

Species	**Capay Reach**		**Hungry Hollow Reach**		**Madison Reach**		**Guesisosi Reach**		**Dunnigan Hills Reach**		**Hoppin Reach**		**Rio Jesus Maria Reach**		*Grand total (ac)*
	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	
Arundo	6835.52	1.69	37.25	0.01	304.66	0.08	59.23	0.01	7739.64	1.91	170.25	0.04	44.25	0.01	3.75
Bamboo	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barbed goatgrass	3674.24	0.91	9.00	0.00	0.00	0.00	1472.70	0.36	0.00	0.00	0.00	0.00	0.00	0.00	1.27
Eucalyptus	1260.38	0.31	0.00	0.00	0.00	0.00	4.00	0.00	1007.00	0.25	1000.00	0.25	0.00	0.00	0.81
Fennel	4.86	0.00	193.53	0.05	0.00	0.00	859.77	0.21	0.25	0.00	100.00	0.02	0.00	0.00	0.29
Edible fig	212.25	0.05	0.00	0.00	0.00	0.00	0.00	0.00	39.00	0.01	259.50	0.06	4.00	0.00	0.13
Poison hemlock	71.06	0.02	300.00	0.07	47472.62	11.73	2483.48	0.61	1957.60	0.48	6799.99	1.68	0.00	0.00	14.60
Himalayan blackberry	3016.20	0.75	0.00	0.00	396.64	0.10	30.00	0.01	48913.43	12.09	15612.38	3.86	0.00	0.00	16.80
Medusahead	13.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	9.00	0.00	0.00	0.00	0.00	0.00	0.01
Oleander	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.25	0.00	0.00	0.00	0.00	0.00	0.00
Fan palm	2.50	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perennial pepperweed	2980.65	0.74	801.26	0.20	46789.79	11.56	4981.85	1.23	56010.17	13.84	105155.02	25.98	3658.12	0.90	54.46
Purple loosestrife	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	112.25	0.03	0.00	0.00	0.00	0.00	0.03
Ravenna grass	102.44	0.03	2.19	0.00	4.06	0.00	410.94	0.10	200.90	0.05	100.73	0.02	0.00	0.00	0.20
Stinkwort	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	11.00	0.00	0.00	0.00	0.01
Tamarisk	123.75	0.03	58.25	0.01	2538.17	0.63	9013.15	2.23	27204.16	6.72	5043.02	1.25	66.25	0.02	10.88
Common teasel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	827.07	0.20	3.00	0.00	0.00	0.00	0.21
Thistles	44569.40	11.01	14733.95	3.64	81607.46	20.17	79670.49	19.69	71909.28	17.77	154692.11	38.23	10760.95	2.66	113.16
Tree of heaven	3464.50	0.86	0.00	0.00	0.00	0.00	0.00	0.00	4448.56	1.10	0.00	0.00	0.00	0.00	1.96
Tree tobacco	849.09	0.21	43.25	0.01	546.32	0.13	3776.60	0.93	8657.82	2.14	3930.43	0.97	369.25	0.09	4.49
Yellow iris	3.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow starthistle	4794.35	1.18	501.70	0.12	61446.77	15.18	9532.05	2.36	20363.90	5.03	99310.21	24.54	20742.73	5.13	53.55
Total area by reach (ac)		17.79		4.12		59.58		27.75		61.63		96.91		8.81	**276.59**

Adapted from Rayburn (2016b).

Changes and Trends

The 1995 Technical Studies described the changes in biological resources on lower Cache Creek prior to 1995, the most pronounced of which was a dramatic decline in native riparian forests and oak woodlands coupled with the spread of invasive arundo and tamarisk. Much of the forest was eliminated in the early to mid-1900s, largely as the result of cattle grazing, timber harvesting, field clearing for agriculture and homesteads, and water diversion. In-stream mining that began with small operations in the early 1900s, and which grew to industrial-scale operations in subsequent decades, further decreased riparian forests and vegetation in general. This current retrospective analysis sought to quantify further changes and trends in vegetation from 1995-2016.

Substantial changes in native and nonnative riparian vegetation have occurred over the past two decades within the CCAP area. There are many potential drivers of these changes, some which have likely occurred synergistically with others. Vegetation in riparian areas is dynamic by definition, and change is the rule rather than the exception due to factors such as channel migration, scouring flows, flooding, sediment deposition, beaver activity, seed dispersal by wildlife, climate (especially extremes, such as drought), fires and other disturbance (both accidental and intentional), land management decisions (e.g., invasive species control, habitat restoration), and the influence of the surrounding landscape.

Interpretation of vegetation changes within the CCRMP area (comparing data from 1995, 2005, 2010, and 2015) and within the entire CCAP area (comparing data from 1995 and 2015) should consider both the actual changes that have occurred and the uncertainty associated with integrating historical data collected by different observers using different methods. For example, the methods originally used in the Technical Studies to classify vegetation for the baseline 1995 map (e.g., visual interpretation of paper photographs) were substantially less precise than the GIS-based methods used in this study to classify vegetation for 2005, 2010, and 2015. Even after reanalysis of the 1995 data in 2016, which still used the original map as the basis, the resulting acreages of riparian forest, oak woodland, willow scrub, and herbaceous vegetation were still relatively coarse estimates compared to those obtained for later years.

Native Vegetation

Changes and trends in native vegetation were first considered from the perspective of the CCRMP area only, using data from all four time periods (1995, 2005, 2010, and 2015). Riparian forest area was estimated at 251.10 ac. in 1995, peaked in 2005 at 300.71 ac., yet declined to some degree over the next 10 years to the current estimate of 251.67 ac. (Table 3.7). The most extensive riparian forests are presently found in the Dunnigan Hills reach, in which large patches of gallery forests are comprised of cottonwoods, willows, oaks, black walnuts, buckeyes, and other species of trees and shrubs. Large forest patches are also found in the Capay, Guesisosi, and Hoppin reaches.

Contraction of forest vegetation is a natural phenomenon in riparian ecosystems, usually attribute to disturbance, flows, changes in climate, declines in groundwater or some combination of these factors. Several factors are at least partially responsible for reduced forest area within the CCRMP area in 2015 including fires, channel migration, and die-back of forest vegetation. The greatest reductions in riparian forest were due to fires intentionally set by landowners to clear brush or remove debris; these fires appeared to have spread beyond the planned areas and burned large patches of high-quality forest habitat on the north side of the channel at the downstream end of the Rio Jesus Maria reach, on the south side of the channel near the downstream end of the Capay reach, and on the north side of the channel in the middle of the Capay reach. Since these areas were not re-seeded with native species after burning, invasive species such as perennial pepperweed, tree of heaven, tree tobacco, and poison hemlock quickly dominated the understory, further reducing habitat value.

Channel migration and high flows have also fragmented forest patches and removed woody vegetation within the CCRMP area, most notably in the Hungry Hollow, Guesisosi, and Madison reaches. Large woody debris piles at these locations provide further evidence of vegetation loss due to flows. Bank erosion on southern banks in the Dunnigan Hills and Hoppin reaches also removed some forest vegetation. Die-back of previously vigorous forest vegetation has also occurred, most notably on the north side of the channel in the Guesisosi, Dunnigan Hills, and Hoppin reaches. It is highly likely that the ongoing extreme drought is primarily responsible for die-back and mortality of mature woody vegetation, most notably cottonwoods.

TABLE 3.7: ACREAGE PER VEGETATION CLASS WITHIN THE CCRMP AREA IN 1995, 2005, 2010, AND 2015.

Year	Acreage Per Vegetation Class (CCRMP)				
	Riparian Forest	Oak Woodland	Willow Scrub		Herbaceous
			Dense Scrub	Scattered Scrub	
1995	251.10	36.13	331.30		229.60
2005	300.71	2.47	149.12	184.79	301.97
2010	281.96	2.68	185.6	113.97	360.08
2015	251.67	2.89	163.75	49.32	474.94

Oak woodland area was estimated at 36.13 ac. in 1995, although this value likely represents a substantial overestimate. Reanalysis of the original 1995 map and data strongly suggested that the oak woodland areas shown on the original map included substantial open areas that were classified as herbaceous vegetation in later years. The initially high estimate of oak woodlands in 1995 notwithstanding, oak woodland area has increased only slightly from 1995 (2.47 ac.) to 2015 (2.89 ac.) due to the gradual increase in size of oak trees in the same locations (Table 3.7).

Dense and scattered shrub classes were pooled as willow scrub in 1995. The total amount of scrub habitat declined from 331.30 ac. in 1995 to 213.07 ac. in 2015 (Table 3.7). From 2005-2015, scattered scrub declined substantially (184.79 ac. to 49.32 ac.) within the CCRMP area, while dense scrub increased to some degree (149.12 ac. to 163.75 ac.) (Table 3.7). Some patches of scattered scrub have transitioned to dense scrub or to a mosaic of dense scrub and herbaceous vegetation, such as on the south bend in the middle of the Hoppin Reach. Substantial increases in dense scrub were observed along the channel in Guesesosi and Dunnigan Hills reaches, and in sporadic other locations such as the downstream end of the Hoppin reach. Recent fires in the Capay reach removed substantial patches of dense scrub, as did channel migration and bank erosion along the south bank near the upstream end of the Dunnigan Hills reach.

Herbaceous vegetation within the CCRMP area increased steadily over the past two decades, peaking at 474.94 ac. in 2015. This increase was likely due to numerous factors, such as substantial growth of marshy vegetation along channel edges (particularly in the Guesesosi and Dunnigan Hills reaches) presumably due to a lack of scouring flows in recent years. Some patches of herbaceous vegetation also developed mid-channel in the Capay and Hungry Hollow reaches, likely as a result of relatively benign flow conditions in recent years. In many other locations, spread of invasive understory species (esp. perennial pepperweed and nonnative thistles) was responsible for increased herbaceous area.

The focused analysis of native vegetation recovery in historically-mined in-channel and off-channel locations provides another perspective on changes and trends in native vegetation within the CCRMP area over the past two decades. Within the Hungry Hollow reach, historically mined locations were mostly bare ground in 1995, with some herbaceous vegetation and trace amounts of riparian forest on the upstream end. In 2015, significant bare ground remained although a mosaic of herbaceous, scrub, and forest vegetation had developed in some places. Barring very high flow events resulting in significant channel meander and scour, it is likely that this trend of slowly developing riparian vegetation will continue in this reach, or even accelerate in years to come. Summer pulse flows might potentially speed this process, decreasing the time required to meet the CCRMP goal of a continuous band of riparian vegetation along lower Cache Creek. Within the Madison reach, more herbaceous and scrub vegetation was observed within historically mined areas in 1995 versus the Hungry Hollow reach. As in the latter reach, a complex vegetation mosaic had developed by 2015, which could continue to expand as discussed for the Hungry Hollow reach. Within the Guesisosi and Dunnigan Hills reach portions that were historically mined, substantial forest, scrub, and herbaceous vegetation was already present in 1995 (especially in the Guesisosi reach). However, both scrub and forest vegetation increased substantially in these areas by 2015, especially in the upstream portion of the Dunnigan Hills reach.

TABLE 3.8: ACREAGE PER VEGETATION CLASS WITHIN THE CCAP AREA (CCRMP AREA AND OCMP AREA) IN 1995 AND 2015.

Year		Acreage Per Vegetation Class (CCAP)				
		Riparian Forest	Oak Woodland	Willow Scrub		Herbaceous
				Dense Scrub	Scattered Scrub	
1995	**CCRMP**	262.56	36.13	331.28		218.17
	OCMP	353.80	589.01	529.85		113.51
	CCAP	**616.35**	**625.14**	**861.12**		**331.68**
2015	**CCRMP**	251.67	2.89	49.32	163.75	474.94
	OCMP	372.54	593.93	207.10	52.52	1835.54
	CCAP	**624.21**	**596.82**	**256.42**	**216.27**	**2310.48**

The broader-scale analysis of vegetation (1995 compared only to 2015) within the OCMP area and the entire CCAP area provided additional insight into changes across the region over the past two decades. At the scale of the entire CCAP area, riparian forest area increased slightly from 616.35 ac. in 1995 to 624.21 ac. in 2015 (Table 3.8). Within the OCMP portion specifically, riparian forest area increased by approximately 20 ac. from 353.80 ac. in 1995 to 372.54 ac. in 2015 (Table 8).

One of the key observations from this analysis was that there had been substantially development of riparian forest and dense scrub vegetation in retired off-channel mining sites within the OCMP area such as the Hayes “Bow-Tie” property (Guesisoi reach, north side), the Millsap Property (Dunnigan Hills reach, north side), the Cache Creek Nature Preserve (Dunnigan Hills reach, north side) and the Correll-Rodgers property (Hoppin reach, south side). The Hayes Bow-Tie property was classified as willow scrub in 1995, but was densely forested in 2015 due to reconnection of the site to the active floodplain. Some forests existed on the Millsap property in 1995 in addition to large amounts of willow scrub and herbaceous vegetation, however substantially more forest had developed on the site by 2015. The present-day site of the Cache Creek Conservancy was essentially devoid of vegetation in 1995, but was restored into a mosaic of wetlands, willow scrub, and riparian forests by 2015. The Correll-Rodgers property was also devoid of vegetation in 1995, but had developed large patches of mature riparian forest by 2015 as a result of active planting and inundation via canal water delivery. These observations provided additional perspective on vegetation recovery post-mining and outcomes of passive restoration projects. However, invasive species including tamarisk, arundo, and perennial pepperweed are also widespread in many of the locations.

The final observation regarding native vegetation is that, as noted previously, large stands of creeping wildrye and other native herbaceous species such as mugwort (*Artemisia douglasiana*), sedges, and rushes, are have persisted in some locations over the past two decades. These patches presumably represent sources of maximum local genetic diversity from which seeds or seedlings could be collected for use in revegetation or restoration projects.

Nonnative Vegetation

A lack of comprehensive baseline data for the CCRMP and CCAP precluded quantitative estimation of changes in distribution and acreage of arundo, Ravenna grass, and tamarisk. However, it is clear from historical reports that dramatic reductions in these three species have been achieved as a result of intensive annual treatment efforts. An equilibrium of sorts has now been achieved, in which a relatively small amount of these three species remain on lower Cache Creek as either resprouts from previous treatment, untreated plants and patches that have persisted along backwater channels or under dense forest canopy, or new recruits from large source populations above Capay Dam or relatively smaller patches within the CCAP area (e.g., on properties to which access has been denied). The current invasive species control program, which focuses on treatment of large patches in close proximity to the low-flow channel, can maintain this status quo but most likely cannot achieve further reductions in these three species without a greater level of funding and effort, treatment of upstream source populations, and implementation of a GPS-based mapping, prioritization, treatment, and monitoring program.

In addition, declines in arundo, ravennagrass, and tamarisk, have been apparently offset to some degree by dramatic increases in the arrival and spread of many new invasive species within the CCAP area over the past two decades. Increases in perennial pepperweed, tree of heaven, nonnative thistles, tree tobacco, Himalayan blackberry, fig, poison hemlock, barbed goatgrass, and medusahead were initially caused by dispersal of seeds or biomass into the region via wind, water, wildlife, livestock, people, and other vectors. A lack of treatment allowed these species to establish, and they were further promoted by disturbance (e.g., fires, OHV use), the lack of active revegetation with native species after disturbance, and the lack of competition from native plants. Species such as perennial pepperweed, nonnative thistles, and Himalayan blackberry are now widespread and often occur in large, homogeneous patches that exclude native vegetation. If these species are not targeted aggressively by future invasive species treatment efforts, they will almost certainly continue to spread across the CCAP and further degrade biological resources within the region. The current invasive species control program is not yet structured to respond effectively to these new invasive species; however, the funding of the 2016 invasive species mapping project is a significant step in that direction since a quantitative baseline has now been created. These data could now be used to acquire additional funding to ramp up systematic treatment and monitoring of additional invasive species in the future. For example, mapping of invasive species within the Capay Valley reach above Capay Dam occurred in late September 2016 (Rayburn 2016c).

3.3.2 Amphibians

Data Collection and Analysis

Relatively few observations of native amphibians were made from 1995–2016 (Table A2-1). A species list maintained by the Cache Creek Conservancy for the Cache Creek Nature Preserve (Dunnigan Hills reach) includes three amphibian species: nonnative bullfrog (*Rana catesbeiana*), native Pacific tree frog (*Pseudacris regilla*), and native California toad (*Anaxyrus boreas* *halophilus*) (Cache Creek Conservancy 2016a). In 2010, University of California undergraduate students sampling amphibians at the Cache Creek Nature Preserve for a class project also detected California red-legged frog (*Rana aurora draytonii;* Federally threatened; State species of special concern) (Elen and Yasuda 2010). Bullfrogs were also noted occasionally and sporadically in some Annual Reports, and frequently at the Cache Creek Nature Preserve. Both bullfrogs and California toads were observed by the Consulting Biologist during 2015–2016 field surveys and Creek Walks. California toads were fairly common, while bullfrogs were widespread throughout the CCRMP area.

Changes and Trends

Qualitative analysis of limited existing data suggests that California toads are likely widespread throughout the CCAP area. Pacific tree frogs are likely present at the Cache Creek Nature Preserve (Dunnigan Hills reach), and may be present in other reaches, especially those will more overstory vegetation. California red-legged frogs may still be present at the Cache Creek Nature Preserve or elsewhere within the CCAP area. Native amphibians are likely being negatively impacted by nonnative bullfrogs and nonnative fish. Bullfrogs and nonnative predatory fish are common through the CCAP study area, and both are known to have substantial negative impacts on native amphibians.

3.3.3 Reptiles

Data Collection and Analysis

Relatively few observations of native reptiles were made from 1995-2016 (Table A2-2). The 1995 Technical Studies (NHC 1995) noted that suitable habitat existed within the CCAP area for the special-status Western pond turtle (*Actinemys marmorata*; State species of special concern) and that the species had been observed along lower Cache Creek although no specific records were found. A Western pond turtle was observed in 1998 by University of California Davis researchers above Moore Dam in the Dunnigan Hills reach during fish surveys (Moyle and Marcheti 1998). Western pond turtles were also observed during the 2012 and 2015 Creek Walks just downstream of the Capay Dam (Yolo County 2012a, 2015) and in the Madison reach during the 2013 and 2014 Creek Walks (Yolo County 2013, 2014). Western pond turtles were observed sporadically by the TAC Biologist during 2016 field work, and also observed by TAC members and others during the 2016 Creek Walk in the Capay, Guesisosi, and Hoppin reaches (Yolo County 2016).

At least one northern Pacific rattlesnake (*Crotalus oreganus oreganus*) was observed by the TAC Biologist in 2011 (Yolo County 2011). Rattlesnakes, garter snakes (*Thamnophis* spp.), alligator lizards (*Elgaria* spp.), and Western fence lizards (*Sceloporus occidentalis*) were observed by the Consulting Biologist in numerous locations along the creek during 2015–2016 field work and during 2015–2016 Creek Walks.

In addition, a species list maintained by the Cache Creek Conservancy for the Cache Creek Nature Preserve includes alligator lizard, garter snake, gopher snake (*Pituphic metanolearus*), king snake (*Lampropeltis getulus*), pond slider (*Pseademys* spp.), Western fence lizard, Western pond turtle, and Western rattlesnake (*Cortalas viridis*) (Cache Creek Conservancy 2016a).

Changes and Trends

Native reptile species are found throughout the CCAP area, and conditions seem to have facilitated the persistence of native reptile populations over the past two decades. Western pond turtles have been continuously observed in deeper pools over this time period, although evidence (e.g., dead or struggling turtles) suggests that populations of this species are negatively impacted in drier years when deeper pools are limited or unavailable. It is unknown to what extent red-eared sliders, a common California nonnative turtle that competes with Western pond turtles, have established with the CCAP area. Other native reptiles, including lizards and snakes, are fairly common throughout the CCAP area and be reasonably assumed to have viable populations.

3.3.4 MAMMALS

Data Collection and Analysis

A substantial number of observations of native and nonnative mammals were made from 1995–2016 (Table A2-3). The ring-tailed cat (*Bassariscus astutus*; State fully-protected species) was mentioned in the 1995 Technical Studies as a special-status species for which suitable habitat occurred within the CCAP area, but no records of species occurrence existed for lower Cache Creek specifically although some historical records existed for Yolo County (NHC 1995). The Technical Studies also mentioned that common mammalian species (e.g., Columbian black-tailed deer; *Odocoileus hemionus columbianus*) had been reported from the CCAP area, but no list was provided.

Tracks and scat of bobcat (*Lynx rufus*), coyote (*Canis latrans*), and an unknown fox species (potentially Sacramento Valley red fox; *Vulpes vulpes* ssp. *patwin*) were observed by UC Davis undergraduates at the Cache Creek Nature Preserve (Dunnigan Hils reach) in 2010 (Croom et al. 2010; Lambert and Culpepper 2010).

In 2011, another undergraduate student observed ring-tailed cat tracks on a muddy riverbank adjacent to dense riparian cover at the Cache Creek Nature Preserve (McDonald-Ryan 2011). Tracks of mountain lion (*Puma concolor*), bobcat, and potentially Sacramento Valley red fox were also observed by the student, while students also observed sign of bobcat at the Preserve in 2011 (Taylor and Kennedy 2011) and 2012 (Pisano and Roberson 2012; Zajac and Mitrovich 2012). Also in 2011, the TAC Biologist observed beaver (*Castor canadensis*), Columbian black-tailed deer, black-tailed jackrabbit (*Lepus californicus*), bobcat, raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*) during field visits (Yolo County 2011).

In 2013, UC Davis students found scat and tracks of wild pigs (*Sus scrofa*), bobcat, and potentially Sacramento Valley red fox at the Cache Creek Nature Preserve (Dunbar et al. 2013; Fussell and Wright 2013). In 2015, a bobcat was observed on a wildlife camera by a landowner at the downstream end of the CCRMP in 2015, and at least one fox, potentially a Sacramento Valley red fox, was also seen in the same location (Keith Hannon, *pers. comm,* June 2016). An American badger (*Taxidea taxus*; State species of special concern) was also observed in a burrow on the CCNP in 2015 (Keith Hannon, *pers. comm.*, June 2016).

In addition, from 2013–2016, the Sacramento Valley Carnivore Study was conducted by researchers from the Mammalian Ecology and Conservation Unit of the University of California Davis Veterinary Genetics Lab in collaboration with CDFW. In late 2015 and early 2016, researchers set up numerous camera stations across the region to survey mammalian carnivores and other species, including 5 stations along lower Cache Creek (1 station each in the Capay, Hungry Hollow, and Rio Jesus Maria reaches, and 2 stations in the Dunnigan Hills reach near the Cache Creek Nature Preserve) within the CCAP area. Notable species recorded on these cameras included coyote (all 5 stations), bobcat (stations in the Dunnigan Hills, Hungry Hollow, and Rio Jesus Maris reaches), and wild pig (Capay reach station) (B.N. Sacks, University of California Davis, unpublished data). Additional species commonly seen on cameras at most stations included Columbian black-tailed deer, Audubon's cottontails (*Sylvilagus audubonii*), black-tailed jack rabbits, striped skunk, opossum (*Didephis* spp.), racoon, and various squirrel species.

Numerous Columbian black-tailed deer, Audubon's cottontails, black-tailed jackrabbits, and fresh beaver dams (most often composed of small to medium branches) were observed by the Consulting Biologist during 2015–2016 field work and during the 2016 Creek Walk. Less-frequently observed species also included striped skunk, raccoon, Western grey squirrel (*Sciarus griseas*), opossum, California ground squirrel (*Spermophilis becheyi*), coyote, bobcat, and numerous small rodents (e.g., California vole; *Microtus californicus*). Two fox carcasses were also observed during this period, one by the Consulting Biologist in 2015, and one by the TAC Hydraulic Engineer during the 2016 Creek Walk. Genetic analysis would have been required to determine the specific species of fox. Adult and juvenile wild pigs were observed by the TAC Biologist in the Hungry Hollow reach during 2015–2016 field work, and scat was also observed in other locations with dense woody vegetation.

A species list maintained by the Cache Creek Conservancy for the Cache Creek Nature Preserve includes American beaver, Audubon's cottontail, black rat (*Rattus rattus*), black-tailed jackrabbit, Columbian black-tailed deer, bobcat, pocket gopher (*Thomomys bottae*) California ground squirrel, California vole, coyote, gray fox (*Uryocyon cinereoargenteus*), hoary bat (*Lasiurus cinerus*), house mouse (*Mus musculus*), Mexican free-tailed bat (*Tadarida brasilienis*), mink (*Mustela vision*), muskrat (*Ondatra zibethicas*), Norway rat (*Rattus norvegicus*), opossum, raccoon, ring-tailed cat, river otter (*Lontra canadensis*), striped skunk, and Western gray squirrel (Cache Creek Conservancy 2016a). Many of these species are common throughout the CCAP and were frequently observed by researchers and TAC Biologists in numerous years and locations (American beaver, Audobon's cottontail, black-tailed deer, black-tailed jackrabbit, various small mammals such as pocket gophers and voles, opossum, raccoon, river otter, and striped skunk.

Changes and Trends

Native mammal species are found throughout the CCAP area, and many species are widespread and commonly observed (e.g., American beaver, black-tailed jackrabbit, Columbian black-tailed deer, cottontail, coyote, opossum, raccoon, river otter, striped skunk, and various small mammals such as gopher and vole). Of these species, beavers are unique in that they influence vegetation, flows, and groundwater within the CCAP through felling trees and constructing dams. Based on field observations, beaver dams are a minor feature within the CCAP area, and may actually be beneficial to other native species (e.g., Western pond turtle) by creating deeper pools that persist into the drier months.

Special-status mammals (American badger and ring-tailed cat) have been detected within the CCAP area in the past via sign or direct observation. However, with only one confirmed detection for each of these species, both at the Cache Creek Nature Preserve, it is uncertain as to their past or present distribution within the CCAP area.

Coyotes and bobcats are both likely widespread within the CCAP area, although they are secretive and difficult to detect without using camera traps or similar methods. Also challenging to observe in the wild, mountain lions are likely occasionally present within the area, although uncommon. Mountain lions observed within the CCAP area may represent younger individuals dispersing from larger populations in the upper Cache Creek watershed. These predatory species likely exert strong influences on their prey species (e.g., deer, rabbits, etc.) and play significant roles in structuring the riparian ecosystem along lower Cache Creek.

The presence of nonnative wild pigs within the CCAP area may be a relatively new phenomenon, although wild pigs have been present in Yolo County and the entire state for some time. California's wild pigs descended from the European wild boar, introduced in Monterey County in the 1920s, and domestic swine imported by European settlers in the 1700s. There are various issues associated with wild pigs in California, including damage to land and disease (Kreith 2007).

3.3.5 BIRDS

Data Collection and Analysis

Compared to amphibians, reptiles, mammals, fish, and invertebrates, substantially more data were available regarding birds within the CCAP area (Table A2-4). Overall, at least 148 species of birds (see Appendix 2) have been observed within the CCAP area since 1995, including the following special-status bird species: bald eagle (*Haliaeetus leucocephalus*; State fully protected species [SFP], State endangered [SE]), bank swallow (*Riparia riparia*; State threatened [ST]), golden eagle (*Aquila chrysaetos*; SFP), loggerhead shrike (*Lanius ludovicianus*; State species of special concern [SSC]), long-eared owl (*Asio otus*; SSC), Northern harrier (*Circus cyaneus*; SSC), song sparrow ("Modesto" population, *Melospiza melodia*; SSC), Swainson's hawks (*Buteo swainsoni*; ST), tricolored blackbird (*Aegelaius tricolor*; SSC and SFP), Vaux's swift (*Chaetura vauxi;*

SSC), white-tailed kite (*Elanus leucurus*; SFP), yellow-headed blackbird (*Xanthocephalus xanthocephalus*; SSC), and yellow warbler (*Steophaga petechia*; SSC). The following data summary focuses on these special-status species and some additional notable native species; see Appendix 2 for a more-detailed accounting of additional species.

1995–2000

The 1995 Technical Studies noted that three special-status species of birds had been recorded in the CNDDB at the time of the report: Swainson's hawk, bank swallow, and tricolored blackbird (NHC 1995). The Technical Studies noted that, as of 1995, suitable habitat occurred within the CCAP area for other notable bird species including Cooper's hawk (*Accipter cooperi*) and yellow warbler. During baseline surveys of the Cache Creek Nature Preserve by Jones & Stokes Associates (1995), species observed included Swainson's hawk, white-tailed kite, red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), great-horned owl (*Bubo virginianus*), spotted sandpiper (*Actitis macularius*), and lesser nighthawks (*Chordeiles acutipennis*) nesting on gravel bars. Northern harrier and Swainson's hawk were observed in 1997 near the Preserve (Moyle and Marcheti 1998).

Active bank swallow colonies were noted just upstream of Moore's Crossing (Dunnigan Hills reach) in 1998 (Yolo County 1998) and upstream of the former Madison bridge in the Madison reach (Yolo County 1999). Truan (2002) observed 130 species of birds during 1999-2001 surveys at the Cache Creek Nature Preserve, including yellow warbler, Northern harrier, bank swallow, loggerhead shrike, tricolored blackbird, and white-tailed kite. Kemper (2000) noted the presence along lower Cache Creek of lesser nighthawks, California scrub-jays (*Aphelocoma californica*), wood ducks (*Aix sponsa*), common gallinules (*Gallinula galeata*), and other species. In addition, tricolored blackbirds were observed by a landowner on a former mining pit on the south bank near the middle of the Dunnigan Hills reach in 2000; tricolored blackbirds had been seen on the same site in the late 1980s and early 1990s (Sally Barrett, *pers. comm.*, June 2016).

2001–2005

At least one Swainson's hawk was observed in the Madison reach in 2001 (CNDDB 2016). Truan (2004a) observed 85 species birds along Putah Creek and at four sites along lower Cache Creek during the breeding season in 1999.; however, species were not reported separately for each creek. Truan (2004b) also conducted a baseline Biological Assessment of the Capay Open Space Park; bird observations included loggerhead shrike, Say's phoebe (*Sayornis saya*), mountain bluebird (*Sialia currucoides*), Northern harrier, white-tailed kite, savanna sparrow (*Passerculus sandwichensis*), Bewick's wren (*Thryomanes bewickii*), Northern rough-winged swallow (*Stelgidopteryx serripennis*), cliff swallow (*Petrochelidon pyrrhonota*), and phainopepla (*Phainopepla nitens*).

2006–2010

Swainson's hawks were observed in 2007 in the Dunnigan Hills, Hoppin, and Rio Jesus Maria reaches, as were bank swallows in the Madison reach (CNDDB 2016). In 2009, UC Davis students observed 28 species of birds at the Preserve, including Lewis' woodpecker (*Melanerpes lewis*), downy woodpecker (*Picoides pubescens*), lesser goldfinch (*Spinus psaltria*), barn owl (*Tyto alba*), blue-gray gnatcatcher (*Polioptila caerulea*), and common yellowthroat (*Geothlypis trichas*) (Bibian et al. 2009, McGrann 2009). In 2010, students observed 17 species of birds including cedar waxwings (*Bombycilla cedrorum)*, ruby-crowned kinglet (*Regulus calendula*), and yellow-rumped warblers (*Setophaga coronata*) (Koos and Sataloff 2010).

Swainson's hawks were the subject of graduate research by Cahill (2014), who investigated habitat preferences, predictive factors of nest presence, and nest tree characteristics within the CCAP area. Cahill made 464 observations of Swainson's hawks across six survey routes spanning the area from March–August 2010, including many large groups; however, these do not represent unique individuals as hawks could have been observed multiple times.

2011–2016

A 2011 survey of the Preserve and areas on the bank south of the Preserve by Point Blue Conservation Science staff found 51 species of birds including Swainson's hawk, black-headed grosbeak (*Pheucticus melanocephalus*), warbling vireo (*Vireo gilvus*), tree swallow (*Tachycineta bicolor*), yellow warbler, Wilson's warbler (*Cardellina pusilla*), song sparrow, yellow-headed blackbird, Nuttall's woodpecker (*Picoides nuttallii*), and lazuli bunting (*Passerina amoena*) (Point Blue 2011). Also in 2011, the then-TAC Biologist observed 41 bird species during the annual Creek Walk and an additional field survey, including American pipit (*Anthus rubescens*), bank swallow, belted kingfisher (*Megaceryle alcyon*), California quail (*Callipepla californica*), green heron (*Butorides virescens*), Northern harrier, osprey (*Pandion haliaetus*), Swainson's hawk, and yellow-billed magpie (*Pica nuttalli*).

Active bank swallow colonies were described in the 2012 and 2013 Cache Creek Annual Reports as being observed along the north bank within the Madison Reach and along the south bank at within the Hoppin reach (>50 pairs). The Hoppin reach colony was substantially smaller in 2013 than 2012 (Yolo County 2013). Active colonies were only observed within the Madison reach (at the same location as in previous years) during the 2014 Creek Walk; this was noted as a significant reduction in colonies compared to previous years (Yolo County 2014). No active bank swallow colonies were observed during the 2015 Creek Walk (Yolo County 2015).

In 2012, UC Davis undergraduates observed 20 species of birds at the Preserve, including white-tailed kite, Northern flicker (*Colaptes auratus*), hairy woodpecker (*Picoides villosus*), red-breasted sapsucker (*Sphyrapicus ruber*), Anna's hummingbird (*Calypte anna*), and red-shouldered hawk (*Buteo lineatus*) (Phillips and Roush 2012). Forty-three species were observed by UC Davis students in 2013, including Pacific wren (*Troglodytes pacificus*), white-crowned sparrow (*Zonotrichia leucophrys*), Hutton's vireo (*Vireo huttoni*), California thrasher (*Toxostoma *redivivum*), ash-throated flycatcher (*Myiarchus cinerascens*), wrentit (*Chamaea fasciata*), Cassin's vireo (*Vireo cassinii*), fox sparrow (*Passerella iliaca*), chipping sparrow (*Spizella passerine*), oak titmouse (*Baeolophus inornatus*), and brown creeper (*Certhia americana*) (Baird et al. 2013).

Swainson's hawks and osprey were observed as fly-overs along lower Cache Creek during the annual Creek Walks from 2012–2016 (Yolo County 2012a–2016). Also during 2012–2016 Creek Walks, colonies of cliff swallows were commonly observed under bridges in numerous reaches, while colonies of northern rough-winged swallows were observed along vertical banks along Guesisosi and Hoppin reaches. A great blue heron rookery (communal nesting site) was observed in the same forested location on the south side of the Capay reach. Bank swallows were observed nesting along a cliff face on the south bank in the Hoppin reach in 2016 (Yolo County 2016).

Additional species observed during the 2016 Creek Walk included white-tailed kites, California thrashers, lesser nighthawks, Western kingbirds (*Tyrannus verticalis*), and bank swallows at a colony near the upstream end of the Hoppin reach (Autumn Turner, *pers*. *comm*., June 2016). Numerous other species were observed by the Consulting Biologist during 2015–2016 field surveys, including killdeer (*Charadrius vociferus*), Northern harrier (including potentially nesting pairs), bushtits (*Psaltriparus minimus*), barn owl, Northern mockingbird (*Mimus polyglottos*), Western tanager *(Piranga ludoviciana*), great-tailed grackle (*Quiscalus mexicanus*), yellow-headed blackbird, and hooded merganser (*Lophodytes cucullatus*). Lastly, a gravel operator interviewed by the Consulting Biologist in 2016 noted that bald eagles were observed at the Granite Construction facility in the Hungry Hollow reach (Suzanne Ek, *pers. comm.*, April 2016). In addition, a long-time resident has for years observed up to 20 long-eared owls using a dense forest site just south of her house in the Dunnigan Hills reach as a migratory stop-over site in both spring and fall (Sally Barrett, *pers. comm.*, June 2016).

Finally, a species list maintained by the Cache Creek Conservancy for the Cache Creek Nature Preserve includes 84 native and nonnative species spanning raptors, songbirds, waterfowl, and shorebirds (Cache Creek Conservancy 2016b). Notable species include black-chinned hummingbird (*Archilochus alexndri*), brown-headed cowbird (*Molothrus ater*), Cooper's hawk, Forster's tern (*Sterna forsteri*), golden-crowned sparrow (*Zonotrichia atricapilla*), greater yellowlegs (*Tringa melanoleuca*), Northern harrier, Nuttall's woodpecker, oak titmouse (*Baeolophus inornatus*), orange-crowned warbler (*Oreothlypis celata*), pied-billed grebe (*Podilymbus podiceps*), Western wood-pewee (*Contopus sordidulus*), white-breasted nuthatch (*Sitta carolinensis*), Swainson's hawk, white-tailed kite, and yellow warbler.

Changes and Trends

Analysis of changes and trends in native bird species and populations was constrained by available data. Limited surveys of bird with the CCAP area have been conducted from 1996–2016, and mostly on and around the Cache Creek Nature Preserve. Additional observations have been made by biologists, landowners, and others throughout the CCAP area, but these data were not collected in a statistically-rigorous manner that would allow for analyses of changes in bird species density or abundance.

Numerous native raptors, waterfowl, shorebirds, and songbirds are found across all habitat types throughout the CCAP area, and it is reasonable to assume that lower Cache Creek is suitable, if not exceptional, habitat for many common and special-status bird species. In particular, habitat within the CCAP area seems to be especially suitable for Swainson's hawks, red-tailed hawks, osprey, white-tailed kites, various swallows, various herons, and a wide variety of native songbirds. Riparian bank swallows have also been consistently observed in some reaches, although evidence suggests that bank swallows may be negatively impacted by drought conditions and lower flows via a lack of foraging resources and freshly exposed banks in which to nest. Tricolored blackbirds were occasionally observed in the mid-late 1990s and early 2000s, but have not been observed in the CCAP area for 15 years. Suitable habitat for tricolored blackbirds still exists, however the species has been in dramatic decline across the Central Valley during this same time period.

The continued recovery of native vegetation across the CCAP area via passive and active restoration should benefit many of the resident and migratory bird species, especially those whose populations have been in gradual decline in California (e.g., California thrasher, loggerhead shrike, Nuttall's woodpecker, oak titmouse, and yellow warbler).

3.3.6 INVERTEBRATES

Data Collection and Analysis

Relatively few observations of native invertebrates were made from 1995–2016 (Table A2-5). The threatened Valley elderberry longhorn beetle (VELB) was noted in the 1995 Technical Studies as occurring along Cache Creek with at least one occurrence (exit holes only) along the Dunnigan Hills reach (NHC 1995). The Sacramento anthicid beetle (*Anthicus sacramento*) was also mentioned in the 1995 Technical Studies as having suitable habitat along Cache Creek, but no observations were known.

In the context of assessing water quality, aquatic insects were sampled by Slotton et al. (1997) on behalf of the Cache Creek Conservancy, and by other UC Davis researchers independently in 1997 (Slotton et al. 1997, Yolo County 1998). Slotton et al. (1997) and collaborators sampled dragonflies, damselflies, and caddisflies. Other university researchers collected 100 individuals from 7 families; details are provided in the 1998 Annual Report (Yolo County 1998). The UC Davis researchers sampled aquatic insects again in 1999 and collected 140 individuals spanning 11 families; details are available in the 1999 Cache Creek Annual Report (Yolo County 1999). Additional aquatic insect sampling was conducted by Slotton and collaborators as a component of the CalFed 2000/2001 study (Slotton et al. 2004), at the Cache Creek Nature Preserve from 2000-2003 (Slotton et al. 2004) and in 2011-2012 with the Capay, Dunnigan Hills, and Hoppin reaches (Slotton and Ayers 2013).

Truan (2004b) observed California velvety tree ants (*Liometopum occidentale*) and old VELB exit holes at the Capay Open Space Park. VELB were also present in the Hoppin reach as of 2005 (CNDDB 2016).

From 2015–2016, the Consulting Biologist observed various dragonflies (e.g., flame skimmer [*Libellula saturata*]), butterflies (e.g., common buckeye [*Junonia coenia*], California sister [*Adelpha californica*], monarch butterfly [*Danaus plexippus*] and Western tiger swallowtail [*Papilio rutulus*]), native bees and bee mimics, nonnative honey bees, ironclad beetles (*Nosoderma diabolicus*), cicadas, and crayfish (living, dead, and as components of wildlife scat) during Creek Walks and field surveys. Caddis fly larval casings were found on the underside of a large rock in a dry stretch just downstream of the Rd. 89 bridge in the Madison reach during the 2016 Creek Walk. In addition, the landowner south of Capay Dam noted that scorpions had been found on her property in the past (Mary Anne Woods, *pers. comm.*, April 2016).

In addition, a species list maintained by the Cache Creek Conservancy for the Cache Creek Nature Preserve includes dozens of insects, arachnids, crustaceans, mollusks, and annelids (e.g., earthworms, leeches) (Cache Creek Conservancy 2016c). Notable species include ancient ant (*Pyramica reliquia*), monarch butterfly, pipevine swallowtail butterfly (*Battus philenor*), and Western swallowtail butterfly. Old VELB exit holes have also been observed at the Cache Creek Nature Preserve (Andrew Rayburn, *pers. obs.*, June 2016).

Changes and Trends

Surveys of native invertebrates with the CCAP conducted from 1996–2016 focused on site-specific surveys for VELB and sampling of aquatic invertebrates at several locations for water quality assessment. However, it is a reasonable assumption that aquatic and terrestrial habitat within the CCAP area has supported, and continues to support, a wide range of native invertebrate species that have been documented historically as well as in recent years. The lone special-status invertebrate species observed, VELB, is likely present throughout the CCAP area especially given the widespread distribution of blue elderberry shrubs in all seven reaches (Rayburn 2016a).

3.3.7 Fish

Data Collection and Analysis

A substantial number of observations of native and nonnative fish were made within the CCAP area from 1995-2016 (Table A2-6). Historically, anadromous fish such as Chinook salmon, steelhead, and Pacific lamprey were observed spawning as far up as Capay Dam on lower Cache Creek (Shapovalov 1947 as cited in Yoshiyama et al. 1996; Moyle et al. 1995). By 1995, anadromous species and many other native fish were virtually absent from lower Cache Creek (NHC 1995). Remaining native species included California roach (*Hesperoleucus symmetricus*), hardhead (*Mylopharodon conocephalus*), hitch (*Lavinia exilicauda*), Sacramento pikeminnow

(*Ptychocheilus grandis*, also known as Sacramento squawfish), Sacramento sucker (*Catostomus occidentalis*), and white catfish (*Ameiurus catus*), although population estimates for these species were not available (NHC 1995). Nonnative species dominated the creek, including bluegill sunfish (*Lepomis. macrochirus*), brown bullhead (*I. nebulosus*), channel catfish (*lctalurus punctatus*), common carp (*Cyprinus carpio*), green sunfish (*L. cyanellus*), largemouth bass (*M. salmoides*), mosquitofish (*Gambusia affinis*), and smallmouth bass (*Micropterus dolomieui*). Several factors were at least partially responsible for the decline of native fish species, including infrequent high flows, a lack of direct connection to the Sacramento River, and abundant nonnative predatory fish.

During mercury sampling in the Guesisosi reach in 1995, researchers caught native Sacramento sucker as well as numerous nonnative species including bluegill sunfish, smallmouth bass, and white crappie (*Pomoxis annularis*) (Slotton et al. 1996). A baseline fish survey was conducted in July 1997 by researchers from the University of California Davis (Moyle and Marchetti 1998, Yolo County 1998). The survey sampled seven areas of the creek (Capay Dam, Esparto Bridge, Interstate 505, Moore Crossing, Stephens Bridge, Correll Preserve, and the downstream Settling Basin outside of the CCAP area boundary) and found 18 fish species, of which five were native: Sacramento sucker, Sacramento pikeminnow, speckled dace (*Rhinichthys osculus*), hitch, and Sacramento blackfish (*Orthodon microlepidotus*). Sacramento sucker and hitch were found in both the Hungry Hollow and Dunnigan Hills reaches, while the other three species were found only in the Dunnigan Hills reach. Nonnative fish, including red shiner (*Cyprinella lutrensis*), smallmouth bass, channel catfish, and common carp made up 89% of the total abundance, and were found throughout lower Cache Creek. Also in 1997, researchers sampling fish for mercury analysis collected numerous native species just upstream of the settling basin, downstream of the CCAP boundary, including hitch, Sacramento blackfish, Sacramento pikeminnow, Sacramento sucker, threadfin shad, and white catfish (Slotton et al. 1997).

In late 2000, UC Davis scientists collecting fish for mercury analysis found evidence of Chinook salmon spawning in the creek (Moyle and Ayers 2000). Four salmon were observed: three just downstream of Hwy. 505 (along with a freshly dug depression in the gravel), and one large male on the bottom of a pool just upstream of Hwy. 113 near Woodland (outside of the CCAP area boundary). Researchers hypothesized that these individuals strayed from the Sacramento River, passing through the Yolo Bypass and the Cache Creek Settling Basin, especially since fall flows were relatively high that year (15-20 cfs). Both Sacramento pikeminnows and Sacramento suckers were also collected in 2000 during juvenile fish sampling for mercury analysis within the Guesisosi Reach, as were speckled dace in 2001 within the Dunnigan Hills reach (Slotton et al. 2004; Slotton and Ayers 2013).

In 2008, Stillwater Sciences conducted a comprehensive fish survey at 10 locations from the Cache Creek settling basin upstream to the Upper Cache Creek Regional Park (Stillwater Sciences 2009). Four of the 10 sampling sites fell within the CCAP area: below Capay Dam (Capay reach), Capay Open Space Park (Hungry Hollow reach), the Cache Creek Nature Preserve (Dunnigan Hills reach), and Huff's Corner (Rio Jesus Maria reach). Below the Capay Dam (including the site near the settling basin, outside of the CCAP area), the survey found 254 fish with common carp being the most abundant species. Nine total species were found, seven of which were non-native including bluegill sunfish, largemouth bass, smallmouth bass, and common carp. Native species were limited to Sacramento pikeminnow (collected in Capay and Rio Jesus Maria reaches) and Sacramento sucker (collected in Capay, Hungry Hollow, and Dunnigan Hills reaches). The report also noted that native threadfin shad (*Dorosoma petenense*) were observed below Capay Dam in large numbers during June 2005, but not observed in the 2008 survey (Stillwater Sciences 2009). As noted above, threadfin shad were also observed by Slotton et al. (1997) just upstream of the settling basin.

From 2010-2012, UC Davis undergraduates surveyed fish for class projects at the Cache Creek Nature Preserve and the adjacent stretch of Cache Creek (Dunnigan Hills reach). In 2010, undergraduates caught numerous juvenile fish during seine sampling including black bullhead (*Ameiurus melas*), green sunfish, largemouth bass, Western mosquitofish, Sacramento hitch, and Sacramento pikeminnow (Ackerman et al. 2010). Two surveys were conducted in 2011; the first found bluegill, black crappie (*Pomoxis nigromaculatus*), green sunfish, Western mosquitofish, and common catfish (Bush and McCleary 2011), while the second found native Sacramento sucker and Sacramento pikeminnow among other species (Briggs et al. 2011). A single California roach was found in 2012 (Munguia et al. 2012).

Slotton and Ayers (2013) collected additional fish samples during mercury sampling in 2011, comprising 83 fish from nine species. Native species collected included the Sacramento pikeminnow, Sacramento sucker, and speckled dace; nonnative species included green sunfish, bluegill sunfish, black crappie, red shiner, channel catfish, mosquito fish, smallmouth bass, and largemouth bass. These results were similar to the earlier surveys conducted by the same researchers from 2000-2001 (Slotton and Ayers 2013).

Slotton and Ayers (2016) also sampled fish in Fall 2015 to assess mercury concentrations in four off-channel mining ponds along lower Cache Creek. One native species (white catfish) was collected during sampling in the Teichert-Reiff pond in the Madison reach, while numerous nonnative species were collected across all four ponds including common carp, channel catfish, green sunfish, largemouth bass, Western mosquitofish, and red shiner. Also in 2015, sunfish were observed on spawning beds by the Consulting Biologist in the Hoppin reach during the annual Creek Walk. Common carp were observed throughout the CCAP area by the Consulting Biologist during 2015–2016 vegetation field surveys, especially in persistent deep pools. UC Davis researcher Peter Moyle collected three native species (Sacramento sucker, Sacramento pikeminnow, and Sacramento hitch) and four nonnative species (bluegill sunfish, green sunfish, largemouth bass, and Western mosquitofish) while sampling at the Cache Creek Nature Preserve in 2015 (Peter Moyle, *pers. comm. to Keith Hannon,* June 2015).

In 2016, incidental observations by the TAC Geomorphologist during the 2016 Creek Walk included several Sacramento suckers in a pool on the north side of the channel in the Hungry Hollow reach and both black bullhead and largemouth bass in deep pools along the north side of the channel in the Dunnigan Hills reach.

Changes and Trends

Analysis of changes and trends in native fish species and populations was constrained by available data. Past surveys have been largely focused on either determining presence/absence at limited sampling locations, or have been conducted in order to obtain tissue samples for mercury analysis. However, qualitative analysis of existing data strongly suggest that some native fish species have persisted within the CCAP area over the past two decades. Sacramento pikeminnow and Sacramento sucker have been observed at multiple sampling locations and in multiple years across many of the reaches, while hitch have been observed in the Guesisosi and Dunnigan Hills reaches in more recent years. The population status of these three species, as well as that of the other native species known to have been present to some degree in lower Cache Creek (threadfin shad, speckled dace, Sacramento blackfish, California roach, white catfish, hardhead, and Chinook salmon) is unknown. Critically, the absence of data (e.g., species not found during a sampling event, locations not sampled in particular years, etc.) cannot result in the conclusion that a particular species is no longer present, especially if the species has been detected in the past. Structured monitoring (e.g., Stillwater Sciences 2009) will be required to determine the present and future status of native fish species on lower Cache Creek.

Another emergent conclusion is that the abundance and diversity of nonnative fish species has remained high over the past two decades. The presence of nonnative fish such as smallmouth bass, largemouth bass, and green sunfish has often been linked to native fish declines on lower Cache Creek (e.g., NHC 1995, Stillwater Sciences 2009). Other persistent factors that negatively impact native fish include infrequent high flows, dry channel conditions in summer months, and a lack of direct connection of Cache Creek to the Sacramento River.

3.4 RECOMMENDATIONS

Changes and trends in biological resources within the CCAP area from 1995–2016 have significant implications for CCAP implementation, evaluation of progress towards CCAP goals, and adaptive management of lower Cache Creek. These implications are reflected in the following sections in terms of recommended updates and changes to plan documents (OCMP, CCRMP, and CCIP) and ordinances (Off-Channel Surface Mining Ordinance, Reclamation Ordinance, and In-Channel Maintenance Mining Ordinance).

3.4.1 Recommendations Regarding Plan Documents

Off-Channel Mining Plan (OCMP)

Section	Recommendation
Introduction	This introductory section should be revised and updated to reflect the results of the 20-year retrospective analysis of changes and trends in biological resources, as well as the current scientific understanding of habitat restoration and invasive species control. The description of present conditions should be updated to reflect 2015 conditions, and compared to baseline conditions in 1995.
OCMP Vision for Biological Resources	It is recommended that this section be updated based on the current scientific understanding of habitat restoration and invasive species control. It is further recommended that updated language be included regarding priority restoration opportunities and priority invasive species.
Section 6.2-1	It is recommended that this goal be expanded to include native invertebrate species as well as native wildlife species.
Section 6.2-2	Specificity should be added regarding the goal of decreasing habitat fragmentation across the OCMP area.
Section 6.2-3	It is recommended that a new goal be added, related to the integration of climate-smart adaptation strategies to increase resiliency and to prepare for future uncertainty regarding effects of climate change on biological resources.
Section 6.3-3	It is recommended that an objective be added regarding standardization of monitoring for habitat revegetation and restoration projects implemented within the OCMP area.
Section 6.3-4	It is recommended that an objective be added regarding coordination of any revegetation or restoration projects with CCAP-scale planning efforts.
Section 6.4-1	It is unlikely that these agencies will want to review restoration plans unless they either directly funded the plan's creation, or if special-status species are directly impacted. It is recommended that the TAC and the Cache Creek Conservancy review habitat plans, but that other agencies are offered a chance, especially USFWS.
Section 6.4-4	It is recommended that this subsection be updated based on present knowledge of the distribution and extent of priority invasive species within the OCMP area.

Section 6.4-7	It is recommended that this subsection be updated regarding development of an integrated plan for habitat revegetation and restoration, which should include both the OCMP and CCRMP areas.
Section 6.4-8 (was Section 6.4-7)	It is recommended that this subsection be updated regarding updated restoration recommendations.
Section 6.4-9 (was Section 6.4-8)	It is recommended that this subsection be updated to emphasize the value of the using of native species in hedgerows, as well as the benefits of native species in hedgerows for pollinators that are known to support agricultural production.

Cache Creek Resource Management Plan (CCRMP)

Section	Recommendation
Section 4.1	This introductory section should be revised and updated to reflect the results of the 20-year retrospective analysis of changes and trends in biological resources, as well as the current scientific understanding of habitat restoration and invasive species control. The description of present conditions should be updated to reflect 2015 conditions, and compared to baseline conditions in 1995.
Vision for Biological Resources	This section should be updated based on current scientific understanding of habitat restoration and invasive species control. Recommendations regarding priority restoration opportunities and priority invasive species should also be updated. Representative photographs of native vegetation types (riparian forest, oak woodland, willow scrub, and herbaceous communities) should be added, and the map of priority restoration sites should be updated.
Section 4.2-1	This goal should be expanded to include native invertebrate and fish species as well as native wildlife species.
Section 4.2-2	This goal should be revised to remove references to foothill habitats of the upper watershed, and instead emphasize a continuous corridor of riparian vegetation spanning the CCRMP area.
Section 4.2-6	It is recommended that a new goal be added, related to the integration of climate-smart adaptation strategies to increase resiliency and to prepare for future uncertainty regarding effects of climate change on biological resources.
Section 4.3-1	The language in this subsection regarding flood conveyance and restoration should be updated.

Section 4.3-2	It is recommended that this objective be expanded to include all elements of biological resources, including vegetation, wildlife, invertebrates, and fish.
Section 4.3-3	It is recommended that this subsection be revised to emphasize the need for standardized implementation and monitoring of habitat revegetation and restoration projects.
Section 4.4-3	It is recommended that this subsection be revised based on the current understanding of distribution and extent of priority invasive species within the CCRMP area. Specific recommendations should be added regarding expanded invasive species treatment efforts, monitoring, and removal of treated biomass.
Section 4.4-4	It is recommended that Yolo County RCD be added as a potential collaborating agency. State and federal agencies (e.g., CDFW, USFWS, USACE) are unlikely to propose habitat restoration projects within the CCRMP area.
Section 4.4-5	This subsection should be revised to reflect landscape-scale planning efforts.
Section 4.4-10	It is recommended that this subsection be updated regarding development of an integrated plan for habitat revegetation and restoration, which should include both the OCMP and CCRMP areas.
Section 4.4-12	It is recommended that this subsection be revised to emphasize the need for review of restoration plans and guidelines by the Cache Creek TAC and the Cache Creek Conservancy.
Section 4.4-13	It is recommended that this subsection should be updated with a reference to the Migratory Bird Treaty Act and avoidance of impacts to migratory birds during the nesting season for all projects.
Section 4.4-14	It is recommended that this subsection be revised to reflect the need for field surveys of special-status species regardless of the status of biological databases. An additional recommendation is that the review process for restoration and/or mitigation plans be updated, as such plans should be reviewed by both the TAC and the Cache Creek Conservancy.
Section 4.4-17	This subsection should be updated to reflect current guidelines of the Yolo HCP/NCCP.
Section 4.5	It is recommended that all performance standards in this section be updated to reflect current standards and methodologies for habitat enhancement and restoration projects. These updates should include: refinements regarding use of native species in bank stabilization projects; guidelines for planting native species; importance of including native herbaceous species in addition to trees and shrubs in revegetation and restoration projects; the need for statistically-valid monitoring of revegetation and restoration projects to inform adaptive management and enhance success; requirements for additional site

	preparation for project sites with abundant nonnative species; expanded species lists for revegetation and restoration projects; including additional herbaceous species; and, revised standards for invasive species control.

Cache Creek Implementation Program (CCIP)

Section	Recommendation
Section 6.1	The *Vegetation and Riparian Habitat* subsection should be revised and updated based on the results of the 20-year retrospective analysis of changes and trends in biological resources detailed in this report.
Section 6.2 (5)	This section should be revised to reflect the need to monitor changes in all elements of biological resources (vegetation, wildlife, invertebrates, and fish), although the emphasis remains on annual monitoring of vegetation.
Section 6.3	The *Vegetation and Riparian Habitat* subsection of the monitoring section should be updated to reflect current vegetation monitoring protocols.

3.4.2 Recommendations Regarding Ordinances

Off-Channel Surface Mining Ordinance

Section	Recommendation
Section 10-4.418	This section should be updated to reflect the current language and status of the Yolo County Habitat Conservation Plan / Natural Community Conservation Plan. A reference to CCAP compliance may also be appropriate.
Section 10-4.439	It is recommended that the TAC and Cache Creek Conservancy staff also approve any wetland restoration plans, in addition to jurisdictional agencies.
Section 10-4.440	The phases "essential cover associated with riparian forest and oak woodland habitat" and "Essential habitat for special status species" are vague; it is recommended that the former be replaced with "mature riparian forest and oak woodland habitat," and the latter with "Suitable habitat for special status species."
Section 10-4.502 (i3)	The term "restoration" should be formally defined in this document.
Section 10-4.701	Suggest introductory paragraph require operators to submit digital and hardcopy versions of annual reports.

Reclamation Ordinance

Section	Recommendation
Article 2	The term "restoration" should be formally defined in this section.
Section 10-5.103 (f)	The phrase about "encouraging…the riparian corridor" is unclear. Suggest replacing with "encouraging…protection and enhancement of riparian habitat."
Section 10-5.514	This section should be updated to reflect the current language and status of the Yolo County Habitat Conservation Plan / Natural Community Conservation Plan. A reference to CCAP compliance may also be appropriate.
Section 10-5.515	It is unlikely that these agencies will want to review restoration plans unless they either directly funded the plan's creation, or if special-status species are directly impacted. It is recommended that the TAC and the Cache Creek Conservancy review habitat plans, but that other agencies are offered a chance, especially USFWS.
Section 10-5.523	It is recommended that language be added about how habitat reclamation and restoration plans should be approved; such plans should be subject to the approval of the TAC and the Cache Creek Conservancy, if not other entities.

In-Channel Maintenance Mining Ordinance

Section	Recommendation
Article 2	The terms "revegetation" and "restoration" should be formally defined in this document.
Section 10-3.415	The terms "revegetation" and "restoration" should not be used interchangeably. Restoration is preferred, as it implies a more ecologically-valuable project with higher standards for success. An approval process for revegetation or restoration plans, including review and approval by the TAC and the Cache Creek Conservancy, should also be defined.

3.4.3 Other Recommendations

Status of Recommendations from the 2006 Status and Trends Report

In the 2006 Status and Trends Report (Yolo County 2006), the TAC Riparian Biologist made recommendations regarding vegetation monitoring and habitat restoration implementation. See Section 4.1.3 for the list and status of 2006 recommendations as of 2016.

3.4.4 CONCLUSION

Biological resources on lower Cache Creek include diverse native plant communities, in addition to over 200 species of common and special-status wildlife, invertebrates, and fish. Nonnative and invasive species are also included within the biological resources framework, due to their significant impacts on native species and communities, creek flows, and other aspects of the terrestrial and aquatic habitat along the creek and in the surrounding landscape. Over the last two decades since implementation of the Cache Creek Area Plan, native riparian vegetation has increased, especially in areas that were formerly mined. In addition, special-status blue elderberry shrubs are abundant along lower Cache Creek, and there is strong evidence that the local population is increasing. Numerous opportunities exist to accelerate further recovery of native vegetation, including restoring additional riparian and upland habitat, increasing base creek flows during spring and summer seasons, and expanding treatment of invasive species. The three invasive plant species that have been historically prioritized for treatment (arundo, ravennagrass, and tamarisk) have been greatly reduced, although many additional nonnative and invasive species are now present and must be targeted for removal using modern mapping and prioritization methods.

While assessment of changes and trends in native wildlife, invertebrates, and fish was limited by available data, the CCAP area is clearly important habitat for a wide range of common and special-status species. The continued recovery of native vegetation is expected to enhance habitat for many of these species, further increasing the value of lower Cache Creek as habitat within the matrix of agricultural and urban lands in Yolo County. Opportunities for additional monitoring of native wildlife, invertebrates, and fish should be explored, likely in partnership with local universities and non-profit organizations, to better understand the status of local populations and to develop targeted conservation strategies as a component of the multi-benefit CCAP framework.

3.5 REFERENCES

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CHAPTER 3

APPENDICES

APPENDIX 3.A – DETAILED METHODS FOR CLASSIFICATION AND ANALYSIS OF VEGETATION ON LOWER CACHE CREEK, YOLO COUNTY, CA (1995–2016)

METHODOLOGICAL LIMITATIONS OF 1995 TECHNICAL STUDIES AND RATIONALE FOR REANALYSIS

Riparian vegetation types within the CCAP area were initially mapped in 1995 by a team of consultants using black and white orthophotos taken in 1989 (NHC 1995). Vegetation was classified according to definitions established for a County-wide wetlands survey (Jones & Stokes Associates 1990), although the exact criteria used are no longer available. Changes in polygon boundaries the occurred between 1989 and 1994 were determined from color aerial photographs taken in 1994, and the 1989 map was updated accordingly in 1995.

Earlier aerial photos (e.g., 1937) were examined by the same consultant group to describe long-term changes in channel geomorphology, although quantitative vegetation data were not captured. However, the researchers did note that, along many reaches of the creek, the extent of riparian vegetation appeared to be at an all-time minimum that represented the end-point of the myriad alterations made to the creek beginning in the mid-1800s (NHC 1995).

Digital mapping and acreage determinations were made by Yolo County information technology staff. This initial mapping effort was conducted at the scale of the CCAP area, and included significant upland areas relatively far (and disconnected) from the channel and associated riparian areas (Fig. 3.1 in main report). Vegetation categories originally included Valley oak forest, cottonwood forest, mixed riparian forest, willow scrub, non-woody riparian vegetation, freshwater marsh, seasonal wetland, and ruderal wetlands, but were apparently reduced to four categories (riparian forest, oak woodland, willow scrub, and herbaceous) for mapping (NHC 1995).

The methodology used to draw the vegetation polygons, as well as to estimate acreage, is uncertain. Some degree of generalization occurred (e.g., edges between blue and yellow polygons are actually green, implying lines drawn on top of one another), and the degree of accuracy is almost uncertain. Subsequent reanalysis of these data, including digitizing of all vegetation polygons from a high-resolution scan of the original map and recalculation of patch areas using modern GIS technology, resulted in acreage estimated substantially different (often higher) than original estimates, which were likely underestimations (see main report and the *Reanalysis of 1995 Technical Studies Data* section below).

REANALYSIS OF 1995 TECHNICAL STUDIES DATA

In 2016, the Consulting Biologist obtained a scanned (600 dpi) version of the highest-quality paper copy of original Technical Studies vegetation map from the Yolo County Natural Resources Division (Fig. 3.1 in main report). The scanned map was then georectified in ArcGIS by the TAC Biologist, digitized to recreate the vegetation classes in digital format, and clipped to match the extent of the CCAP. No edits were made to vegetation classes or patch boundaries (i.e., no reclassification), since the aerial photography used to create the original maps was not available in digital format and since older methods of classification were originally used. Four vegetation classes (*herbaceous*, *willow scrub*, *riparian forest*, and *oak woodland*) were present within the CCAP area. A fifth class originally mapped in the Technical Studies, *gravel wash*, was not included due to its minimal vegetation.

As noted above, reanalysis suggested that the original Technical Studies underestimated acreage of all vegetation classes in the CCAP. For example, the original study estimated that approximately 200 ac. of riparian forest remained in the CCAP area in 1995; however, reanalysis of the same polygons in 2016 provided a much higher estimate of 616.35 ac of riparian forest. One possible explanation for this discrepancy could be that, while the polygons were drawn at the scale of the entire CCAP (see Fig. 3.1 in main report), the acreage values reported in the Technical Studies might have been estimates of only that vegetation that was present within the CCRMP portion of the CCAP area. For example, the 2016 reanalysis estimated that there were 262.56 ac. of riparian forest within the CCRMP portion of the CCAP area, which is much closer to the acreage of riparian forest reported in the original Technical Studies.

Methodological Limitations of 2006 Trend Analysis and Rationale for Reanalysis

A 10-year GIS-based analysis was undertaken by the TAC in 2006 to evaluate changes and trends in vegetation within the CCRMP portion of the CCAP area from 1996–2005 (Yolo County 2006). Vegetation was classified from black and white, high-resolution orthophotos taken in 2004. Unlike the baseline vegetation classification in the 1995 Technical Studies in which four vegetation classes were used, a single class ('mature woody vegetation') was used to lump together all woody vegetation greater than approximately 12-15 ft. in height. Stands of invasive giant reed and tamarisk were included, since the degree of intermixing with native vegetation made separation impractical. The rationale for this approach was well-described in the report; however, the methodology had several limitations that complicated assessment of changes in native vegetation:

- The 1995 Technical Studies used four vegetation classes, three of which were associated with woody vegetation (riparian forest, oak woodland, willow scrub). Each of the three classes most likely encompasses mature and immature woody vegetation. The 2006 study used one vegetation class for mature woody vegetation, but compared the results to the 'riparian forest' class acreage from 1995, which was itself likely underestimated (see *Methodological Limitations of 1995 Technical Studies* section above).
- The 1995 Technical Studies were conducted at the scale of the CCAP area (CCRMP and OCMP), while the 2006 study was conducted at the scale of the CCRMP. The comparison in woody vegetation acreage between the two time periods did not take this scale mismatch into account.

- Immature and/or short-statured woody vegetation, as well as herbaceous (non-woody) vegetation, provide substantial value to wildlife, invertebrates, and to fish via water shading. These vegetation types were excluded from the 2006 study, but were originally mapped in the 1995 Technical Studies.

Reclassification of 2005 Vegetation and Standardization of Vegetation Classes

These factors necessitated reanalysis of vegetation from this time period to facilitate comparison with data from the original 1995 Technical Studies (albeit reanalyzed). A complete reclassification of 2005 vegetation was conducted by the Consulting Biologist in 2016 using 2005 black and white aerial photography cross-checked with 2006 color aerial photography. Five vegetation classes were used: *herbaceous*, *scattered scrub*, *dense scrub*, *riparian forest*, and *oak woodland*. These classes were based on those used in the original Technical Studies, with the exception of scattered scrub and dense scrub. These woody vegetation classes represented an expansion of the original willow scrub class used in the 1995 Technical Studies, and reflected observations by the Consulting Biologist that both types of vegetation occurred in distinct patches throughout the CCAP. Supplementary data (e.g., LiDAR-derived elevation data) were used to assist with discrimination of dense scrub and riparian forest, which were often intermingled in mixed stands of vegetation. All vegetation was mapped, with the exception of scattered, low-growing patches of native Oregon false goldenaster (*Heterotheca oregona*) growing in near monoculture on gravel washes (analogous to the *gravel wash* vegetation class from the 1995 Technical Studies) concentrated in the Hungry Hollow and Madison reaches. The five vegetation classes described above were subsequently used for additional vegetation in more recent years as described below, and were ground-truthed during field work. See Figs. A1-1 through A1-4 below for representative photographs of each vegetation class.

FIGURE A1-1. REPRESENTATIVE PHOTOGRAPHS (2015–2016) OF RIPARIAN FOREST WITHIN THE CCAP AREA.

FIGURE A1-2. REPRESENTATIVE PHOTOGRAPHS (2015–2016) OF DENSE SCRUB (LEFT) AND OAK WOODLAND (RIGHT) WITHIN THE CCAP AREA.

FIGURE A1-3. REPRESENTATIVE PHOTOGRAPHS (2015–2016) OF SCATTERED SCRUB WITHIN THE CCAP AREA. Mulefat-dominated scrub on the channel floor (left) and yerba santa-dominated scrub on an upper bench (right).

FIGURE A1-4. REPRESENTATIVE PHOTOGRAPHS (2015–2016) OF HERBACEOUS HABITAT WITHIN THE CCAP AREA.
Upper left to lower right: upland restored grassland dominated by purple needlegrass (Stipa pulchra), grassland on lower terrace near channel dominated by creeping wildrye (Elymus triticoides), wetland sedge (Carex spp.), and a large patch of native sky lupine (Lupinus nanus).

Methodological Limitations of 2011 Transect Analysis and Rationale for Reanalysis

In 2011, some vegetation analysis was conducted by a previous biologist using a transect-based approach. Aerial imagery from 2011 was compared to imagery from 2010, and LiDAR data were also used to estimate vegetation heights into order to create two vegetation classes: Class 3 ASPRS (American Society of Photogrammetry and Remote Sensing) Low Vegetation (0.25' – 4.99' above bare ground), and Class 5 High Vegetation > 5' above bare ground). The former class was intended to represent understory tall grasses and shrubs, while the latter represented overstory saplings and trees. Data from the 2006 Yolo Natural Heritage Program was apparently intended to serve as a baseline for change, but it is unclear how these data were actually used.

As with the methodology implemented for the 2006 Trend Analysis, the rationale for the transect- and LiDAR-based methodology used in the 2011 was well-described in the report (Yolo County 2011). However, as was the case for the 2006 Trend Analysis, the methodology had several limitations that complicated assessment of changes in native vegetation:

- The two vegetation classes did not correspond to those used in the baseline 1995 Technical Studies, nor did they correspond to the single class used for the original 2006 Trend Analysis. This lack of continuity to previously-collected data confounded long-term analysis of vegetation trends.
- The two vegetation classes did not necessary correspond to ecologically valid habitat types (with corresponding differences in value for wildlife and invertebrates). For example, oak woodlands and dense scrub are both very different habitat types than riparian forests, yet were lumped together in the "high vegetation" class as vegetation > 5' in height.
- The transects only represented a small fraction (85.9 ac, or 3.6%) of the 2,324 ac. within the CCRMP boundary, and extrapolation of changes along the transects to the entire CCRMP area was problematic (as noted in the 2011 Annual Report).

Classification of 2010 Vegetation

These issues, coupled with a need for an intermediate time step between 2005 and 2015 vegetation for the purpose of trend analysis, necessitated a complete classification of 2010 vegetation from 2010 color aerial photography. Existing LiDAR data and color infrared photography from 2010 were used to assist with differentiating dense scrub and riparian forest. For example, LiDAR data helped discriminate taller trees characteristic of riparian forest from shorter, shrubbier vegetation characteristic of dense scrub. The five vegetation classes described above (Figs. A1-1 through A1-4) were used to ensure consistency.

Classification of 2015 Vegetation

Complete classifications of 2015 vegetation was also performed in 2016. In 2015, the County obtained high-resolution color aerial photography taken with UAVs through a contract with Airphrame. First return data from the 2015 UAV flight were used by the County GIS contractor to create an approximate surface of vegetation heights, which was used by the Consulting Biologist to assist with differentiating dense scrub and riparian forest for the 2015 dataset. As described above, vegetation classes were ground-truthed during field work, and representative photographs were taken of the five vegetation classes (Figs. A1-1 through A1-4).

APPENDIX 3.B – DETAILED RESULTS OF INTEGRATED ANALYSIS OF CHANGES AND TRENDS IN BIOLOGICAL RESOURCES ON LOWER CACHE CREEK, YOLO COUNTY, CA (1995–2016)

HISTORICAL PERSPECTIVE ON BIOLOGICAL RESOURCES ALONG LOWER CACHE CREEK

Changes and in biological resources on lower Cache Creek (1995-2016) were substantial, yet the changes that have occurred since the early- to mid-1800s have been even more pronounced. A brief review of the deeper history of the region provides additional context to changes subsequently describe over the past two decades.

Descriptions of riparian vegetation along Cache Creek prior to the 1900s are scarce, but generally give the impression that extensive riparian forests were common. An 1821 expedition by Spanish Conquistadors passed through present-day Yolo County, and expedition diaries describe lower Cache Creek as being surrounded by oak forests (Russell 1940; NHC 1995). An addition account from 1870 described the area as "well wooded" (NHC 1995). Bryan (1932) gives an account of an 1851 Mt. Diablo Meridian Line survey that crossed lower Cache Creek about two miles east of the present day I-505 Bridge. The survey documented a narrow, 99 ft. channel bracketed by 400 ft. and 1400 ft. bands of willows and cottonwoods that merged into banks of oaks. This observation stands in sharp contrast to the approximately 700 ft. wide channel and sparse riparian vegetation that characterize the same site today (Yolo County 2006). Other observations provide insight into large-scale clearing of woodlands in the region as land was being settled and converted to farms. The mid-19th century seems to have been a period of rapid acceleration in terms of landscape change (NHC 1995). For example, in an account from 1869, an observer noted that:

> *The traveler who visited this country fifteen years ago could not fail of being favorably impressed with its well wooded streams and tracks of oak timber which marked the old water courses. Should he return now, he would find but a small portion of this peculiar beauty remaining...Thousands of cords of oak have been destroyed in this country by the timber being felled for brush fences and rotting in that position…A few years hence and the effect of this wanton destruction will be felt, when Cache Creek and the plains shall be stripped of their groves and left bare and dry (Sprague and Atwell, 1869.)*

These accounts support the general hypothesis that riparian vegetation was historically dense and abundant along Cache Creek, spanning wide riparian corridors that surrounding multiple dynamic creek channels (WRAYC 2007). It can be reasonably assumed that native wildlife, fish, and invertebrates were abundant within these intact riparian habitats, as was the case throughout the Central Valley historically.

DETAILED MAPS OF 2015 VEGETATION

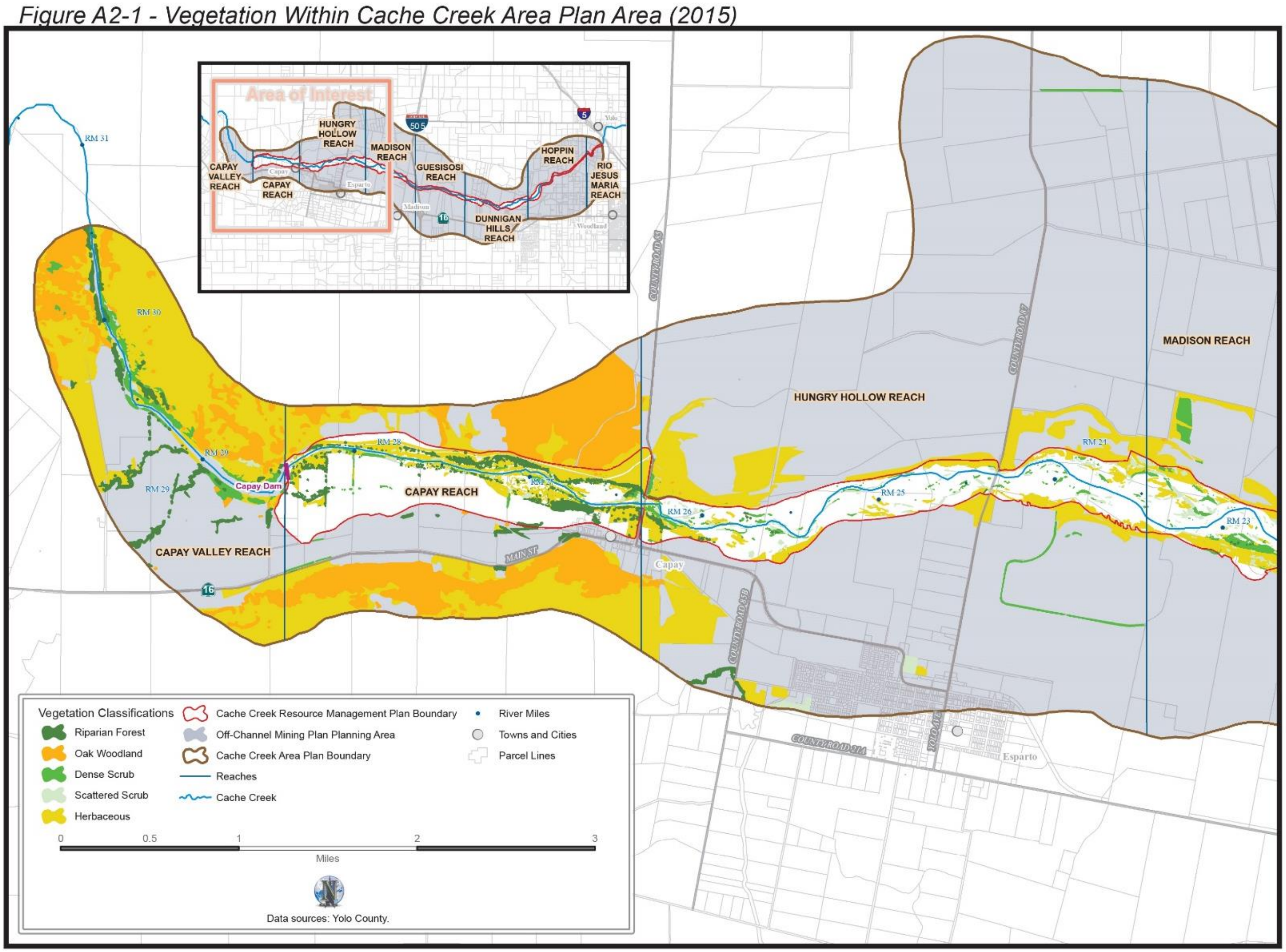

FIGURE A2-1: 2015 VEGETATION WITHIN THE UPSTREAM PORTION OF THE CCAP AREA.

Figure A2-2 - Vegetation Within Cache Creek Area Plan Area (2015)

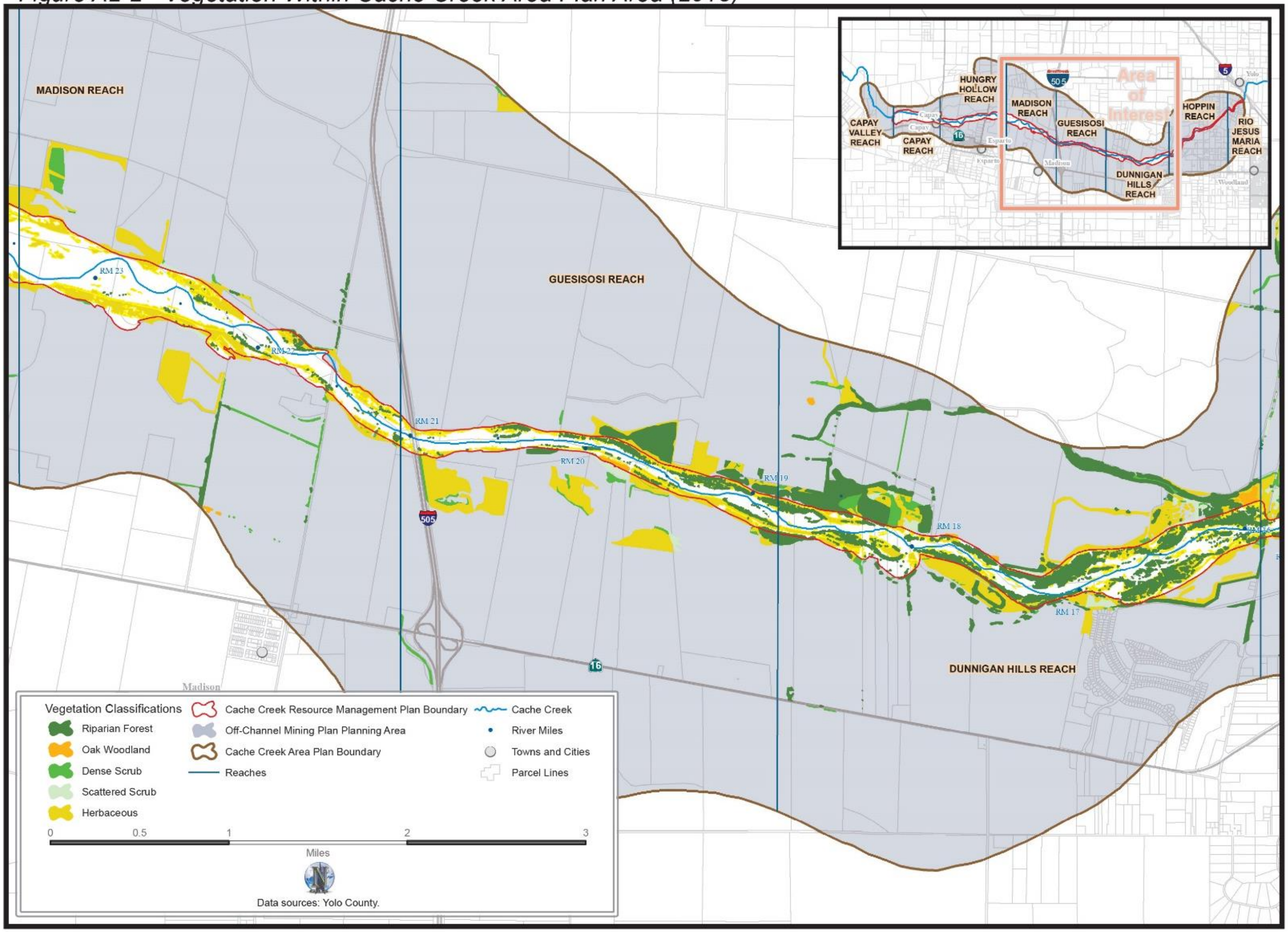

FIGURE A2-2: 2015 VEGETATION WITHIN THE MIDDLE PORTION OF THE CCAP AREA.

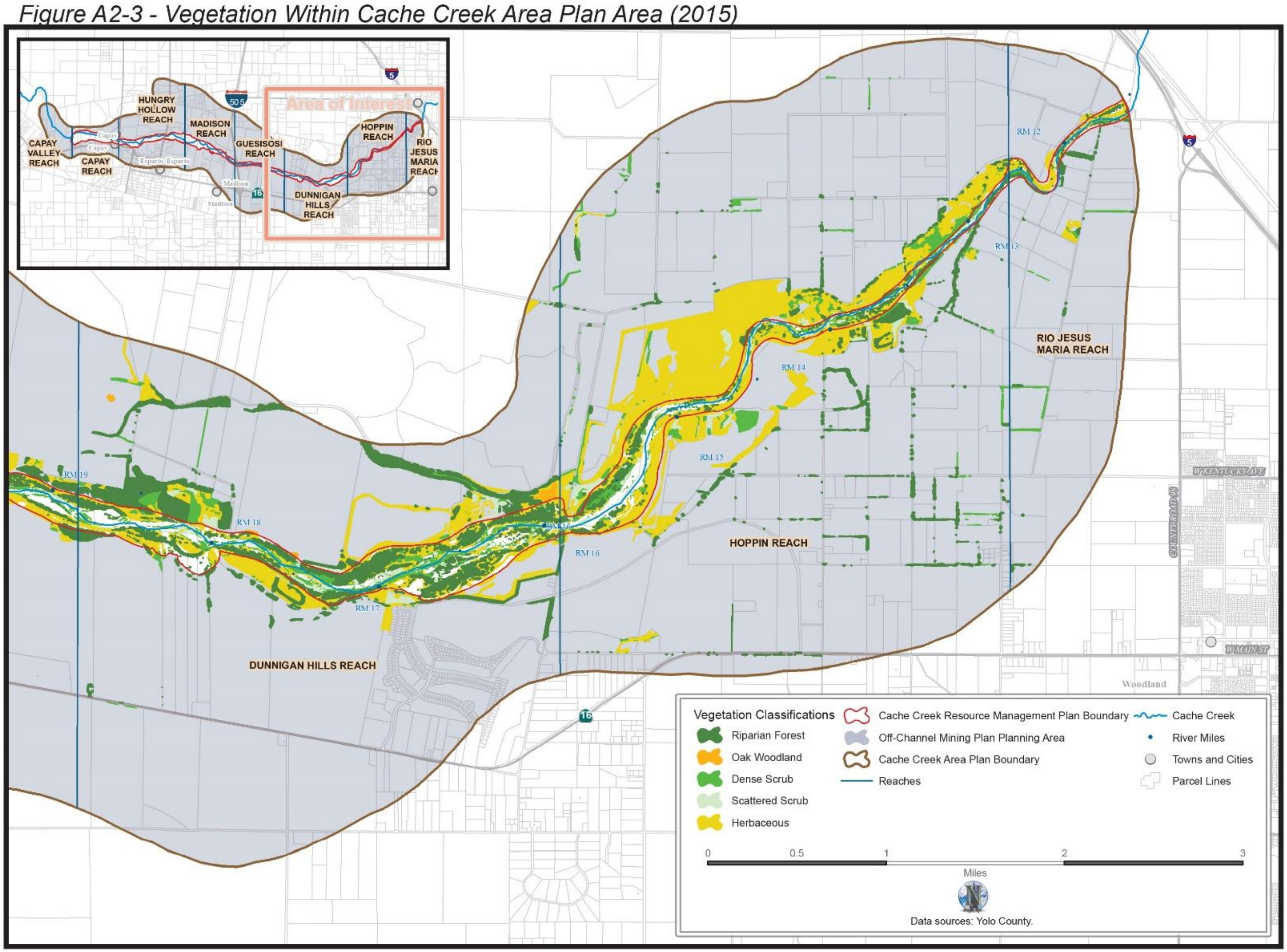

FIGURE A2-3: 2015 VEGETATION WITHIN THE DOWNSTREAM PORTION OF THE CCAP AREA.

SUMMARY TABLES OF OBSERVATIONS OF AMPHIBIANS, REPTILES, MAMMALS, BIRDS, INVERTEBRATES, AND FISH (1995–2016)

TABLE A2-1: SUMMARY OF NATIVE AMPHIBIAN OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
California toad	*Anaxyrus boreas halophilus*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
										Present (2015)	A. P. Rayburn, *pers. obs.* (2015)
										Present (2016)	A. P. Rayburn *pers. obs.* (2016)
California red-legged frog	*Rana aurora draytonii*	FT, SSC					Present (2010)				Elen and Yasuda (2010)
Pacific chorus frog	*Pseudacris regilla*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
							Present (2010)				Elen and Yasuda (2010)

[1]Observation implies potential presnece throughout reach

[2]Reference did not report reach in which species was observed

[3]FT = Federally threatened; SSC = California amphibian species of special concern

TABLE A2-2: SUMMARY OF SPECIAL-STATUS AND OTHER NOTABLE NATIVE REPTILE OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Alligator lizard	*Gerrhonotus multicarinatus*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
										Present (2015)	A. P. Rayburn, *pers. obs.* (2015)
										Present (2016)	A. P. Rayburn, *pers. obs.* (2016)
Garter snake	*Thamnophis* spp.	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
										Present (2015)	A. P. Rayburn, *pers. obs.* (2015)
										Present (2016)	A. P. Rayburn, *pers. obs.* (2016)
Gopher snake	*Pituphic metanolearus*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
King snake	*Lampropeltis getulus*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
Northern Pacific rattlesnake	*Crotalus oreganus oreganus*	None								Present (2011)	Yolo County (2011)
										Present (2015)	A. P. Rayburn, *pers. obs.* (2015)
										Present (2016)	A. P. Rayburn, *pers. obs.* (2016)
Western fence lizard	*Sceloporus occidentalis*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)
										Present (2015)	A. P. Rayburn, *pers. obs.* (2015)
										Present (2016)	A. P. Rayburn, *pers. obs.* (2016)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]FT = Federally threatened; SSC = California reptile species of special concern

TABLE A2-2 (CONT.): SUMMARY OF SPECIAL-STATUS AND OTHER NOTABLE NATIVE REPTILE OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Western pond turtle	*Actinemys marmorata*	SSC								Assumed present (1995)	NHC (1995)
							Present (1997)				Moyle and Marcheti (1998) Yolo County (1998)
							Present (unspecified date)				Cache Creek Conservancy (2016a)
			Present (2012)								Yolo County (2012)
					Present (2013)						Yolo County (2013)
					Present (2014)						Yolo County (2014)
			Present (2015)								Yolo County (2015)
			Present (2016)			Present (2016)		Present (2016)			Yolo County (2016)
Western rattlesnake	*Crotalus viridis*	None					Present (unspecified date)				Cache Creek Conservancy (2016a)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]FT = Federally threatened; SSC = California reptile species of special concern

TABLE A2-3: SUMMARY OF SPECIAL-STATUS AND NOTABLE NATIVE MAMMAL AND NONNATIVE WILD PIG OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
American badger	*Taxidea taxus*	SSC					Present (2015)				K. Hannon, *pers. comm.* (2016)
Bobcat	*Lynx rufus*	None					Present (2010)				Croom et al. (2010) Lambert and Culpepper (2010)
							Present (2011)			Present (2011)	McDonald-Ryan (2011) Taylor and Kennedy (2011) Yolo County (2011)
							Present (2012)				Pisano and Roberson (2012) Zajac and Mitrovich (2012)
							Present (2013)				Dunbar et al. (2013) Fussell and Wright (2013)
									Present (2015)		K. Hannon, *pers. comm.* (2016)
			Present (2015–2016)	Present (2015–2016)			Present (2015–2016)		Present (2015–2016)		B.N. Sacks, unpublished data (2016)
			Present (2016)								A.P. Rayburn, *pers. obs.* (2016)
Mountain lion	*Puma concolor*	None					Present (2011)				McDonald-Ryan (2011)
Ring-tailed cat	*Bassariscus astutus*	SFP								Potentially present (1995)	NHC (1995)
							Present (2011)				McDonald-Ryan (2011)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]SSC = California amphibian species of special concern; SFP = State fully protected species

TABLE A2-3 (CONT.): SUMMARY OF SPECIAL-STATUS AND NOTABLE NATIVE MAMMAL AND NONNATIVE WILD PIG OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Sacramento Valley red fox	*Vulpes vulpes* spp. *patwin*	None					Potentially present (2010)				Croom et al. (2010) Lambert and Culpepper (2010)
							Potentially present (2011)				McDonald-Ryan (2011)
							Potentially present (2013)				Fussell and Wright (2013)
									Potentially present (2015)		K. Hannon, *pers. comm.* (2016)
Wild pig	*Sus scrofa*	None					Present (2013)				Fussell and Wright (2013)
				Present (2015)							A. P. Rayburn, *pers. obs.* (2015)
			Present (2015–2016)								B. N. Sacks, unpublished data (2016)
				Present (2016)							A. P. Rayburn, *pers. obs.* (2016)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]SSC = California amphibian species of special concern; SFP = State fully protected species

TABLE A2-4: SUMMARY OF SPECIAL-STATUS NATIVE BIRD OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016); SEE TABLE A2-7 FOR ALL SPECIES OBSERVED.

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Bald eagle	*Haliaeetus leucocephalus*	SFP, SE		Present (within last 10 years)							Suzanne Ek, *pers. comm.* (2016)
Bank swallow	*Riparia riparia*	ST								Assumed present (1995)	NHC (1995)
							Present (1998)				Yolo County (1998)
					Present (1999)						Yolo County (1999)
							Present (1999-2001)				Truan (2002)
					Present (2007)						CDFW (2016)
										Present (2011)	Yolo County (2011)
					Present (2012)			Present (2012)			Yolo County (2012)
					Present (2013)			Present (2013)			Yolo County (2013)
					Present (2014)						Yolo County (2014)
								Present (2016)			Yolo County (2016)
Burrowing owl	*Athene cunicularia*	SSC		Present (1995)							Yolo County (1996)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]ST = State threatened; SE = State endangered; SSC = California bird species of special concern; SFP = State fully protected species

[4]"Modesto" population only

TABLE A2-4 (CONT): SUMMARY OF SPECIAL-STATUS NATIVE BIRD OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016); SEE TABLE A2-7 FOR ALL SPECIES OBSERVED.

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Golden eagle	*Aquila chrysaetos*	SFP		Present (1995)							Yolo County (1996)
Loggerhead shrike	*Lanius ludovicianus*	SSC		Present (1995)							Yolo County (1996)
							Present (1999-2001)				Truan (2002)
				Present (2004)							Truan (2004b)
Long-eared owl	*Asio otus*	SSC								Present (unspecified date)	Sally Barrett, *pers. comm.* (2016)
Northern harrier	*Circus cyaneus*	SSC					Present (unspecified date)				Cache Creek Conservancy (2016b)
				Present (1995)							Yolo County (1996)
							Present (1997)				Moyle and Marcheti 1998 Yolo County 1998
							Present (1999-2001)				Truan (2002)
				Present (2004)							Truan (2004b)
				Present (2007)							Yolo County (2009b)
										Present (2011)	Yolo County (2011)
				Present (2015)							A. P. Rayburn, *pers. obs.* (2015)
								Present (2016)			A. P. Rayburn, *pers. obs.* (2016)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]ST = State threatened; SE = State endangered; SSC = California bird species of special concern; SFP = State fully protected species

[4]"Modesto" population only

TABLE A2-4 (CONT): SUMMARY OF SPECIAL-STATUS NATIVE BIRD OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016); SEE TABLE A2-7 FOR ALL SPECIES OBSERVED.

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Song sparrow[4]	*Melospiza melodia*	SSC					Present (2011)				Point Blue (2011)
Swainson's hawk	*Buteo swainsoni*	ST					Present (unspecified date)				Cache Creek Conservancy (2016b)
										Assumed present (1995)	NHC (1995)
					Present (1995)		Present (1995)				Jones & Stokes (1995) Yolo County (1996)
							Present (1997)				Moyle and Marcheti (1998) Yolo County (1998)
							Present (1999-2001)				Truan (2002)
					Present (2001)						CDFW (2016)
					Present (2002)			Present (2002)			CDFW (2016)
					Present (2004)	Present (2004)	Present (2004)	Present (2004)			CDFW (2016)
						Present (2007)	Present (2007)	Present (2007)	Present (2007)		CDFW (2016)
					Present (2009)						CDFW (2016)
			Present (2010)	Present (2010)	Present (2010)	Present (2010)	Present (2010)	Present (2010)	Present (2010)		Yolo County (2012b) Cahill (2014)
							Present (2011)				Point Blue (2011)
										Present (2011)	Yolo County (2011)
										Present (2012)	Yolo County (2012)
										Present (2013)	Yolo County (2013)
										Present (2014)	Yolo County (2014)
										Present (2015)	Yolo County (2015)
										Present (2016)	Yolo County (2016)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]ST = State threatened; SE = State endangered; SSC = California bird species of special concern; SFP = State fully protected species

[4]"Modesto" population only

TABLE A2-4 (CONT): SUMMARY OF SPECIAL-STATUS NATIVE BIRD OBSERVATIONS1 WITHIN CCAP AREA (1995–2016); SEE TABLE A2-7 FOR ALL SPECIES OBSERVED.

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Tricolored blackbird	*Aegelaius tricolor*	SFP, SSC								Assumed present (1995)	NHC (1995)
							Present (2000)				Sally Barrett, *pers. comm.* (2016)
							Present (1999-2001)				Truan (2002)
					Present (2011)						CDFW (2016)
Vaux's swift	*Chaetura vauxi*	SSC					Present (1999-2001)				Truan (2002)
White-tailed kite	*Elanus leucurus*	SFP					Present (unspecified date)				Cache Creek Conservancy (2016b)
							Present (1995)				Jones and Stokes (1995)
							Present (1999-2001)				Truan (2002)
				Present (2004)							Truan (2004b)
							Present (2012)				Phillips and Roush (2012)
										Present (2015)	A. P. Rayburn, *pers. obs.* (2015)
								Present (2016)			Yolo County (2016)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]ST = State threatened; SE = State endangered; SSC = California bird species of special concern; SFP = State fully protected species

[4]"Modesto" population only

TABLE A2-4 (CONT): SUMMARY OF SPECIAL-STATUS NATIVE BIRD OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016); SEE TABLE A2-7 FOR ALL SPECIES OBSERVED.

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Yellow-headed blackbird	*Xanthcephalus xanothocephalus*	SSC					Present (2011)				Point Blue (2011)
										Present (2016)	A. P. Rayburn, *pers. obs.* (2016)
Yellow warbler	*Setophaga petechia*	SSC					Present (unspecified date)				Cache Creek Conservancy (2016b)
							Present (1999)				Truan (2002)
							Present (2011)				Point Blue (2011)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]ST = State threatened; SE = State endangered; SSC = California bird species of special concern; SFP = State fully protected species

[4]"Modesto" population only

TABLE A2-5: SUMMARY OF SPECIAL-STATUS NATIVE INVERTEBRATE OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT		Present (1995)			Assumed present (1995)				NHC (1995) Yolo County (1996)
				Assumed present (2004)							Truan (2004b)
								Present (2005)			CDFW (2016)
								Present (2011)			CDFW (2016)
							Assumed present (2016)				A. P. Rayburn, *pers. obs.* (2016)

[1]Observation implies potential presnece throughout reach

[2]Reference did not report reach in which species was observed

[3]FT = Federally threatened

TABLE A2-6: SUMMARY OF NATIVE FISH OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
California roach	*Hesperoleucus symmetricus*	SSC								Assumed present (1995)	NHC (1995)
							Present (2012)				Munguia et al. (2012)
Chinook salmon	*Oncorhynchus tsawytscha*	SSC				Present (2000)					Moyle and Ayers (2000)
Hardhead	*Mylopharodon conocephalus*	SSC								Assumed present (1995)	NHC (1995)
Sacramento blackfish	*Orthodon microlepidotus*	None					Present (1997)				Moyle and Marcheti (1998) Yolo County (1998)
Sacramento hitch	*Lavinia exilicauda*	SSC								Assumed present (1995)	NHC (1995)
				Present (1997)			Present (1997)				Moyle and Marcheti (1998) Yolo County (1998)
							Present (2010)				Ackerman et al. (2010)
						Present (2011)					Slotton and Ayers (2013)
						Present (2012)					Slotton and Ayers (2013)
							Present (2015)				P. Molye, *pers. comm.* (2015)
Sacramento pikeminnow	*Ptychocheilus grandis*	None								Assumed present (1995)	NHC (1995)
							Present (1997)				Moyle and Marcheti (1998) Yolo County (1998)
						Present (2000)					Slotton and Ayers (2004a)
			Present (2008)						Present (2008)		Stillwater Sciences (2009)
							Present (2010)				Ackerman et al. (2010)
							Present (2011)				Briggs et al. (2011)
			Present (2011)					Present (2011)			Slotton and Ayers (2013)
							Present (2015)				P. Molye, *pers. comm.* (2015)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]SSC = California fish species of special concern

TABLE A2-6 (CONT.): SUMMARY OF NATIVE FISH OBSERVATIONS[1] WITHIN CCAP AREA (1995–2016).

Common name	Scientific name	Special status[3]	Reach								Reference
			Capay	Hungry Hollow	Madison	Guesisosi	Dunnigan Hills	Hoppin	Rio Jesus Maria	Unspecified[2]	
Sacramento sucker	*Catostomus occidentalis*	None								Assumed present (1995)	NHC (1995)
						Present (1995)					Slotton et al. 1996
				Present (1997)			Present (1997)				Moyle and Marcheti (1998) Yolo County (1998)
						Present (2000)					Slotton and Ayers (2004a)
			Present (2008)	Present (2008)			Present (2008)				Stillwater Sciences (2009)
							Present (2011)				Briggs et al. (2011)
								Present (2011)			Slotton and Ayers (2013)
							Present (2015)				P. Molye, *pers. comm.* (2015)
				Present (2016)							M. Tompkins, *pers. obs.* (2016)
Speckled dace	*Rhinichthys osculus*	None								Present (1997)	Moyle and Marcheti (1998) Yolo County (1998)
							Present (2001)				Slotton and Ayers (2004a)
						Present (2012)					Slotton and Ayers (2013)
Threadfin shad	*Dorosoma petenense*	None	Present (2005)								Stillwater Sciences (2009)
White catfish	*Ameiurus catus*	None								Assumed present (1995)	NHC (1995)
					Present (2015)						Slotten and Ayers (2016)

[1]Observation implies potential presence throughout reach

[2]Reference did not report reach in which species was observed

[3]SSC = California fish species of special concern

TABLE A2-7: LIST OF ALL BIRD SPECIES OBSERVED WITHIN THE CCAP AREA (1995–2016).

Common name	**Scientific name**	**Common name**	**Scientific name**
Acorn woodpecker	*Melanerpes formicivorus*	Lazuli bunting	*Passerina amoena*
Allen's hummingbird	*Selasphorus sasin*	Lesser goldfinch	*Spinus psaltria*
American avocet	*Recurvirostra americana*	Lesser nighthawk	*Chordeiles acutipennis*
American bittern	*Botaurus lentiginosus*	Lewis's woodpecker	*Melanerpes lewis*
American coot	*Fulica americana*	Loggerhead shrike	*Lanius ludovicianus*
American goldfinch	*Spinus tristis*	Long-billed curlew	*Numenius americanus*
American kestrel	*Falco sparverius*	Long-eared owl	*Asio otus*
American pipit	*Anthus rubescens*	Mallard	*Anas platyrhynchos*
American robin	*Turdus migratorius*	Marsh wren	*Cistothorus palustris*
Anna's hummingbird	*Calypte anna*	Merlin	*Falco columbarius*
Ash-throated flycatcher	*Myiarchus cinerascens*	Mountain bluebird	*Sialia currucoides*
Bald eagle	*Haliaeetus leucocephalus*	Mourning dove	*Zenaida macroura*
Bank swallow	*Riparia riparia*	Nashville warbler	*Oreothlypis ruficapilla*
Barn owl	*Tyto alba*	Northern flicker	*Colaptes auratus*
Barn swallow	*Hirundo rustica*	Northern harrier	*Circus cyaneus*
Belted kingfisher	*Megaceryle alcyon*	Northern mockingbird	*Mimus polyglottos*
Bewick's wren	*Thryomanes bewickii*	Northern pintail	*Anas acuta*
Black phoebe	*Sayornis nigricans*	Northern rough-winged swallow	*Stelgidopteryx serripennis*
Black-chinned hummingbird	*Archilochus alexandri*	Northern shoveler	*Anas clypeata*
Black-crowned night heron	*Nycticorax nycticorax*	Nuttall's woodpecker	*Picoides nuttallii*
Black-headed grosbeak	*Pheucticus melanocephalus*	Oak titmouse	*Baeolophus inornatus*
Black-throated gray warbler	*Setophaga nigrescens*	Olive-sided flycatcher	*Contopus cooperi*
Blue grosbeak	*Passerina caerulea*	Orange-crowned warbler	*Oreothlypis celata*
Blue-gray gnatcatcher	*Polioptila caerulea*	Osprey	*Pandion haliaetus*
Brewer's blackbird	*Euphagus cyanocephalus*	Pacific wren	*Troglodytes pacificus*
Brown creeper	*Certhia americana*	Pacific-slope flycatcher	*Empidonax difficilis*
Brown-headed cowbird	*Molothrus ater*	Phainopepla	*Phainopepla nitens*
Bullock's oriole	*Icterus bullockii*	Pied-billed grebe	*Podilymbus podiceps*
Burrowing owl	*Athene cunicuiaria*	Red-breasted nuthatch	*Sitta canadensis*
Bushtit	*Psaltriparus minimus*	Red-breasted sapsucker	*Sphyrapicus ruber*
California gull	*Larus californicus*	Red-shouldered hawk	*Buteo lineatus*
California quail	*Callipepla californica*	Red-tailed hawk	*Buteo jamaicensis*
California scrub-jay	*Aphelocoma californica*	Red-winged blackbird	*Agelaius phoeniceus*
California thrasher	*Toxostoma redivivum*	Ring-billed gull	*Larus delawarensis*
California towhee	*Melozone crissalis*	Ring-necked pheasant	*Phasianus colchicus*
Canada goose	*Branta canadensis*	Rock pigeon	*Columba livia*
Cassin's vireo	*Vireo cassinii*	Ruby-crowned kinglet	*Regulus calendula*
Cattle egret	*Bubulcus ibis*	Rufous hummingbird	*Selasphorus rufus*
Cedar waxwing	*Bombycilla cedorrum*	Savanna sparrow	*Passerculus sandwichensis*
Chipping sparrow	*Spizella passerina*	Say's pheobe	*Sayornis saya*
Cliff swallow	*Petrochelidon pyrrhonota*	Sharp-shinned hawk	*Accipiter striatus*
Common gallinule	*Gallinula galeata*	Snowy egret	*Egretta thula*
Common merganser	*Mergus merganser*	Song sparrow	*Melospiza melodia*
Common raven	*Corvus corax*	Spotted sandpiper	*Actitis macularius*
Common yellowthroat	*Geothlypis trichas*	Spotted towhee	*Pipilo maculatus*
Cooper's hawk	*Accipiter cooperii*	Swainson's hawk	*Buteo swainsoni*
Dark-eyed junco	*Junco hyemalis*	Swainson's thrush	*Catharus ustulatus*
Double-crested cormorant	*Phalacrocorax auritus*	Townsend's warbler	*Setophaga townsendi*
Downy woodpecker	*Picoides pubescens*	Tree swallow	*Tachycineta bicolor*
Dusky flycatcher	*Empidonax oberholseri*	Tricolored blackird	*Aegalaius tricolor*
Eurasian collared dove	*Streptopelia decaocto*	Turkey vulture	*Cathartes aura*
European starling	*Sturnus vulgaris*	Vaux's swift	*Chaetura vauxi*
Forster's tern	*Sterna forsteri*	Violet-green swallow	*Tachycineta thalassina*
Fox sparrow	*Passerella iliaca*	Warbling vireo	*Vireo gilvus*
Golden-crowned sparrow	*Zonotrichia atricapilla*	Western bluebird	*Sialia mexicana*
Golden eagle	*Aquila chrysaetos*	Western gull	*Larus occidentalis*
Great blue heron	*Ardea herodias*	Western kingbird	*Tyrannus verticalis*
Great egret	*Ardea alba*	Western meadowlark	*Sturnella neglecta*
Greater white-fronted goose	*Anser albifrons*	Western sandpiper	*Calidris mauri*
Greater yellowlegs	*Tringa melanoleuca*	Western screech-owl	*Megascops kennicottii*
Great-horned owl	*Bubo virginianus*	Western tanager	*Piranga ludoviciana*
Great-tailed grackle	*Quiscalus mexicanus*	Western wood-pewee	*Contopus sordidulus*
Green heron	*Butorides virescens*	White-breasted nuthatch	*Sitta carolinensis*
Hairy woodpecker	*Picoides villosus*	White-crowned sparrow	*Zonotrichia leucophrys*
Hammond's flycatcher	*Empidonax hammondii*	White-tailed kite	*Elanus leucurus*
Hermit thrush	*Catharus guttatus*	White-throated swift	*Aeronautes saxatalis*
Hermit warbler	*Setophaga occidentalis*	Wild turkey	*Meleagris gallopavo*
Hooded merganser	*Lophodytes cucullatus*	Wilson's warbler	*Cardellina pusilla*
House finch	*Haemorhous mexicanus*	Wood duck	*Aix sponsa*
House sparrow	*Passer domesticus*	Wrentit	*Chamaea fasciata*
House wren	*Troglodytes aedon*	Yellow-billed magpie	*Pica nuttalli*
Hutton's vireo	*Vireo huttoni*	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Killdeer	*Charadrius vociferus*	Yellow warbler	*Setophaga petechia*
Lark sparrow	*Chondestes grammacus*	Yellow-rumped warbler	*Steophaga coronata*

CHAPTER 4

REVIEW OF ANNUAL RECOMMENDATIONS

4.1 Review of 2006 Cache Creek Status Report and Trend Analysis Recommendations

4.1.1 Status of Recommendations by TAC Hydraulic Engineer

3.2-1 Flood Monitoring: Implement a flood monitoring program in coordination with the Yolo County Flood Control and Water Conservation District, the City of Woodland, and emergency response partners. Monitoring and inspection during flood events provides valuable information about the impact of flood events on Cache Creek, including bank erosion, loss of vegetation, and damage to infrastructure. It also may provide useful information to emergency response partners.

There have not been any large (i.e. 5-year return interval or larger) flood events on Cache Creek since 2006. This recommendation should be implemented in the future, and in addition the CCAP should consider budgeting for members of the TAC to inspect Cache Creek in the aftermath of any event larger than a 5-year return interval.

3.2-2 Stream Flow Gages: Install stream flow gages at Capay and Madison. The CCRMP recommends the installation of additional stream flow gages within the CCRMP area to provide a more complete picture of how hydraulic processes in the creek operate. The new gages would complement existing stations at Rumsey and Yolo, and would have real-time telemetering capabilities.

This recommendation has not been implemented. A streamgage at the Capay Dam should be implemented as previously recommended.

3.4-1 Complete hydraulic (HEC-RAS) model: Utilize up-to-date digital terrain model (DTM) data, transect surveys, and stage data to develop a HEC-RAS model to evaluate increased flooding hazards related to changes in channel morphology.

The TAC Hydraulic Engineer is completing this task during 2016.

3.4-2 Flood Capacity: Work with the Cache Creek Conservancy to expand invasive vegetation removal efforts in the Jesus Maria and Hoppin subreaches to address channel flood capacity concerns.

3.5-1 Water Quality Standards: Incorporate regulatory standards that pertain to Cache Creek as they become available from regulatory agencies into the CCRMP Water Quality Monitoring Program. Provide information in the 2007 Annual Report about the relationship between water quality data and regulatory standards, as appropriate.

Where available, the TAC Hydraulic Engineer has compared CCRMP water quality monitoring data against relevant regulatory standards in this retrospective analysis.

3.5-2 Water Quality Analysis: Conduct further analysis of pH, ammonia nitrogen, nitrate nitrogen, total Kjeldahl nitrogen, total nitrogen, TPH as diesel, and fecal coliform to identify trends and determine if existing levels are negatively impacting agriculture or the environment. Focus coliform monitoring efforts on the areas between Capay Dam and Gordon Slough to help determine the source of high coliform counts in samples collected near the confluence of Gordon Slough and Cache Creek. Provide an update on these analyses in the 2007 annual report.

With the exception of fecal coliforms, these contaminants are not present in elevated levels in Cache Creek. The TAC Hydraulic Engineer recommends development of a plan to perform additional targeted fecal coliform sampling to attempt to determine the location of the source in Gordon Slough.

3.5-3 Water Quality Monitoring: Continue to refine the water quality constituents to better reflect likely contaminants. Sample collection testing constituents should reflect only those shown to be present in Cache Creek with an annual sampling of constituents listed on the EPA's most current list for surface water recommendations.

The TAC Hydraulic Engineer has refined the water quality monitoring program to better reflect contaminants that are present in 2014 and 2015, and recommends in this report that further streamlining of analytes be done.

3.5-4 Methyl mercury: Work with the Central Valley Regional Water Quality Control Board to develop a 20-year plan for reducing methyl mercury in fish tissue. 3.6-1 Constructed Wetlands Management: Investigate best management practices to reduce methylation of mercury in wetlands environments.

3.7-1 Mercury Total Maximum Daily Load (TMDL): Add three turbidity monitoring sites within the CCRMP area in 2006 such that the turbidity monitoring conducted by the County can take the place of site-by-site monitoring otherwise required by the new mercury TMDL standards.

Studies (CVRWQCB 2008) have shown that Cache Creek is a significant contributor of mercury to the San Francisco Bay-Delta, and that most of the mercury in Cache Creek originates far upstream of the CCRMP boundary. As projects involving wetlands or associated vegetation are proposed, efforts should be undertaken to minimize conditions favorable to methylation of mercury.

3.7-2 Turbidity vs. Total Suspended Solids (TSS): Evaluate whether the CCRMP requirements for sediment monitoring can be met with turbidity monitoring instead of sampling for total suspended solids, which the County currently conducts and is more costly and time consuming.

The TAC Hydraulic Engineer's retrospective on water quality monitoring does not show an adequate correlation between analysis of TSS and turbidity to warrant removal of TSS analysis from the water quality monitoring program.

4.1.2 Status of Recommendations by TAC Geomorphologist

4.1-1 Digital Terrain Model (DTM): Utilize light detection and ranging (LiDAR) imagery taken of the CCRMP area that will collect high-resolution elevation data for the creation of the 2006 DTM.

LiDAR surveys were completed in 2006 and 2011 and converted to DTMs. In addition, DTMS developed from aerial photography were completed in 1997, 1998, 2002, 2004, 2005, and 2010. An experimental, drone-based photogrammetry survey was completed in 2015, but the resulting data was not sufficient for creation of a DTM.

4.2-1 Volumetric Change: Utilize DTM data to conduct a quantitative assessment of significant volumetric changes in channel capacity and areas of excessive erosion between 1997 and 2006.

In support of this 2016 status and trends evaluation, we completed quantitative assessments of volumetric changes in channel morphology and identified areas of significant channel erosion and deposition. Specifically, we quantified erosion and deposition between 1997 and 2011, 1997 and 1998, 2002 and 2004, and 2010 and 2011. This report documents these evaluations and provides insights on both long-term and short-term changes in channel conditions caused by ongoing erosion and deposition.

4.4-1 Channel morphology: Survey transect locations to provide data necessary for calibration of a HEC-RAS model to evaluate increased flooding hazards related to changes in channel morphology.

The channel transects described in the 2006 status and trends report have not been surveyed since 2006. However, in support of this 2016 status and trends evaluation, we mapped changes in channel morphology using aerial photographs from 1993, 1996, 1998, 2005, 2006, 2010, 2011, and 2015 to identify areas of high, medium, and low levels of channel change. Further, as detailed in the Hydraulic Engineer status and trends evaluation, the current version of the HEC-RAS hydraulic model is two-dimensional and best developed with DTM data. The combination of high resolution aerial photograph and a DTM-based hydraulic model for Cache Creek eliminates the need for channel transect surveys.*3.2-1 Flood Monitoring: Implement a flood monitoring program in coordination with the Yolo County Flood Control and Water Conservation District, the City of Woodland, and emergency response partners. Monitoring and inspection during flood events provides valuable information about the impact of flood events on Cache Creek, including bank erosion, loss of vegetation, and damage to infrastructure. It also may provide useful information to emergency response partners.*

There have not been any large (i.e. 5-year return interval or larger) flood events on Cache Creek since 2006. This recommendation should be implemented in the future, and in addition the CCAP should consider budgeting for members of the TAC to inspect Cache Creek in the aftermath of any event larger than a 5-year return interval.

4.1.3 Status of Recommendations by TAC Riparian Biologist

5.2-1 Utilize new technology for improved monitoring and analysis: Conduct digital color aerial photography and utilize Light Detection and Ranging (LiDAR) imagery in 2006 to provide more detailed and accurate analysis of riparian growth trends. Once the mapping process has been adapted for these new technologies, monitoring studies can occur at a much finer level of spatial accuracy. In addition, Yolo County can distinguish various plant communities utilizing the imagery and monitor vegetative growth over time. Use of LiDAR technology also will decrease the time needed for annual updating in comparison to previous digitization methods.

This recommendation has been implemented. High-resolution color photography has been collected when appropriate since 2006, in addition to LiDAR data and multispectral imagery, although the latter two types of data have not been collected as regularly as aerial photography due to budgetary constraints. It is recommended that LiDAR data be collected concurrently with aerial photography in future years, especially since the cost of such data collection has decreased dramatically.

5.2-2 Mapping guidelines: Set specific guidelines for preparing vegetation mapping and riparian vegetation surveys to ensure consistency in data collection.

This recommendation has been implemented. Standardized vegetation mapping methods have now been established and implemented as of 2015 for native and nonnative vegetation, and should be used in the future to assess changes and trends in both vegetation types.

5.2-3 Increase monitoring detail: Utilize LiDAR imagery for vegetation mapping so Yolo County can monitor riparian community types and growth as well as vegetative coverage.

This recommendation has been partially implemented. LiDAR data are useful for classifying native vegetation types from high-resolution aerial photography, but are not sufficient alone based on the updated vegetation mapping methods developed in 2015.

5.3-1 Monitoring standards: Develop a standard method and process for monitoring human-assisted restoration projects within the CCRMP area that would allow for comparative analysis of projects and provide guidance for future CCRMP area project development consistent with CCRMP goal 4.2-5. During the first few years of plant establishment, the project proponent should count the principal tree and shrub species for survival rate. The project proponent should use this information to determine if some areas are more productive than others. Relative growth rates would also provide indication of site suitability. After a number of years of good growth, percentage of cover in restored areas could be utilized to monitor established vegetation.

This recommendation has not been implemented. Standardized performance criteria and monitoring methods for habitat restoration projects within the CCAP area were recommended in 2015 and as a component of this report. It is strongly recommended that Cache Creek

Conservancy staff collaborate with Yolo County and Yolo County RCD staff to develop and implement such criteria and methods as soon as possible.

5.4-1 Color aerial photography: Utilize color aerial photography for tamarisk monitoring to assist in determining annual action plans for tamarisk removal programs throughout Cache Creek watershed and to provide a method of tracking the relative success of invasive species removal over time. Tamarisk and arundo removal outside of the CCRMP area is important because tamarisk and arundo seeds from upstream can float down and reestablish plants within the CCRMP area.

This recommendation has been partially implemented. Color aerial photography has been used to verify in-field mapping of invasive plant species. Field surveys are necessary since many invasive species occur as individual plants or small patches that are not distinguishable from aerial photography.

4.2 Review of Annual Report Recommendations (1999-2015)

An annotated matrix containing the status of TAC recommendations from Annual Reports dating back to 1999 can be found on the following pages.

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

No.	YEAR	RECOMMENDATION	LOCATION / AREA	CATEGORY	DICIPLINE	STATUS								GEOMORPH STATUS NOTE (TOMPKINS)	HYDRO STATUS NOTE (FRANK)	BIO STATUS NOTE (RAYBURN)	ADDITIONAL NOTE / COMMENTS
						1999	2006	2010	2011	2012	2013	2014	2015				
98-1	1998	Develop a set of standardized conditions of approval for flood hazard permits within the CCRMP area.	CCRMP	Procedural	Admin	Completed											
98-2	1998	Create and over-the-counter permit to construct low-flow, temporary stream crossings.	CCRMP	Procedural	Admin	Completed											Idea was to allow farmers better access in areas where bridges are far apart during spring plantings.
98-3	1998	Create a standard hold harmless form for property owners on projects where the County is coordinating channel improvements. Liability issues have been a recurring issue on channel improvement projects that have resulted in lengthy delays.	CCRMP	Procedural	Admin	Completed											
98-4	1998	Obtain a general 401 Certification from the Regional Water Quality Control Board to reduce costs and streamline the permitting process.	CCRMP	Procedural	Admin	Completed			In Progress (Renewal Process)				Completed				
98-5	1998	Petition the State Mines and Geology Board for an exemption from SMARA for the CCRMP.	CCRMP	Procedural	Admin	In Progress	Completed										
98-6	1998	Establish monitoring plots for vegetation in lieu of the 5-year biological survey.	CCRMP	Monitoring	Biology		Completed (2002)									With modern technology (e.g., high-resolution digital photography collected via fix-wing aircraft and UAVs, LiDAR, mobile mapping devices for use during field surveys, etc.); large-scale surveys of vegetation every five years are logistically and financially feasible. Surveys are conducted according to standardized methods developed in 2015/2016, and involve collection of aerial imagery, GIS-based vegetation classification, and field-surveys to confirm habitat types. Monitoring plots are still recommended as complementary methods for fine-scale vegetation monitoring.	The 1998 Annual Report (p. 7) states that "performing an area-wide biological survey every five years...would be expensive and would not provide the annual data necessary to evaluate incremental vegetative success. Representative plots would provide greater detail in a more timely manner." Veg transects were created and have been used most recently in Erik Ringelberg's work as Biologist. See also 99-7 and 2010.B.14
98-7	1998	Change the water quality constituents to better reflect likely contaminants.	CCRMP	Monitoring	Hydrology	Completed								Program has been collecting data on both total Boron and total K nitrogen since 2000. (MT)	This recommendation has been implmemented multiple times in the past few years. The WQ monitoring program is trimmed to a minimum at this point.		
98-8	1998	Allow TAC to develop feasible alternatives to using peizometers to monitor groundwater levels.	CCRMP	Monitoring	Hydrology	In Progress					N/A			Peizometers were deemed too expensive and too easily damaged in flood events. MT not sure if this recomm is still relevent. Producers well data now in WRID as well.	There are adequate monitoring wells/data from producers facilities and CA state database. Recommendation should be closed.		
98-9	1998	Monitor previously approved projects within the CCRMP area to learn which methods of erosion control, stream stabilization, and revegetation are most successful.	CCRMP	Monitoring	TAC	In Progress								Should be done through historical aerial photos. (MT)		This recommendation remains relevant, as post-implementation monitoring is critical to evaluating the success of such projects. Additional recommendations for monitoring restoration projects are included in the 2015 and 2016 Annual Reports, and in the various reports and plan revisions associated with the 2016 CCAP Update.	
98-10	1998	Install stream gauges at Capay and Madison with real-time telemetering capabilities.	CCRMP	Monitoring	Hydrology	In Progress								Existing guages work fine - these might improve spatial resolution (MT) - check with EL.	This is a good recommendation that has never been implemented due to funding/O&M constraints.		This recommendation has not been implemented. A streamgage at the Capay Dam should be implemented as previously recommended.
98-11	1998	Capay Bridge Erosion Control: Remove gravel bar and use material to construct spurs on the north bank upstream of Capay Bridge (CR 85). Revegetate areas between spurs.	Capay Reach	Channel Improvement	TAC	In Progress					N/A						Not noted in any recent Creek Walk - no longer applicable?
98-12	1998	Channel stabilization upstream of I-505 bridge: relocate the low-flow channel, construct gravel spurs and concrete rip-rap. Regrade slopes and revegetate slopes and areas between spurs.	Madison Reach	Channel Improvement	TAC	Completed											
98-13	1998	Convert the Coors basin to seasonal wetlands. Expand existing shallow wetlands habitat, provide filtration and minor recharge of water from Gordon Slough.	Dunnigan Hills Reach	?	Biology, Hydrology	Completed									Completed.		
98-14	1998	Remove stream banks that separate isolated areas from the main creek channel to provide additional flood capacity, create new expansion areas for riparian vegetation, and reduce velocities.	CCRMP	Channel Improvement	TAC	Completed										Some banks were removed or breached since 1998 to facilitate floodplain reconnection in some downstream reaches; the exact locations are likely described in the master project list. It is unknown how the success of such projects were evaluated, especially in terms of flood capacity and velocity reduction.	
98-15	1998	Revegetate in appropriate areas.	CCRMP	Channel Improvement	Biology	Completed										The general recommendation still applies as of 2016, and will likely be a permanent recommendation for the CCAP. See recommendation No. 98-9 above for details about recommended restoration methods.	
98-16	1998	Erosion control upstream of Moore's Crossing (approx. halfway between I-505 and CR 94B)	Dunnigan Hills Reach	Channel Improvement	TAC	Completed											

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

No.	YEAR	RECOMMENDATION	LOCATION / AREA	CATEGORY	DICIPLINE	STATUS								GEOMORPH STATUS NOTE (TOMPKINS)	HYDRO STATUS NOTE (FRANK)	BIO STATUS NOTE (RAYBURN)	ADDITIONAL NOTE / COMMENTS
						1999	2006	2010	2011	2012	2013	2014	2015				
98-17	1998	Clear tamarisk and giant reed in selected areas.	CCRMP	Channel Improvement	TAC	In Progress										This recommendation still applies as of 2016, although the extent of these two invasive plant species has been greatly reduced within the CCAP area (see Rayburn 2016 report detailing results of a CCRMP-wide invasive species survey) since 1998. However, populations still remain in within the CCRMP area, and extensive populations begin just upstream of the Capay Dam. A updated framework for invasive species treatment and monitoring was developed in 2016 by the TAC Biologist (Rayburn 2016).	
98-18	1998	Obtain critical lands and/or easements from willing sellers to preserve riparian habitat for public enjoyment and to form areas of continuous protection.	CCRMP	Restoration	All	Completed									Completed.	Completed, but additional land acquisition opportunities will likley arise in the future and should be prioritized.	Parkway Plan
99-1	1999	Acquire a portable water quality sampling machine	CCRMP	Monitoring	Hydrology		Completed								Completed.		
99-2	1999	Rezone the following properties to include an Open Space (OS) overlay zone: Millsap, CCNP, Correll, and Rodgers.	CCRMP	Procedural	Admin												
99-3	1999	Restrict incompatible materials from being used as riprap in the channel	CCRMP	Procedural	Admin												
99-4	1999	Survey and paint elevation marks on the abutments of County bridges to provide more accurate readings during flood events.	CCRMP	Monitoring	Hydrology, Geomorphology										This is a good recommendation that should be carried forward and implemented pending approval from the bridge owners.		
99-5	1999	Create a Cache Creek website that provides info on monitoring, studies, and restoration activities	CCRMP	Monitoring	TAC		Completed								Completed.		
99-6	1999	Digitize historic contour maps (from 1980-97)	CCRMP	Monitoring	TAC												
99-7	1999	Establish stream transects to monitor plant colonization and success, instead of test plots. (See No. 98-6)	CCRMP	Monitoring	TAC		Completed (2002)									This idea was explored in the 2000s, but not continued. Regular monitoring of the entire CCAP area is now feasible, although monitoring plots or transects could be established to track fine-scale changes in vegetation. See No. 98-6.	Also see No 98-6 and 2010.B.14
99-8	1999	Develop and review HEC models for lower Cache Creek	CCRMP	Monitoring	Geomorphology					In Progress					As part of the 2016 CCAP update, this has been completed and a report is forthcoming.		Mentions that cessation of mining in Creek has led to aggradation and loss of flood capacity/freeboard. Listed in 99, 2006
99-9	1999	Revegetate in appropriate areas: upstream of I-505 is a priority	CCRMP	Monitoring	Biology		In Progress									Upstream of I-505 remains a priority, but other priority restoration projects have been identified as of 2016. See No. 98-9 for details about recommended restoration monitoring methods.	
99-10	1999	Obtain critical lands and/or easements from willing sellers to preserve riparian habitat for public enjoyment and to form areas of continuous protection.	CCRMP	Restoration	TAC												Duplicate of 98-18.
06-3.2-1	2006	Implement a flood monitoring program, including monitoring and inspecting during flood events.	CCRMP	Monitoring	TAC				Complete						Completed.		There have not been any large (i.e. 5-year return interval or larger) flood events on Cache Creek since 2006. This recommendation should be implemented in the future, and in addition the CCAP should consider budgeting for members of the TAC to inspect Cache Creek in the aftermath of any event larger than a 5-year return interval.
06-3.4-1	2006	Remove invasives in the Jesus Maria and Hoppin reaches to improve flood capacity.	Jesus Maria, Hoppin	Channel Improvement	Geomorphology, Biology			In Progress								This recommendation still applies as of 2016, although the extent of invasive plant species has been reduced in this region. See No. 98-17.	
06-3.5-1	2006	Incorporate regulatory standards into Water Quality Monitoring as they become available.	CCRMP	Monitoring	Hydrology			In Progress						Should be done periodically	This is an ongoing process evaluated by the TAC Hydraulic Engineer on a regular basis.		Where available, the TAC Hydraulic Engineer has compared CCRMP water quality monitoring data against relevant regulatory standards in this retrospective analysis.
06-3.5-2	2006	Conduct further analysis of pH, ammonia nitrogen, nitrate nitrogen, total K nitrogen, total nitrogen, TPH (as diesel), and fecal coliform	CCRMP	Monitoring	Hydrology									Still needed?	The WQ monitoring program and its constituents for analysis have been extensively evaluated and modified in the last 3 years.		With the exception of fecal coliforms, these contaminants are not present in elevated levels in Cache Creek. The TAC Hydraulic Engineer recommends development of a plan to perform additional targeted fecal coliform sampling to attempt to determine the location of the source in Gordon Slough.

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

No.	YEAR	RECOMMENDATION	LOCATION / AREA	CATEGORY	DICIPLINE	STATUS 1999	2006	2010	2011	2012	2013	2014	2015	GEOMORPH STATUS NOTE (TOMPKINS)	HYDRO STATUS NOTE (FRANK)	BIO STATUS NOTE (RAYBURN)	ADDITIONAL NOTE / COMMENTS
06-3.5-3	2006	Refine water quality constituents to better reflect likely constituents	CCRMP	Monitoring	Hydrology					Completed				Should be done periodically - next review in 2016?	The WQ monitoring program and its constituents for analysis have been extensively evaluated and modified in the last 3 years.		The TAC Hydraulic Engineer has refined the water quality monitoring program to better reflect contaminants that are present in 2014 and 2015, and recommends in this report that further streamlining of analytes be done.
06-3.5-4	2006	Work with CVRWQCB to develop 20-year plan for reducing methyl mercury in fish tissue	CCRMP	Monitoring	Hydrology									Area of program responsibility?	These recommendations do not appear to be the responsibility of the CCRMP and outside entities have been brought in to do studies (Slotton). The TAC Hydraulic Engineer stays up to date with these studies.		Studies (CVRWQCB 2008) have shown that Cache Creek is a significant contributor of mercury to the San Francisco Bay-Delta, and that most of the mercury in Cache Creek originates far upstream of the CCRMP boundary. As projects involving wetlands or associated vegetation are proposed, efforts should be undertaken to minimize conditions favorable to methylation of mercury.
06-3.6-1	2006	Investigate best management practices to reduce methylation of mercury in wetlands	CCRMP	Monitoring	Hydrology, Biology									Area of program responsibility?	These recommendations do not appear to be the responsibility of the CCRMP and outside entities have been brought in to do studies (Slotton). The TAC Hydraulic Engineer stays up to date with these studies.		
06-3.7-1	2006	Mercury TDML: Add three turbidity monitoring sites to conform to new mercury TDML standards	CCRMP	Monitoring	Hydrology									Area of program responsibility?	This is probably not the responsibility of the CCRMP.		
06-3.7-2	2006	Examine whether TSS monitoring can be replaced with turbidity monitoring. Turbidity monitoring is cheaper and easier but may/may not comply with CCAP standards	CCRMP	Monitoring	Hydrology										Previously resolved per the notes in this table.		The TAC Hydraulic Engineer's retrospective on water quality monitoring does not show an adequate correlation between analysis of TSS and turbidity to warrant removal of TSS analysis from the water quality monitoring program.
06-4.1-1	2006	Digital Terrain Model (DTM) - Use LiDAR data to create a 2006 DTM	CCRMP	Modeling	Geomorphology									Complete	A 2011 DEM was created and a new one will be created in 2017.		LiDAR surveys were completed in 2006 and 2011 and converted to DTMs. In addition, DTMS developed from aerial photography were completed in 1997, 1998, 2002, 2004, 2005, and 2010. An experimental, drone-based photogrammetry survey was completed in 2015, but the resulting data was not sufficient for creation of a DTM.
06-4.2-1	2006	Use DTM data to conduct a quantitative assessment of significant volumetric changes in channel capacity and areas of excessive erosion between 1997 and 2006	CCRMP	Modeling	Geomorphology									Complete through 2011			
06-4.4-1	2006	Channel morphology - survey transect locations to provide data necessary for calibration of a HEC-RAS model	CCRMP	Modeling	Geomorphology										No longer necessary due to switch to 2D model that requires continuous DEM. DEMs are regularly produced as part of the program.		The channel transects described in the 2006 status and trends report have not been surveyed since 2006. However, in support of this 2016 status and trends evaluation, we mapped changes in channel morphology using aerial photographs from 1993, 1996, 1998, 2005, 2006, 2010, 2011, and 2015 to identify areas of high, medium, and low levels of channel change. Further, as detailed in the Hydraulic Engineer status and trends evaluation, the current version of the HEC-RAS hydraulic model is two-dimensional and best developed with DTM data. The combination of high resolution aerial photograph and a DTM-based hydraulic model for Cache Creek eliminates the need for channel transect surveys.
06-5.2-1	2006	Conduct digital aerial photography and utilize LiDAR imagery to improve accuracy and detail	CCRMP	Monitoring	Biology		Completed				In Progress					Ongoing.	
06-5.2-2	2006	Set mapping guidelines: specific guidelines for vegetation mapping and riparian surveys to ensure consistency in data collection	CCRMP	Monitoring	Biology											Completed in 2016. See No. 98-6.	
06-5.3-1	2006	Develop a standard method and process for monitoring human-assisted restoration projects that will allow for comparative analysis and provide guidance for future projects	CCRMP	Monitoring	TAC										This is a vague recommendation with unknown scope and funding to develop.	See No. 98-9.	
06-5-4.1	2006	Use color aerial photography for tamarisk monitoring	CCRMP	Monitoring	Biology		Completed									Color aerial photography is now used inform field-based invasive species monitoring; see No. 98-17.	On-going task
06-6.1-1	2006	Resource agency coordination with landowners to promote and implement invasive species removal program	Capay Reach	Channel Improvement	Biology			In Progress								Ongoing. Landowner engagement has been largely successful as a component of the invasive species management program. Some large patches of arundo and tamarisk remain on properties to which the County and the Cache Creek Conservancy have been unable to access due to a lack of landowner permission.	
06-6.1-2	2006	Coordinate invasive species removal with riparian restoration projects	Capay Reach	Channel Improvement	Biology						In Progress					Ongoing. Strongly recommended as part of the 2016 CCAP Update . See No. 98-17.	
06-6.1-3	2006	Use bioengineering methods for erosion control	Capay Reach	Channel Improvement	TAC										This is a vague recommendation with unknown scope and funding to develop.		

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

No.	YEAR	RECOMMENDATION	LOCATION / AREA	CATEGORY	DICIPLINE	STATUS 1999	2006	2010	2011	2012	2013	2014	2015	GEOMORPH STATUS NOTE (TOMPKINS)	HYDRO STATUS NOTE (FRANK)	BIO STATUS NOTE (RAYBURN)	ADDITIONAL NOTE / COMMENTS
06-6.1-4	2006	PG&E Palisades: coordinate a solution to exposed pipeline and concrete blanker conditions	Capay Reach	Channel Improvement	TAC					Completed					Ongoing discussions with PG&E regarding solution to the Palisades have been occuring as of 2016.		FHDP issued in 2012
06-6.1-5	2006	RM 26.6: Erosion on south bank - determine if it has the potential to endanger infrastructure. Coordinate erosional control project with landowner including mid-channel bar alterations	Capay Reach	Channel Improvement	TAC												
06-6.1-6	2006	Capay Bridge: Monitor aggradation at the Capay Bridge and work with PPW on channel reorientation and/or sediment removal to address adverse orientation of the low-flow channel. Explore habitat restoration opportunities up or downstream in conjunction with any erosion control project	Capay Reach	Channel Improvement	TAC												
06-6.2-1	2006	Erosion control: protect infrastructure by installing "hard points" such as spur dikes or protected banks. Ensure that future erosion control projects adjacent to the low-flow channel require reinforcement of the toe as regular maintenance.	Hungry Hollow	Channel Improvement	TAC										The current TAC does not recommend installation of hard points.		
06-6.2-2	2006	Human-Assisted Habitat Restoration: Assess soil conditions and water requirements for plant species specified in projects. Include soil amendments or topsoil when planting and ensure the presence of a water source	Hungry Hollow	Channel Improvement	Admin			In Progress								Ongoing. In general, this recommendation is part of the current approach to restoration implementation. Also see No. 98-9.	
06-6.2-3	2006	Capay Open Space Park (RM 26.3): Complete park plan implementation including additional trails and handicap access to Cache Creek	Hungry Hollow	Parkway	Admin				Completed								
06-6.2-4	2006	Granite Construction Bank Stabilization Project (RM 25.7): Monitor reconstruction of the bank toe along the Granite property to protect the upper bank	Hungry Hollow	Channel Improvement	Geomorphology		Completed							Continue to monitor. Expect action required after WY 2017 high flows.			
06-6.2-5	2006	Jensen Site (RM 25.4): Evaluate the cause of the projects failure with project designers and landowner. Establish guidelines for repair or replacement.	Hungry Hollow	Channel Improvement	TAC										The Jensen property remains an erosion issue with annual monitoring. Any stabilization project will be reviewed by the TAC and subject to 2016 Channel Form Template conformity.		
06-3.2-6	2006	Esparto Bridge (CR 87): Implement preventative erosion control measures to protect public infrastructure and evaluate habitat restoration opportunities	Hungry Hollow	Channel Improvement	TAC										Recent observations have not identified an imminent need for a stabilization project.		
06-6.3-1	2006	Lower Madison habitat restoration: Look for habitat restoration and enhancement opportunities to connect existing riparian vegetation in the lower reach	Madison Reach	Restoration	Biology												
06-6.3.2	2006	Grube-Payne Site (RM 22.3-22.1): Work with landowner to develop a restoration project on 20 ac or bank terrace to promote a vegetated corridor for both habitat value and erosion control	Madison Reach	Channel Improvement	Geomorphology, Biology			Completed							Completed.		
06-6.3-3	2006	Grube-Payne Site (RM 22.1): Monitor reconstruction of agricultural tailwater pipe to ensure compliance with specifications detailed in the original design & prevent further erosion	Madison Reach	Channel Improvement	Geomorphology, Biology												
06-6.3-4	2006	Grube-Payne Site (RM 21.8): Work with landowner to develop a restoration project on 24 ac or bank terrace to promote a vegetated corridor for both habitat value and erosion control	Madison Reach	Channel Improvement	Geomorphology, Biology											Potentially completed. Likely described in master list of projects.	
06-6.3-5	2006	Old Madison Bridge Site/Dunbar (RM 21.5): Erosion control project that deflects the energy of the channel meander located upstream of the Dunbar site and reform the existing spur dike at the Dunbar site to stabilize the north bank	Madison Reach	Channel Improvement	Geomorphology, Biology									Continue to monitor.			
06-6.3-6	2006	I-505 Bridge area (RM 21): Work with Syar and landowner to provide soil and plantings on upper portions of rip-rapped slopes. Improve habitat at spur dikes	Madison Reach	Channel Improvement	Geomorphology, Biology											Potentially completed. Likely described in master list of projects.	
06-6.4-1	2006	Bank stabilization in Guesisosi reach should include toe bank protection and vegetation. Lots of restoration opportunities with available groundwater.	Guesisosi Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

No.	YEAR	RECOMMENDATION	LOCATION / AREA	CATEGORY	DICIPLINE	STATUS 1999	2006	2010	2011	2012	2013	2014	2015	GEOMORPH STATUS NOTE (TOMPKINS)	HYDRO STATUS NOTE (FRANK)	BIO STATUS NOTE (RAYBURN)	ADDITIONAL NOTE / COMMENTS
06-6.4-2	2006	Guesisosi Reach-Upper South Bank: Assist property owner to develop a plan to address bank erosion and required mining setbacks.	Guesisosi Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
06-6.5-1	2006	RM 18.6-18.1: Spur dikes have eroded significantly. Bank is vulnerable to erosion. Need to assess further stabilization of the bank to protect Moore's siphon.	Dunnigan Hills Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
06-6.5-2	2006	Moore's Siphon (RM 18): Assist YCFCWCD is developing a long-term solution to the Moore's siphon crossing	Dunnigan Hills Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
06-6.6-1	2006	Stephen's Bridge (CR 94B / RM 15.9): Look at preventative measure to reduce erosion potential at bridge. Look at habitat restoration opportunities	Hoppin Reach	Channel Improvement	TAC										Recent observations have not identified an imminent need for a stabilization project.		
06-6.6-2	2006	Correll Pond (RM 13.8): Address erosion of the embankment adjacent to the overflow structure	Hoppin Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
06-6.6-3	2006	Correll -Rodgers Habitat Restoration (RM 13.9-13.7): Develop a site plan that includes habitat enhancement and public access	Hoppin Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
06-6.6-4	2006	Harrison Site (RM 13.4): Revegetate lower bank areas. Use fencing or other barriers, instead of tubex tubes, for animal predation and protection from ATV's.	Hoppin Reach	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
06-6.7-1	2006	Flood Control/Invasive Removal: Coordinate with landowners, DWR, and the CCC to promote and implement an invasive species removal program within the floodplain	Jesus Maria Reach	Channel Improvement	TAC										Significant flood control issues related to the vegetation have not been noted in recent analyses. The RCD has performed invasive species removal projects in the past.	Ongoing. See No. 98-17.	
06-6.7-2	2006	Huff's Corner (RM 11.6): Finalize design and present to TAC for comments any plans for improvements to CR 18 and/or levee protection at Huff's Corner	Jesus Maria Reach	Channel Improvement	TAC			Completed							Completed.		
06-7.3.1	2006	Project Prioritization: Establish a protocol and prioritization method for determining how all projects (County proposed & privately proposed) will be reviewed, approved, and prioritized by County staff and the TAC. Projects should be reviewed for consistency with any requirements and recommendations in the CCRMP/CCIP, design, construction methods, monitoring requirements as necessary, and maintenance.	CCRMP	Procedural	Admin			Completed									
06-7.3-2	2006	Project Development Guidelines: Develop a project checklist for parties interested in developing projects in the CCRMP. Educate the public in permit requirements to improve public understanding of the CCRMP area project evaluation and implementation process.	CCRMP	Procedural	Admin			???									
10-G-1	2010	HEC-RAS modeling of the entire CCRMP should be completed and analyzed in 2011 to allow an analysis of the 100-year flood capacity.	CCRMP	Modeling	Geomorphology					In Progress							See 2011.G.B.4
10-G-2	2010	Adopt a protocol for bed material sampling and a description of how the data will be used.	CCRMP	Modeling	Geomorphology					Deleted				Implement on 2017 Creek Walk			Deleted with adoption of 2012 Annual Report (See 1.4.2)
10-G-3	2010	Estimate the annual rate of channel bed aggradation over time using DTM data. DTM data from prior to 2006 should be added to the study. A frequency analysis of flows should be done to consider the relative influence of the 2006 data on the results.	CCRMP	Modeling	Geomorphology					Not Started	In Progress			Complete. Update with new LiDAR and aerial photography in 2017.			See 2011.G.A2.2
10-G-4	2010	Continue to study the relationship between rates of aggradation and channel characteristics in various reaches of the creek. A frequency analysis of flows should be done to consider the relative influence of the 2006 data on the results.	CCRMP	Modeling	Geomorphology									Complete. Update with new LiDAR and aerial photography in 2017.			
10-G-5	2010	Review the benefits of monitoring bed armoring and formulate a recommendation regarding future monitoring.	CCRMP	Modeling	Geomorphology					On Hold	Deleted			Delete - no longer recommending bed armoring per CFT.			Deleted with adoption of 2012 Annual Report. See 2011.G.C2.2

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

No.	YEAR	RECOMMENDATION	LOCATION / AREA	CATEGORY	DICIPLINE	STATUS 1999	2006	2010	2011	2012	2013	2014	2015	GEOMORPH STATUS NOTE (TOMPKINS)	HYDRO STATUS NOTE (FRANK)	BIO STATUS NOTE (RAYBURN)	ADDITIONAL NOTE / COMMENTS
10-G-6	2010	Update reach descriptions using more accurate georeferenced length measurements for each of the reaches.	CCRMP	Modeling	Geomorphology					In Progress				Complete in 2017 Technical Report.			See 2011.G.B1.1
10-G-7	2010	Report on the flood potential directly upstream from Huff's Corner (Rio Jesus Maria) including location and magnitude of flow potential at this site.	Jesus Maria Reach	Modeling	Geomorphology										The potential for flooding in this area is highly dependent on the flood state of the Sacramento River. The 2016 hydraulic analyses identified that absent major flooding on the Sacramento River, out of bank flooding will start occur here in between the 50 and 100-year return interval events.		
10-H-8	2010	Work with County disaster relief personnel to maximize the technical expertise of the TAC during flood events.	CCRMP	Monitoring	Hydrology				Complete						Completed.		
10-H-9	2010	Upgrade turbidity monitoring methods to include continuous turbidity monitoring. This newer technology will allow better tracking of sediment and contaminant loads.	CCRMP	Monitoring	Hydrology					In Progress					Given the ephemeral nature of Cache Creek, the expense and maintenance of continuous turbidity measurements may not have a high cost / benefit ratio. Recommend additional discussion with County of Yolo regarding this recommendation.		See 2011.H.B1.2
10-H-10	2010	Address high summer water temperatures by restoring native shrubs and trees in the riparian zone for shade.	CCRMP	Monitoring	Hydrology				In Progress							Ongoing. Restoration and recovery of riparian vegetation continues, but Hungry Hollow and Madison reaches are still characterized by sparse vegetation in 2016. See No. 98-9 and 99-9.	
10-H-11	2010	Monitor levels of orthophosphates, diesel fuel, fecal coliform, and total coliform in creek water.	CCRMP	Monitoring	Hydrology										This is occuring on a yearly basis.		
10-H-12	2010	Undertake required methylmercury monitoring and analysis. Consider additional partnerships to monitor and analyze methylmercury.	CCRMP	Monitoring	Hydrology				In Progress		Completed	Superseded by 2013.H.1			Superseded.		Dr. Slotton's Ambient Mercury Study (2013). See 2011.B.A6.10
10-H-13	2010	Use existing shallow wells near Cache Creek to identify groundwater patterns. Many of these wells (piezometers) were drilled on gravel company property to satisfy CCAP requirements.	CCRMP	Monitoring	Hydrology						Completed				Completed.		
10-B-14	2010	Conduct surveys of the Andregg vegetation transects to develop baseline data to support vegetation monitoring	CCRMP	Monitoring	Biology											Discontinued as of 2016. See 98-6.	
10-B-15	2010	Conduct a study of vegetation classes in the riparian zone based on the color aerial photos	CCRMP	Monitoring	Biology											Completed in 2016, as was a comprehensive analysis of changes and trends in riparian vegetation from 1995-2016. Standardized vegetation monitoring methods developed in 2016; see No. 98-6.	
10-B-16	2010	Assess and possibly update the CCRMP boundary to compensate for channel migration	CCRMP	Monitoring	Biology					In Progress							Adopted a Working Study Area Boundary in 2012. See 2011.B.A2.12
10-B-17	2010	Review and modify the Andregg vegetation transects for changes caused by channel migration	CCRMP	Monitoring	Biology											Discontinued as of 2016. See 98-6.	
10-18	2010	Monitor OHV impacts and work with YCSD to reduce illegal OHV activity in the creek. Work with CCC to respond to erosion and vegetation damage caused by OHV activity	CCRMP	Monitoring	Biology			In Progress								Ongoing.	
10-CIP-1	2010	Coordinate with YCFCWCD on reconstruction of the Moore's siphon (RM 18.1)	CCRMP	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
10-CIP-2	2010	Consider bank repair at RM 20.8 where the toe of the levee is eroded	CCRMP	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		
10-CIP-3	2010	Repair minor erosion at the emergency bank stabilization sites (RM 20.8 - 19.8)	CCRMP	Channel Improvement	TAC										At this time it is up to the landowner to initiate a project.		

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2011.G.A1.1	2011	HEC RAS modeling CCRMP reach completed and analyzed, and compared with 1996 conditions if possible.	CCRMP	Monitoring	Geomorphology				In Progress			Completed			HEC-RAS modeling completed in 2016. It was not compared with 1996 conditions, but changes in geomorphology have been evaluated over the 21-year period of CCAP.		
2011.G.A2.2	2011	Estimate the annual rate of channel bed aggradation over time.	CCRMP	Monitoring	Geomorphology					Not Started	In Progress			Complete. Update with new data in WY 2017.			
2011.G.A3.3	2011	Annual aerial survey contract and scope of work should be amended	CCRMP	Monitoring	Admin			Completed		In Progress							
2011.G.A4.4	2011	Continue to monitor actively migrating bends, and use a predictive model	CCRMP	Monitoring	Geomorphology					In Progress				Continue monitoring. Use new TAC hydraulic model to predict channel change / migration potential.			
2011.H.A1.5	2011	Complete review of hydrology and water quality objectives in CCRMP	CCRMP	Monitoring	Hydrology					Completed					Completed.		
2011.H.A2.6	2011	Review Cache Creek water quality database and identify duplication of effort.	CCRMP	Monitoring	Hydrology					Completed					Completed.		
2011.H.A3.7	2011	Prioritize and/or eliminate constituent testing based on HA1 and HA2 above	CCRMP	Monitoring	Hydrology					In Progress	Completed				Completed.		
2011.H.A4.8	2011	Continue to monitor contaminants of concern in creek water based on water quality database review and prioritization described above.	CCRMP	Monitoring	Hydrology					In Progress					Completed.		
2011.H.A5.9	2011	Continue groundwater monitoring near Cache Creek, ~~incorporating data from mining sites~~	CCRMP	Monitoring	Hydrology					Completed	Completed (WRID)				This is occuring on a yearly basis.		
2011.B.A6.10	2011	Complete methylmercury monitoring and analysis in the CCRMP study area. Consider additional partnerships to monitor and analyze methylmercury	CCRMP	Monitoring	Hydrology					In Progress	Completed	Superseded by 2013.H.1			Superseded.		Dr. Slotton's Ambient Mercury Study (2013)
2011.B.A1.11	2011	Continue to work with County staff and the aerial contractor to further refine and classify vegetation	CCRMP	Monitoring	Biology					In Progress						Ongoing. UAV-based aerial photography collection was initiated via contract in 2016. Additional methods will continue to be explored as technology improves.	
2011.B.A2.12	2011	Determine whether CCRMP boundary should be updated	CCRMP	Monitoring	TAC					In Progress					Evaluated during 2016 CCAP Update.		Adopted a "Working Study Area" boundary in 2012.
2011.B.A3.13	2011	Coordinate with full TAC in 2012 to identify areas and sites best suited for natural regeneration of riparian and upland habitat conditions	CCRMP	Monitoring	Biology					In Progress	???	???	In Progress			Ongoing. See No. 99-9.	
2011.B.A4.14	2011	Continue to participate in the Cache Creek Watershed Wide Invasive Management Plan	CCRMP	Monitoring	Biology					In Progress						Ongoing, although CCWWIMP likely needs to be updated. See No. 98-17.	
2011.G.A.15	2011	Channel shifting patterns near RM 26.4 should be actively monitored	CCRMP	Monitoring	Geomorphology					In Progress	On Hold (Need Aerials)			Continue to monitor.			
2011.G.A.16	2011	Bank erosion at RM 26.9 on the south bank ... continued engagement with PGE	Capay Reach	Channel Improvement	Geomorphology					In Progress				Continue to monitor.			

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2011.G.A.17	2011	The bank retreat patterns near RM 25.4 -25.5, RM 22.0, and RM 20.6 for regeneration of riparian habitat. Site-specific small scale revegetation plantings explored.	CCRMP	Channel Improvement	Geomorphology					Not Started	In Progress						
2011.G.A.18	2011	Active bank retreat near RM 21.6 (near the old Madison Bridge) should be monitored in 2012.	Madison Reach	Monitoring	Geomorphology					Completed	On Hold (Need Aerials)			Continue to monitor.			
2011.G.A.19	2011	Significant erosion at the I-505 crossing should be assessed. Vegetation should be removed in order to protect the bridge piers.	Guesisosi Reach	Monitoring	Geomorphology					???	In Progress			Recommend detailed hydraulics / sediment transport study at Highway 505.			
2011.G.A.20	2011	Replace dead arundo and tamarisk in the Capay Reach with native plantings.	Capay Reach	Monitoring	Geomorphology					In Progress						This recommendation was repeated and emphasized in 2016. See No. 98-17.	Coordinate with the Cache Creek Conservancy
2011.G.B1.1	2011	Update reach descriptions using updated values for all channel characteristics. Standardize the reach endpoint descriptions.	CCRMP	Monitoring	Geomorphology					In Progress				Complete. Update with new data in WY 2017.			
2011.H.B1.2	2011	Continue to pursue partnerships to install continuous turbidity monitoring	CCRMP	Monitoring	Hydrology					In Progress					Given the ephemeral nature of Cache Creek, the expense and maintenance of continuous turbidity measurements may not have a high cost / benefit ratio. Recommend addition discussion with County of Yolo regarding this recommendation.		
2011.B.B.3	2011	Mapping protocols should be developed to define the procedure and schedule for mapping vegetative cover within the CCRMP study area	CCRMP	Monitoring	Biology					In Progress						Completed in 2016, as was a comprehensive analysis of changes and trends in riparian vegetation from 1995-2016. Standardized vegetation monitoring methods developed in 2016; see No. 98-6.	
2011.G.B.4	2011	Complete HEC-RAS modeling of the Huff's corner area, and a comparison with the 1996 100-year flood capacity.	Jesus Maria Reach	Monitoring	Geomorphology					In Progress					2016 HEC-RAS modeling completed. Comparison with 1996 modeling can be evaluated during 2017.		
2011.G.H.B.5	2011	The flood conveyance at the I-505 bridge: Coordinate with CALTRANS and stakeholders, and complete hydraulic modeling to determine before- and after-skimming water surface elevations if the bar were skimmed.	Guesisosi Reach	Monitoring	Geomorphology					On Hold	???	???	Not Started	Coordinate if skimming project imminent.	This could be accomplished with the 2016 model of Cache Creek if desired and funded by the County of Yolo.		
2011.H.B.6	2011	Implement water temperature monitoring by placing water temperature data loggers in each reach.	CCRMP	Monitoring	Hydrology					On Hold	???	???	Not Started		Dependent on funding.		
2011.G.C1.1	2011	Sampling the bed surface material	CCRMP	Monitoring	Geomorphology					Deleted				Complete during 2017 Creek Walk.			Deleted with adoption of 2012 Annual Report
2011.G.C2.2	2011	Develop a protocol and sampling schedule to measure bed armoring	CCRMP	Monitoring	Geomorphology					Deleted				No longer recommended.			Deleted with adoption of 2012 Annual Report
2011.B.C.3	2011	Undertake more detailed ancillary wildlife assessments in conjunction with field work.	CCRMP	Monitoring	Biology					In Progress	???	???	Not Started			Ongoing. Additional recommendations made regarding need for statistically-valid wildlife inventory and monitoring data made as component of 2016 CCAP Update.	
2011.G.C.4	2011	Channel bank retreat upstream from Moore's Siphon near RM 18.1 should be monitored.	Dunnigan Hills Reach	Monitoring	Geomorphology					In Progress	On Hold			Continue to monitor.			
2012.G.A.1	2012	Assessment of bar skimming in the following locations: RM 26.1, 25.5, 21.6, and 20.3 - 20.5.	CCRMP	Channel Improvement	Geomorphology						???	???	In Progress	Reevaluate assessment after WY 2017 high flows.			
2012.G.A.2	2012	Channel maintenance project on upper bank at Huff's Corner (RM 11.6) to prevent downstream unraveling of existing bank protection	Jesus Maria Reach	Channel Improvement	Geomorphology						???	???	Not Started	Reevaluate assessment after WY 2017 high flows.			

Current Status of Cache Creek Annual Status Report Recommendations (1999-2015)

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						1999	2006	2010	2011	2012	2013	2014	2015				
2012.G.A.3	2012	Repair levee and bank erosion at RM 19.5	Guesisosi Reach	Channel Improvement	Geomorphology						???	???	Not Started	Reevaluate assessment after WY 2017 high flows.			
2012.G, H, B.4	2012	Create Creek Walk protocols	CCRMP	Monitoring	All						???	???	Not Started				
2012.H.A.1	2012	Increased mercury concentrations detected in 2012 surface water samples need to be communicated to on-going mercury studies in the watershed and evaluated in 2013	CCRMP	Monitoring	Hydrology						Complete				Completed.		
2012.H.A.2	2012	Update and maintain geo-spatially referenced photo log for use on Creek Walks and to document on-going changes and conditions on the Creek.	CCRMP	Monitoring	Hydrology					Complete		In Progress			Completed with ArcGIS online application for Creek Walk data.		
2012.H.B.1	2012	Compile water Quality Impact Catalogue and associated source and contaminant potential assessment	CCRMP	Monitoring	Hydrology						In Progress				Completed during 2016 CCAP Update.		
2012.G.B.3	2012	Channel maintenance project on lower bank at Huff's Corner (RM 11.6) to prevent downstream unraveling of existing bank protection	Jesus Maria Reach	Channel Improvement	Geomorphology						???	???	Not Started	Reevaluate assessment after WY 2017 high flows.			
2012.G, H.B.2	2012	Channel maintenance project at south bank RM 12.35 to prevent the recruitment of foreign material into the Creek	Jesus Maria Reach	Channel Improvement	Geomorphology Hydrology						???	???	Not Started	Reevaluate assessment after WY 2017 high flows.			
2012.G.C.1	2012	Establish a high-flow triggered bank stability monitoring plan for the I-505 bridge	Guesisosi Reach	Monitoring	Geomorphology						Monitoring Only			Complete - use 15,000 trigger recommendation in 2017 Technical Study			
2012.G.C.2	2012	Establish a high-flow triggered bank stability monitoring plan for the south bank at the Cemex Slope Protection project site (RM 20.6)	Guesisosi Reach	Monitoring	Geomorphology						Monitoring Only			Complete - use 15,000 trigger recommendation in 2017 Technical Study			
2012.G.C.3	2012	Remove berm/concrete barrier at Correll Rodgers (RM 13.8)	Hoppin Reach	Channel Improvement	Geomorphology						???	???	Not Started	Reevaluate assessment after WY 2017 high flows.			
2012.H.C.1	2012	Historical analysis on movement/migration of the vehicle boneyard (south bank RM 26.6)	Capay Reach	Monitoring	Hydrology					Complete							
2013.H.1	2013	Monitory mercury concentations in surface water in 2014. If elevated concentrations persist, but are below the CTR criterion of 0.05 ug/L, informinform other ongoing mercury studies of this condition. If concentrations exceed the CTR, initiate coordination with the Regional Water Quality Control Board and/or the Bureau of Land Management to consider source analysis		Monitoring	Hydrology							In Progress			Performed by Slotton studies.		
2013.H?	2013	As new aerial photography of the CCIP area becomes available, measure distance between channel bank and edge of vehicle boneyard to determine if 50-foot minimum distance has been encroached.			Geomorphology									Complete. Update with new data in WY 2017.			
2013.H?	2013	Conduct condition assessments on the following potential water quality contaminant sources: a. Pond drain pipe at RM 20.0 b. Perched drain pipe at RM 20.35 c. Vehicles and perched drain pipes in Dunnigan Hills reach (RM 16.5 – 18.9) d. Vehicle at RM 15.6			Hydrology										These were never implemented. Recommend locating these sites during 2017 Creek Walk and determine current status and concerns.		
	2013	Monitor levee erosion on north bank at RM 23.0 – 22.8		Monitoring	Geomorphology									Continue to monitor.			
	2013	Mid-channel bars have formed in selected areas. Bar-skimming for channel maintenance is possible in the following locations: a. Near RM 26.1 b. Near RM 25.5 c. Near RM 25.0 d. Near RM 21.6 (currently low priority)		Channel Improvement	Geomorphology									Reevaluate assessment after WY 2017 high flows.			

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	2013	Complete Volumetric Change Detection analysis for lower Cache Creek		Modeling	Geomorphology									Complete. Update with new data in WY 2017.			
2013.B.1	2013	Explore opportunities to increase surface water flows in Cache Creek to improve conditions for native/riparian vegetation		Channel Improvement	Biology							???	On Hold			Ongoing as of 2016.	
2013.B.2	2013	Continue to monitor tree loss and damage by beavers to determine if intervention is required in select locations		Monitoring	Biology							In Progress				Ongoing as of 2016 as component of annual Creek Walk.	
High Priority #22	2014	Remove large bar to reduce erosive pressure on bank at RM 11.7 (upstream from Huff's corner on north side).		Channel Improvement	Geomorphology								Incomplete	Reevaluate assessment after WY 2017 high flows.			
Medium Priority #12	2014	Monitor for bank retreat at the following locations: RM 26.9 (south [right] bank), RM 26.4 (south bank), RM 26.0 (south bank), RM 25.4-25.5 (south bank), RM 25.1 (bed degradation), RM 22.0 (north bank), RM 21.6 (north bank), RM 21.4 (spur dike toe erosion), RM 20.4 (south bank), RM 19.8 (south bank), RM 18.8-18.7 (south bank), RM18.2-18.0 (north bank), RM 15.4 (south bank), RM 15.0 (beneficial deposition on both banks), RM 14.3 (north		Monitoring	Geomorphology								In Progress	Reevaluate assessment after WY 2017 high flows.			
Medium Priority #13	2014	Make observations at the following locations: RM 21.8 (south bank), RM 20.4 (potential for bar skimming; mid-channel), RM 17.8 (north bank), RM 11.6 (south bank).		Monitoring	Geomorphology								In Progress	Continue to monitor.			
Medium Priority #14	2014	Remove remaining (some webbing burned in Water Year 2015) exposed webbing at the PG&E site (RM 26.9).		Channel Improvement	Geomorphology								Not Started	Reevaluate assessment after WY 2017 high flows.			
Medium Priority #15	2014	Evaluate potential for bar-skimming channel maintenance in the following locations: near RM 26.1, near RM 25.0-25.5, near RM 20.3-20.8 (high potential and benefits).		Monitoring	Geomorphology								Not Started	Reevaluate assessment after WY 2017 high flows.			
Low Priority #6	2014	Encourage property owner to remedy erosion at the toe of the embankment on south bank (RM 20.4, 19.8).		Channel Improvement	Geomorphology								Not Started	Reevaluate assessment after WY 2017 high flows.			
NA	2014	The primary hydrologic and hydraulic recommendation for 2014 is to complete 2015 water quality sampling during the first flush event as defined by the proposed lowered first flush flow threshold, and if contaminant concentrations are not consistent with recent trends, complete a second water year 2015 water quality sampling campaign during low flow conditions.	CCRMP	Monitoring	Hydrology								Completed		A second water quality sampling was not needed in either 2015 or 2016.		
NA	2015	Capay Dam damage due to flows in December 2014 should be addressed and corrective actions implemeneted to prevent similar future damage.	Capay Reach	Channel Improvement	Hydrology										Not completed. More damage occurred in 2017.		
NA	2015	Erosion sites from December 2014 event should be monitored in the future	CCRMP	Monitoring	Hydrology										Ongoing monitoring is occuring		
NA	2015	TAC should develop 2D hydraulic model for the study area.	CCRMP	Monitoring	Hydrology								Completed		2D model was completed in 2016.		
NA	2015	Water quality sampling protocols should be amended for 2015/2016 to track contaminants that were elevated over historical norms in 2014/2015	CCRMP	Monitoring	Hydrology								Completed		Water quality monitoring has been amended, and the high values in 2015 did not occur again in 2016 and may be anomalies.		
NA	2016	Longitudinal profiles of water surface elevations should be performed in the future to calibrate the 2D hydraulic model.	CCRMP	Monitoring	Hydrology								Completed		Completed in 2016 and 2017 for 4500 and 20,000 cfs, respectively.		