CACHE CREEK
ANNUAL STATUS REPORT
2011

Prepared by:

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CHAPTER 1 - EXECUTIVE SUMMARY

1.1 PURPOSE OF THE REPORT

The Yolo County Board of Supervisors adopted the Cache Creek Resources Management Plan (CCRMP) and Cache Creek Improvement Program (CCIP) in 1996, creating an integrated strategy for enhancing the resources of lower Cache Creek. The CCRMP is a river management plan that eliminated in-channel commercial mining, works to restore habitat along the creek banks, and established an ongoing program for erosion control, bank stabilization, and floodway management. The CCRMP provides the policy framework for restoration of the 14.5 mile Lower Cache Creek. The CCIP is the implementation plan for the CCRMP that identifies categories of specific restoration/protection projects along the creek, including: bank stabilization, channel maintenance, revegetation, and habitat restoration.

Information and landowner participation are critical components in the implementation of the CCRMP and CCIP. The monitoring mandated by the CCIP provides data on stream flow, water quality, erosion, and vegetation that guides creek management recommendations of the three-member Technical Advisory Committee (TAC).

The CCRMP and CCIP are evolving programs that adjust and adapt in response to new creek conditions. Data and public input collected over the past year have been reviewed by the TAC and provide the foundation to make recommendations for the continuing management of Cache Creek. This Annual Report provides the County with a review of the TAC's analysis for 2011.

1.2 ACCOMPLISHMENTS

Yolo County has implemented an annual monitoring program since 1997. Since that time, more than thirty in-channel projects have been undertaken, with review by County staff and the Cache Creek TAC. These projects have been varied, from bank stabilization and habitat enhancement to providing public access at public parks and open spaces. Each year the TAC reviews these project sites, collects and analyzes creek data, and makes new recommendations to the County for consideration under the CCRMP/CCIP.

A number of activities were completed in 2011 that implement the CCIP and CCRMP. These activities included monitoring work, public meetings, public outreach, permitting, and program activities. Brief descriptions of major activities are given here:

1. Nine (9) public **Technical Advisory Committee (TAC) meetings** were held during 2011. TAC meetings were attended by TAC members, County staff, members of various agencies, and the public. County staff and TAC members have also attended meetings of the Cache Creek Conservancy, the Cache Creek Stakeholders Group, the Delta Methylmercury TMDL Nonpoint Sources Workgroup, the Yolo County Water Resources Association, FloodSAFE YOLO, and CalFed (and its successors).

2. County staff continued the process of seeking **reauthorization of general permits** required for the efficient implementation of the CCRMP, including a Section 404 Discharge Permit from the US Army Corps of Engineers, a Biological Opinion for endangered species (Valley Elderberry Longhorn Beetle and bank swallow) from the US Fish and Wildlife Service, a Streambed Alteration Agreement (Section 1601/1603) from the California Department of Fish and Game, and a Section 401 Water Quality Certification from the Central Valley Regional Water Quality Control Board. Reauthorization of regulations in the State Surface and Mining Reclamation Act that recognize the CCRMP as the functional equivalent of a Reclamation Plan for CCIP projects was achieved with the passage of Senate Bill 133 (Wolk) in 2011.

3. The County acquired an **aerial survey.** The 2011 final product includes aerial photographs and orthophotoquads of the full CCAP area, as well as topographic mapping, Digital Terrain Models (DTMs), and Digital Elevation Models (DEMs) of the CCRMP area.

4. County staff and TAC members **participated in regional partnerships** related to the San Francisco Bay/Delta including the Bay Delta Conservation Plan and the Delta Methylmercury TMDL Nonpoint Sources Workgroup. These groups meet periodically to coordinate regulatory and ecological issues in the San Francisco Bay/Delta region. Yolo County is an important stakeholder in these groups because of water quality and sediment issues in the Cache Creek watershed.

5. The TAC conducted its **2011 Creek Walk** on May 17, 18, and 19th. The Creek Walk is one of the requirements of the CCIP. Ten or more participants walked each day, and covered the length of CCRMP area over the three day period. Participants included the TAC, gravel producers, community stakeholders, and County staff. The TAC produced Creek Walk reports for each discipline, and recommendations from the Creek Walk reports are included in this annual report.

6. **Channel stability near the bridges** was analyzed by considering the cross section bed surface profile 50 and 150 feet upstream and downstream of each bridge.

7. **Channel shift patterns at active bends** were analyzed with DTM and aerial photo data. Specific bends were analyzed separately at River Miles 26.4, RM 25.4 to 25.5, RM 21.7-21.5, near RM 20.6, and at RM 18.5-18.0. Site specific observations were made for each area.

8. **Total annual sediment transport was analyzed.**

9. **The 100-year flood capacity** was considered for a reach of the creek in the vicinity of Huff's Corner near River Mile 12.5.

10. **Changes in volume ("cut and fill")** were considered in the time period 2010-2011, based on Digital Terrain Models (DTM).

11. **Channel slope was analyzed by reach**. The slope of each reach was determined using GIS analysis and data derived from the DTM's. 2011 data were compared with 2010 data.

12. **HEC-RAS model development** for the entire CCRMP area has been in progress with the TAC Geomorphologist collaborating with the California Department of Water Resources and Wood Rodgers in building this model.

13. **Water surface elevations of a 7,000 cfs event** that occurred in March of 2011 were documented. These documented flow levels are being used to calibrate the hydraulic HEC-RAS model.

14. The County joined discussions regarding partnerships that will **monitor turbidity and flow** at two monitoring stations, one each at the upstream and downstream ends of the CCRMP area.

15. The County **collected surface water samples three times during the 2011 water year,** and had them analyzed for a suite of pesticides, herbicides, biological pollutants,

and metals. Samples were collected during the first fall rain, peak winter flow, and low flow summer conditions.

16. **Groundwater monitoring was expanded**, and the 2011 annual report contains groundwater information from 17 wells that border Cache Creek.

17. The County expanded **partnerships** with the Yolo County Sheriff's Department and Cache Creek Conservancy to reduce problems associated with illegal OHV use in Cache Creek.

1.3 SUMMARY OF SIGNIFICANT FINDINGS

Based on monitoring and observations during 2011, the TAC has come to the following conclusions:

1. **The 100-year flood capacity** was considered for a reach of the creek in the vicinity of Huff's corner near River Mile 12.5. The analyses suggest that during a 100-year event, significant flooding will occur upstream from Huff's corner for about a three-mile length of the channel. The extent and magnitude of flooding has not yet been compared with the conditions that existed when the CCRMP was adopted in 1996; nor has the analysis yet been clarified with respect to recent changes in FEMA floodway analysis protocol regarding uncertified levees.

2. **Total annual sediment transport in 2011** was estimated by an empirical sediment transport model to be about 900,000 tons (Figure 1), which is the second largest quantity since 2005**.** Because the modeling provides only a rough estimate, dimensionless transport shows the relative transport as percentage of the maximum year (Table 1).

   Estimates reported in the 2010 annual report were updated using annual water years, rather than calendar years. The results of modeling showed that 2011 had the second largest rate of sediment transport since 2005, and was significantly larger than any year except 2006.

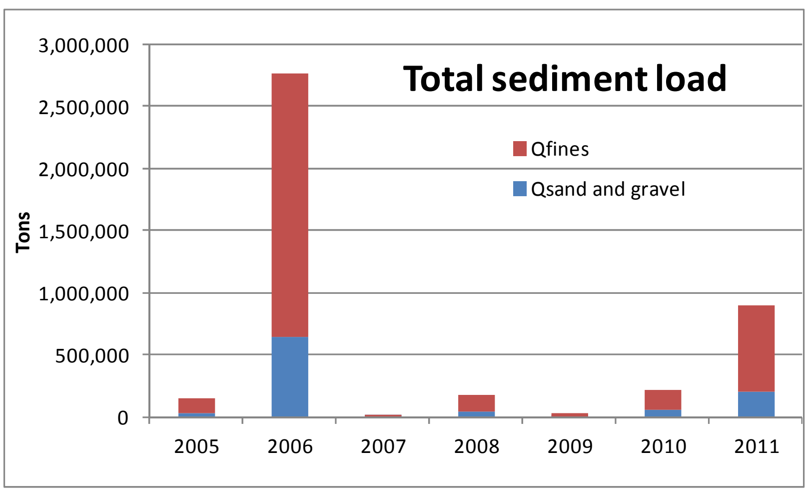

Figure 1 Total sediment transport in tons

Water year	Total load
2005	5%
2006	100%
2007	0%
2008	6%
2009	1%
2010	8%
2011	32%

Table 1 Total dimensionless sediment transport

Values are given as a percentage of the 2006 load

3. **Changes in volume ("cut and fill")** in 2010-2011, based on the DTM data, appear to indicate that there was net loss in volume in most areas of the creek. The reported loss in volume may be due to DTM interpretation techniques, rather than bed erosion. In particular, the difference in water surface elevations between 2010 and 2011 could account for most of the changes in volume.

4. **Channel slopes and lengths** for the reaches in the CCRMP area stayed roughly the same between 2010 and 2011. The main change was in the Madison Reach, where the length of the low-flow channel shortened by about ten percent and the slope increased about five percent, due to the low-flow channel straightening when it “cut through” three separate bends. The slope profiles, cut from the DTM data, appear to be about one to two feet deeper in 2011 for all reaches except the Hoppin Reach, which showed no change. Natural variation in the location of the deepest part of the channel (thalweg) may have contributed to this difference. However, this result may have largely been the result of the differences in water surface elevation at which the DTM data were collected.

5. **Channel shift patterns at active bends** throughout the CCRMP area were examined, and tended to show bank retreat on the outside of the bend, and deposition of new flood plain on the inside of the bend. Bends at River Miles (RM) 26.4, RM 25.4 to 25.5 (Hungry Hollow Reach), near RM 21.7-21.5 (Madison Reach), near RM 20.6 (Guesisosi Reach), and at RM 18.5-18.0 (Dunnigan Hills Reach) were specifically noted for active shifting patterns that are near the banks.

   Channel shift patterns at RM 21.7-21.5, near the site of the old Madison Bridge, showed significant channel shift in past years. The 2010-2011 patterns show less bank retreat on the left hand side of the channel, looking downstream. The main low-flow channel has shifted to the right hand side of the channel at RM 21.5. There was significantly more bank retreat immediately upstream from this site, near River Mile 21.7. A preliminary modeling exercise of channel migration suggested that no immediate action is required, although continued monitoring is recommended.

6. **Analysis of channel bed stability near the bridges** by comparisons of cross section bed surface profiles between 2010 and 2011 suggest that the channel bed is relatively stable in the immediate vicinity of the bridges.

7. **Surface Water quality is generally good,** although several constituents do not meet state or federal guidelines. Ammonia, orthophosphate, boron, temperature, pH and bacteria levels are elevated and should be monitored. The TPH as diesel problem that was described in the 2010 annual report was not evident in the 2011 data, so the source of this pollutant may have been fixed or removed.

8. **Groundwater levels** are stable across the CCRMP area, indicating that recharge and pumping are relatively equal, and the groundwater basin is being managed in a sustainable manner. Some of the beneficial recharge is from unlined irrigation canals, and is a deliberate management strategy by the Yolo County Flood Control and Water Conservation District. This strategy appears to be working.

9. A preliminary analysis of the Andregg Transects shows that the extent and density of **riparian vegetation** appears to have declined since 2010.

10. There has been significant reduction in the population, density, and extent of **tamarisk and arundo** since 1999.

1.4 RECOMMENDATIONS

Recommendations in this report are based on physical, hydrologic and biological assessment of Cache Creek, with guidance from the CCRMP. The TAC conducted a variety of independent analyses in 2011, attended public meetings, and worked together on a three day creek walk. These activities produced several recommendations that will be carried forward into 2012 and used to guide future TAC activities.

Recommendations are listed by discipline, and are not prioritized. These recommendations will form the analytical basis for TAC activities and the determination of channel improvement projects during 2012.

1.4.1 Geomorphology Recommendations:

1. **HEC RAS modeling** of the entire CCRMP reach should be completed and analyzed, and compared with 1996 conditions if possible. This would allow an analysis of changes in the **100-year flood capacity** for the entire CCRMP reach area since the CCRMP was adopted. This analysis should be clarified with recent changes in FEMA floodway analysis protocol regarding uncertified levees.

2. **Sampling the bed surface material** can be done relatively easily, with small expense, providing data that may be useful in future calculations of sediment transport. A simple protocol for bed surface material sampling to provide the data called for in the CCIP should be developed, and sampling should be carried out in 2012.

3. The annual **aerial survey contract and scope of work** should be reviewed. The use of USDA NAIPS aerial surveys should be considered for years when LIDAR is not needed, which may save a substantial amount of money. In addition, the cut and fill analysis procedures need to be reviewed and potentially revised. A protocol needs to be developed so that the cut and fill calculations accurately describe the difference in the bed surface elevations from year to year.

4. Estimate the **annual rate of channel bed aggradation** over time. If possible, DTM data from prior to 2006 should be added to this study.

5. Continue to **monitor actively migrating bends**, and use a predictive model of channel migration to forecast likely future dynamics at the sites identified in the Geomorphology and Channel Hydraulics chapter.

6. Update **reach descriptions** using updated values for all channel characteristics. Standardize the reach endpoint descriptions.

7. Develop a protocol and sampling schedule to measure **bed armoring** based on analysis of existing bed armoring data. A simple estimate of the degree of bed armoring can help in sediment transport modeling.

1.4.2 Hydrology and Water Quality Recommendations:

8. Continue to pursue **partnerships** with Yolo County Flood Control and Water Conservation District, Department of Water Resources, and the United States Geological Survey to install **continuous turbidity monitoring** equipment. This will have the added benefit of improving our estimates of sediment flux and mercury loads on Cache Creek.

9. Include **surface water temperature** as a variable in future project designs, and work to incorporate woody debris and floodplain connectivity as mitigation efforts to high temperatures.

10. Continue to **monitor contaminants** of concern in creek water: orthophosphate, diesel fuel, fecal coliform, and total coliform. Reevaluate constituent list to eliminate unnecessary testing.

11. Complete **methylmercury** monitoring and analysis in the CCRMP study area. Consider additional partnerships to monitor and analyze methylmercury.

12. Continue **groundwater monitoring** near Cache Creek, incorporating data from mining sites to expand the data available in the Yolo County Water Resources Information Database.

1.4.3 Biology Recommendations:

13. The **CCRMP boundary** should be updated to reflect channel migration, and the **permanent transects (Andregg)** should be reviewed for minor modifications based on the updated boundary.

14. Continue to work with County staff and the aerial contractor to **further refine and classify vegetation** utilizing the LiDAR data.

15. LiDAR data provides an effective tool for monitoring changes in riparian vegetation within the CCRMP area. An unsupervised (automated) classification should be completed when LiDAR data is next collected.

16. Undertake more detailed ancillary **wildlife assessments** in conjunction with field work (particularly the annual creekwalk).

17. Continue to participate in the Cache Creek Watershed Wide Invasive Management Plan scheduled for completion in 2012.

18. Coordinate with full TAC in 2012 to **identify areas and sites best suited for natural regeneration of riparian habitat conditions** due to changing physical conditions (e.g. see geomorphologist's discussion of channel shift near RM 25.4-25.5).

1.4.4 General Recommendations:

19. Continue to monitor **OHV impacts** and work with the Yolo County Sheriff's Department to reduce illegal OHV activity in Cache Creek and work with the Cache Creek Conservancy and the Yolo County Parks Department to respond to erosion and vegetation damage caused by OHV activity.

1.4.5 Channel Improvement Priorities:

The Creek Walk and TAC site visits during 2011 identified the need for several potential channel improvement projects. The following set of potential projects will be further assessed and prioritized for implementation in the 2012 budget cycle:

- Complete HEC-RAS modeling of the Huff's corner area, and a comparison with the 1996 100-year flood capacity. If flood capacity has been significantly reduced, consider implementing, in consultation with stakeholders, **flood reduction measures**, such as bar removal, and other techniques to increase flood conveyance capacity.

- **Channel shifting patterns** near RM 26.4 on the south bank near Capay Bridge, which has resulted in erosion near the south side of the bridge, should be actively monitored for possible future action. No remedial action is recommended at this time.

- DTM analyses show that **bank erosion** at RM 26.9 on the south bank is occurring adjacent to the PGE instream structure. The TAC recommends continued engagement with PGE to insure that new stabilization is consistent with the CCIP, and that the existing right-of-way weed management problems are resolved.

- The bank retreat patterns at three sites (near RM 25.4 -25.5, RM 22.0, and RM 20.6) show that the channel bends in these locations are evolving in a typical pattern for stream channel evolution. As the bend moves downstream, there is a pattern of cutting into the terrace, and a pattern of fill in its wake. The fill makes newly created floodplain areas that could be prime locations for reestablishing riparian vegetation. This dynamic process can be utilized for **regeneration of riparian habitat**. In coordination with local land owners, site-specific small scale revegetation plantings should be considered to supplement natural regeneration.

- **Active bank retreat near RM 21.6** (near the old Madison Bridge) was not significant with the moderate flows in 2011, but should be monitored in 2012.

- Channel **bank retreat** upstream from Moore's Siphon near RM 18.1 was noted and should be monitored. No remedial action is recommended at this time.

- There is significant erosion on the northern bridge piers at the Road 87 crossing, and at the I-505 crossing. The situation should be assessed to determine if riparian vegetation is impairing and/or deflecting flow at the bridges. If so, the vegetation should be **removed in order to protect the bridge piers.**

- The flood conveyance at the I-505 bridge is reduced due to in channel filling of the south bay. If the channel bed in the south bay were to be **skimmed** back to design elevations, conveyance would be increased. Coordinate with CALTRANS and stakeholders, and complete hydraulic modeling to determine before- and after-skimming water surface elevations if the bar were skimmed.

- **Implement water temperature** monitoring by placing water temperature data loggers in each reach.

- **Replace dead arundo and tamarisk in the Capay Reach with native plantings** in selected areas in this reach, in order to avoid destabilization of the floodplain.

CHAPTER 2 - GEOMORPHOLOGY AND CHANNEL HYDRAULICS

2.1 OVERVIEW

The 2011 annual geomorphology report documents the existing conditions of geomorphic processes and metrics that are specified in the CCRMP and CCIP. This 2011 report expands on metrics reported in the 2010 annual report and includes new considerations that were not addressed in 2010.

In 2011, we continued to use existing HEC-RAS models to consider site-specific flooding patterns at the 100-year recurrence interval event, and an analysis of the entire CCRMP reach is likely to be done in 2012. We addressed two topics that were mandated in the original CCRMP/CCIP that relate to the size of the material making up the bed of the stream, which have not been done since 1996. Both “bed material size” and “bed armoring” can be measured rather simply, using similar methods to those used in the original Technical Studies. Although these methods will not yield research-quality data, they can be informative to compare with the 1996 data. The sediment transport in the 2011 water year was estimated using the relationships defined in 1996, which provide us with an estimate of the relative amounts being transported each year. Patterns of bed aggradation and degradation are important to indicate whether the bed of the stream is replenishing its supply, or is not. The cut and fill analyses that have been contracted to aerial survey companies aim to determine the aggradation patterns.

We have two years of “cut and fill” data, but because of issues of data precision and monitoring protocols, it is not clear that the existing analyses give us a clear picture of how much the bed is aggrading or degrading. The cut and fill analyses do give one image of the lateral dynamics of bank migration, which will help with planning purposes. These cut and fill images, along with longitudinal profiles (slopes), were used in 2011 to consider reach-by-reach geomorphic characteristics. Cross section bed profiles were used to consider the stability of the bed and banks near bridges.

2.2 FLOOD CAPACITY

2.2.1 FLOOD CAPACITY SUMMARY

The analyses included here suggest that the area near Huff’s corner has significantly smaller capacity than a 100-year capacity. How the current conditions compare with 1996 conditions is a task proposed for 2012 work. The area of potential flooding in the 100-year event is roughly three miles long and extends from just downstream from the Highway 5 Bridge upstream for about 3 miles. This finding was confirmed by engineers who helped prepare a recent flood study for the city of Woodland (Pers. Comm. John Pritchard, Wood Rodgers Associates).

2.2.2 FLOOD CAPACITY ANALYSIS

One of the roles of the TAC, as defined by the CCIP, is to identify areas where existing channel capacity can no longer contain a 100-year flood event[1]. This requires an analysis with a hydraulic model, such as HEC-RAS. HEC-RAS is the “River Analysis System” developed and maintained by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. The main use of HEC-RAS is mathematical modeling of water surface elevations at different discharges. The input data include the channel bed and bank topography. The model is calibrated based on observed water surface elevations at defined discharges. The model is then able to predict water surface elevations at other discharges based on input data and calibration data. In the future, the TAC will utilize a HEC-RAS model developed in coordination with the Department of Water Resources’ FloodSAFE Yolo program to identify areas where the

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[1] Objectives 2.3-3, 2.3-5, and performance standard 2.5-8

capacity is less than the 100-year flood. As of December 2011, there was no new useable HEC-RAS model available that covers the entire CCRMP area. Therefore, no assessment can be made of the entire CCRMP area. In lieu of a total study, a limited study was done with a limited model, as described below.

The 2010 annual report and discussions at TAC meetings have suggested that we investigate the flood patterns in the vicinity of Huff's corner. A model was available that was originally made in 1997-8 for flood studies for the City of Woodland and other areas. This model was adapted to be used at a restoration site on Cache Creek (Correl-Rogers) by CEMEX. The model also extended to the Huff's corner site. Flows were used that represent the flood values of the 100-year flood.

This previously-used HEC-RAS model[2] has cross sections starting downstream of Road 94B, and extends to the Yolo Settling Basin. There are cross sections approximately every 500 feet, resulting in about 140 cross sections and about 13 miles of HEC-RAS study. The model from 94B to Highway 5 is useful for studying the flood dynamics near Huff's Corner (RM 12.5).

Although the model was built in 1998, we expect that the general patterns of flooding indicated by the model will be valid. Model results were reviewed with the California Department of Water Resources' Consulting engineers at Wood Rodgers[3] and the general results of the present TAC HEC-RAS studies were confirmed. In addition, the general pattern of the present model results were confirmed by local residents in the vicinity of the modeled flooding. In short, we expect that the model results represent the general ***pattern*** and general location of flood potential.

These results will be compared with the results of the HEC-RAS model that is expected to be available for the complete CCRMP in 2012.

Figure 2 Aerial photo showing the reach for which the limited HEC-RAS study was done

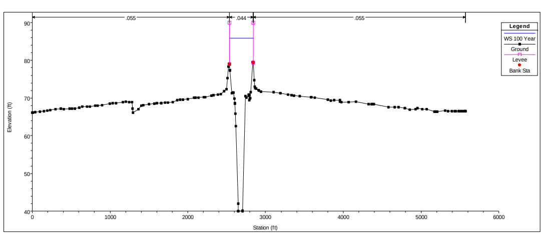
[2] The model is dated February 1998, and was obtained from Cunningham Engineering. Personal Communication from Cunningham indicated that the model was based on Flood Studies done by the City of Woodland.
[3] Per. Com. John Pritchard, Wood Rodgers HEC-RAS specialist, November 2011.

The following analyses were based on the 1998 model that was developed in this reach, and new analyses were done to estimate the water surface elevation of the 100-year recurrence interval flood. The value for discharge of the 100-year flood was taken from an analysis of data at the Capay gage done by Kamman Engineering[4]. 61500 cfs was estimated for the 100-year recurrence interval flood. Relative to much of the CCRMP area, the reach has a very narrow width in the vicinity of Huff's corner. As discussed below, although the results here are based on a limited area, based on old topography, and not calibrated to current conditions, the results are useful to indicate that there is flooding at the 100-year flood in this area, although we have not yet compared it with 1996 conditions. It is expected that DWR's forthcoming HEC-RAS model will refine these results.

This discussion starts in the downstream direction, and moves upstream, because that is how the hydraulics of flooding are controlled (i.e. downstream control).

Figure 3 shows cross section bed topography and water surface elevations for the 100-year recurrence interval flood. The axes scales are not included at the small scale of the plots in the report, but the main point of showing the graphs is clear. The axis (y or vertical axis) that represents the depth ranges have plots that range from a total of 30 feet to a total of 50 feet. The 100-year recurrence interval flood is shown with the straight (blue) line. Levees are shown with straight vertical lines.

Station 53000 is the furthest downstream cross section, located approximately one mile downstream of Interstate 5. All of the cross sections from 53000 to 56000 (a little more than half a mile) show that the 100-year flood is contained with the channel, or, more accurately, within the levees. At station 57000, the 100-year flood overtops the banks on both sides, a condition that continues, except in the immediate vicinity of the bridge (see Stations 58300 and 58530). From the next cross section, at station 59500, to station 68999, the 100-year flood overtops the banks on both sides. The flood continues to overtop one or more banks (with a few exceptions) up to roughly station 77900. From there up to station 84500 (the upstream end of the model), the model shows that the 100-yr flood is contained, but comes very near the top of the banks. Upstream from there, the 100-yr flood will generally stay within the banks.



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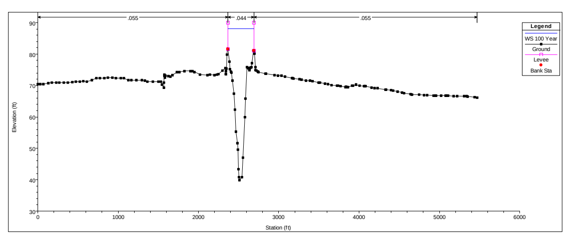
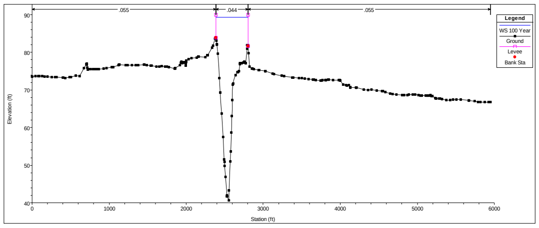


Station 55000

[4] Watershed-Based Assessment of Hydrologic and Geomorphic Conditions in Cache Creek through Capay Valley Yolo County, California. *Prepared for the* Yolo County Resource Conservation District. Kamman Hydrology & Engineering, Inc., May 19, 2010



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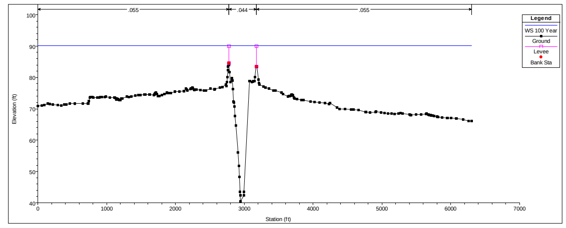

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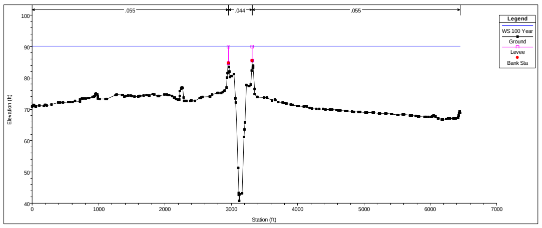

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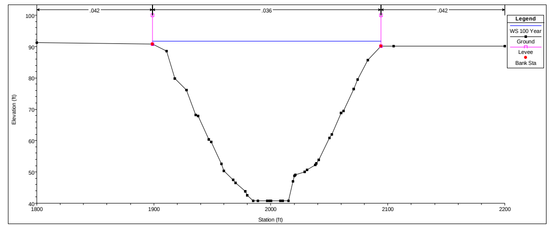

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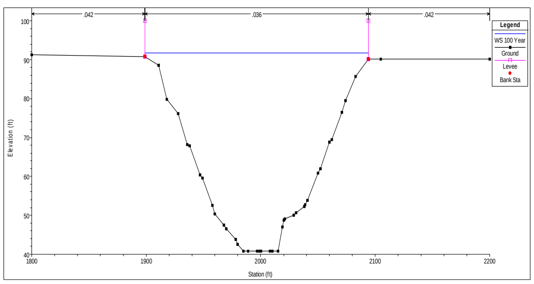

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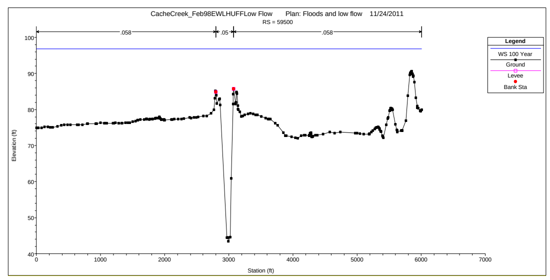

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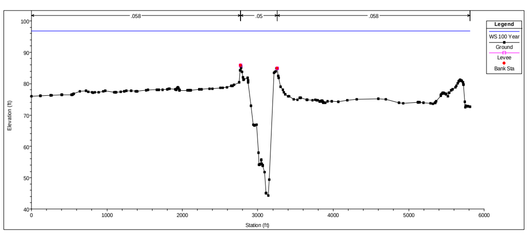

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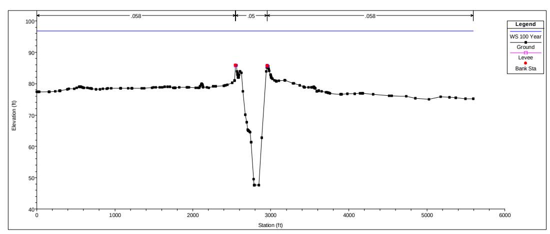

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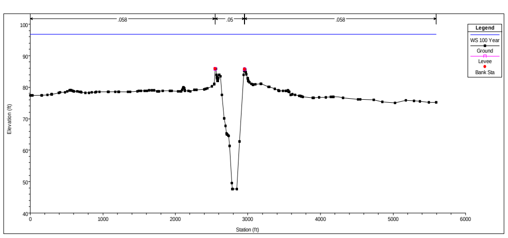

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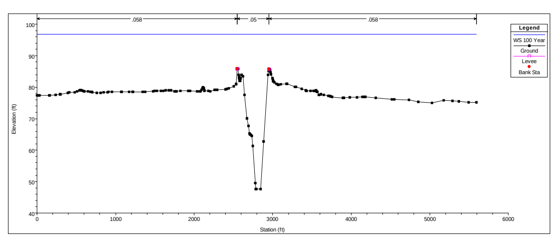

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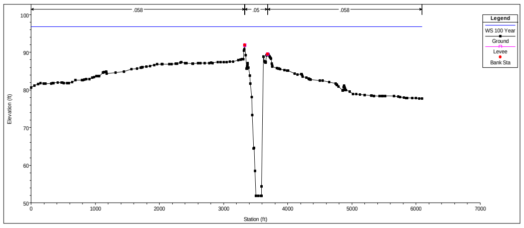

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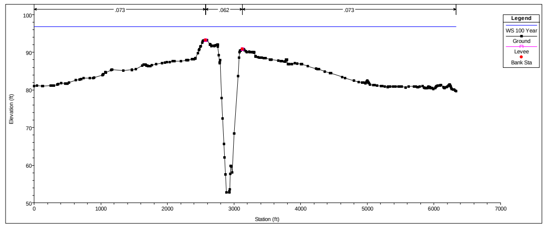

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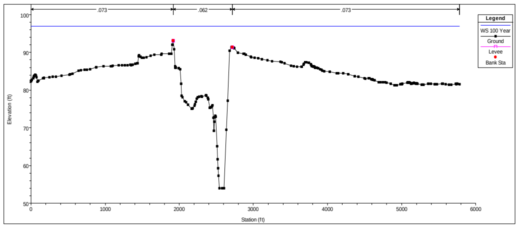

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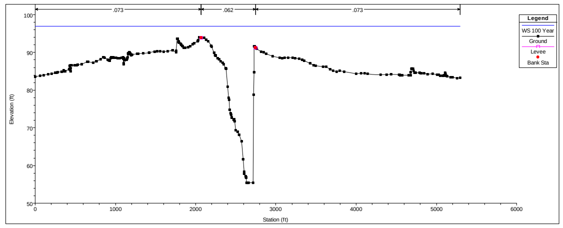

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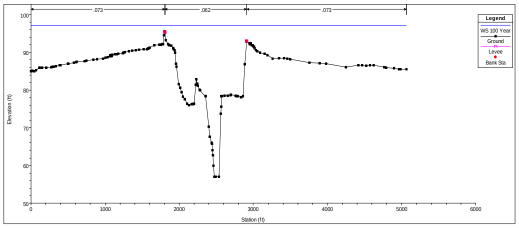

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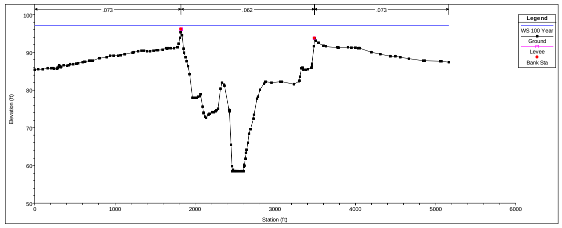

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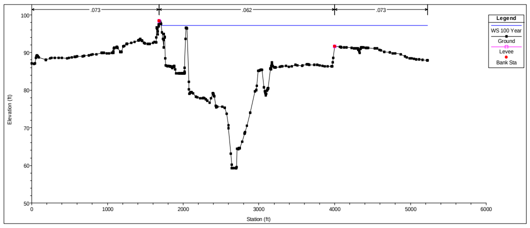

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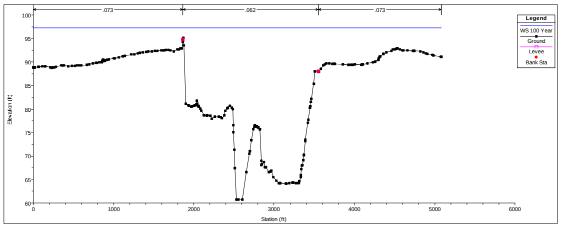

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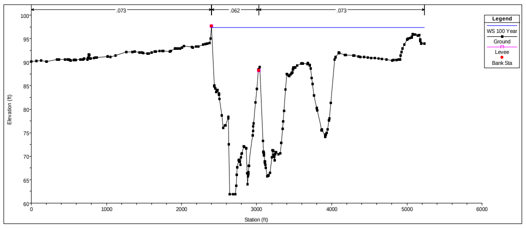

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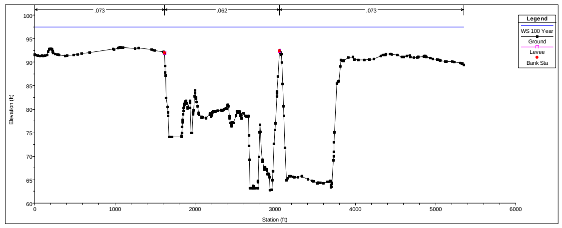

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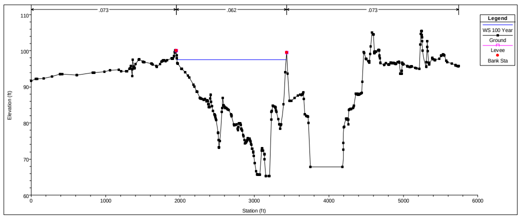

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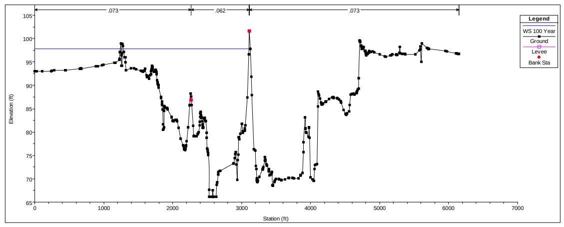

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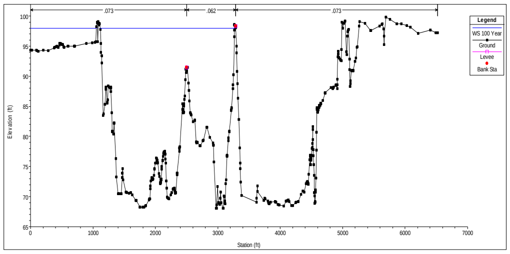

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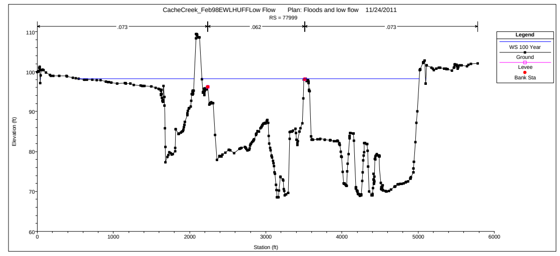

Station 77999

Figure 3 HEC-RAS plots showing the cross section bed profile and flood elevations

The 100-yr flood is shown in solid blue line.

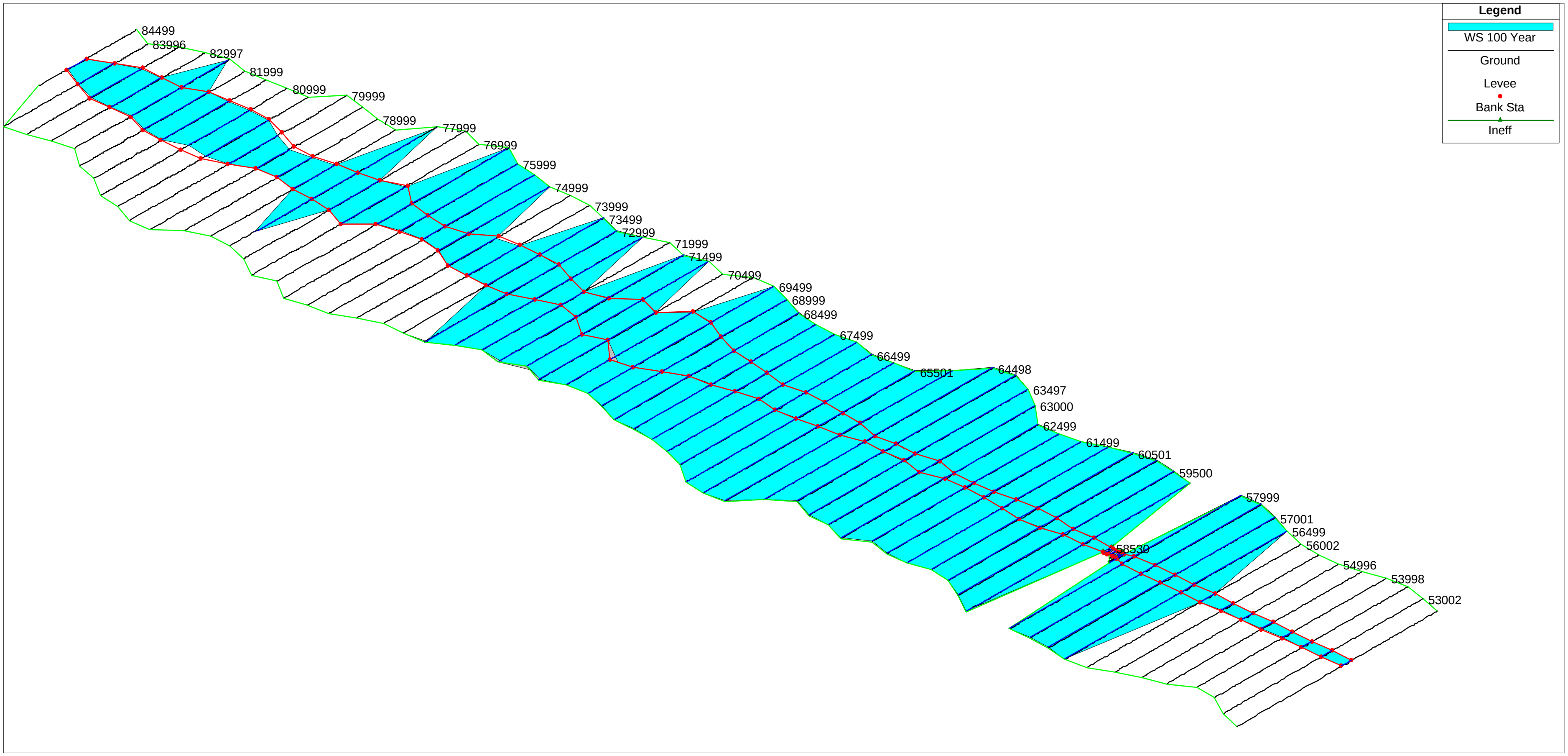

Figure 4 HEC-RAS figure showing the over-bank flooding in the vicinity of Huff's corner

The 100-yr flood is shown in blue. The red represents the top of the bank.

Figure 5 Areas of complete and partial flooding in the vicinity of Huff's corner (HEC-RAS)

The light blue line shows the extent of channel where the model shows that the 100-year flood overtops both banks. The pink line shows the extent of channel where flooding generally overtops one bank.

In general, the results show that the 100-year flood overtops the banks in the vicinity of Huff's corner, but does not overtop the banks both upstream and downstream from Huff's corner. This has been observed and reported anecdotally (Pers. Com. Pollock, Adamo.)

Although the HEC-RAS model that was used here is useful in describing the nature of the flooding in this area, it does use old topography of the channel at this location. The bed topography has changed since the time of the model; but because there is so much distance from the top of the bank in the model and the water surface elevation of the 100-yr flood, we expect that the same PATTERN will be true when the updated data are used. The pattern is likely to be the same, but the detailed locations are likely to differ. Downstream, the channel is constrained by levees on the banks. Upstream, the channel is constrained for the most part by the height of the banks. At this time, we do not know how this flooding pattern compares with the conditions in 1996, when the CCRMP was established.

This can be compared with the Federal Emergency Management Agency Flood Insurance Rate Maps (FEMA FIRM) maps[5] effective 06/18/2010 as shown in the following figure. The FEMA FIRM maps show areas in the legal 100-yr flood zone in the dark shading. There is more extensive flood zone shown in this mapping than the HEC-RAS modeling shows, but the area of complete flooding shown in the RAS modeling is consistent with the FEMA mapping.

[5] https://msc.fema.gov/webapp/wcs/stores/servlet/CategoryDisplay

Figure 6 FEMA FIRM maps June 2010

The dark area represents the FEMA 100-yr flood zone.

2.2.3 FLOOD WATER SURFACE ELEVATIONS AT HIGH FLOW IN 2011

On March 26, 2011, the TAC geomorphologist visited Cache Creek when it was flowing at about 7,000 cubic feet per second, as the water levels in the creek were receding after the peak of the storm flow had passed. In order to document the water surface elevations and other conditions, pictures were taken in the vicinity of each of the bridges in the CCRMP area. The photos, with time and location taken, were included in a technical memo dated November 27, 2011, which was submitted to the County and to Wood Rodgers.

In each picture, it was indicated whether the photo was taken looking upstream or looking downstream. These pictures were submitted as a report that was requested by Wood Rodgers in order to calibrate the HEC-RAS model that they are constructing for the FloodSAFE Yolo project of the California Department of Water Resources that the County will utilize to meet the CCIP requirements relative to the CCRMP/CCIP program modeling requirements. Gage records and representative photographs are included in this annual report.

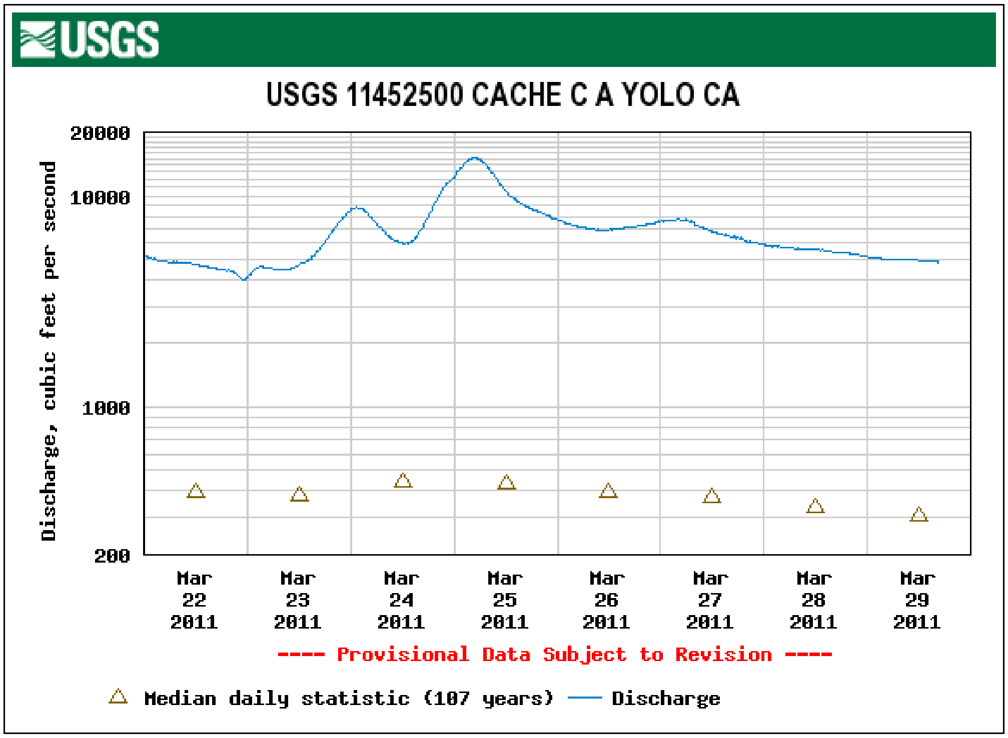

Figure 7 USGS gage Yolo record March 22 – March 29

Figure 8 a From Capay Bridge looking downstream

Figure 8 b From Esparto Bridge looking upstream

Figure 8 c From Esparto Bridge looking downstream

Figure 8 d From Highway 505 Bridge looking upstream

Figure 9 a From Road 94b Bridge looking upstream

Figure 9 b From Road 94b Bridge looking downstream

2.3 BED MATERIAL SAMPLING

Measurements of the bed material size are called for in the CCRMP and the CCIP. The CCRMP states “In addition to continuous water discharge monitoring, periodic sampling of suspended sediments, bed material, and bed load over a range of flow conditions are required to develop a sediment discharge rating curve.” Specifically related to bed material sampling, the CCIP states, “In addition to the samples collected during discharge and high flow measurements, bed material grab samples will be collected annually in each of the seven reaches identified in the Streamway Study within the CCRMP area. Two samples per reach will be collected. These samples will be collected at the time of the TAC's annual inspection.

Samples will be taken from exposed bar areas that are representative of the material being transported along the stream's bed during higher flows. Grain size distribution curves will be prepared for all samples annually.” The CCIP goes on to say, “In addition to bed load samples taken from the flowing stream, dry bed material samples collected in each reach at the time of the annual inspection will be analyzed in the laboratory for gradation. Bed load transport can be calculated from stream properties and bed material size. Table 2 lists the type of compilation, analysis, and data storage required for each measurement type.”[6]

Bed Material Samples	Record field sampling locations and conditions on standard forms. Review laboratory results. Enter date, sample location, and key gradation parameters in County database.	Store field forms in hard copy format; store laboratory results in County database.	Plot D16, D50, and D84 against stream longitudinal station. Plot D16, D50, and D84 for each reach against data for all previous years of record.

Table 2 Cache Creek Improvement Plan (CCIP) excerpt, Table 14

A preliminary discussion with the aggregate industry representative, TAC members, and County staff has led to a question of whether collecting the bed material information is cost effective. Sampling could be done on the creek walk, which would require no extra work. The price of analyzing samples could be determined, and brought back for TAC consideration in a meeting in 2012. For a relatively small expense and time, we could make and analyze the bed material samples, as specified above by the CCRMP and CCIP. These measurements can be used for more detailed sediment transport calculations. In addition, it would be possible to document the reach-by-reach changes to determine what patterns the data reveal over 3-5 years. Typical protocols have been established for such sampling, and have been reported in the literature.[7]

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[6] CCIP p. 39

[7] *“In a 350 m wide reach of the braided, gravel-bed Ashley River, the surface layer of the bed material was sampled in 141 areas of homogeneous graded sediment along seven cross-sections, and 30 kg bulk samples were collected at 86 randomly selected locations along the cross-sections. At one location, a single 854 kg sample composed of 28 subsamples was also collected. Analysis of the single large sample indicate that accurate determination of mean grain size D at the site requires, desirably, a sample of ~100 kg, but that of samples in which the weight of the largest stone is less than 5 per cent of the total weight have unbiased estimates of D. Spatial variability of bulk material is such that 228 and 50 samples are needed to estimate D to ± 10 and ± 20 per cent respectively of the true value; requirements for estimating inclusive graphic standard duration are only 11 and 3 respectively. The grain-size distribution of the surface layer is only weakly related to the bulk material beneath. The results of ‘Wolman sampling’ along 12 cross-sections at two pace intervals (average 120 stones per cross-section) indicate that estimation of overall surface D to ±10 and ±20 per cent would require sampling along 64 and 14 cross-sections respectively. It is concluded that accurate characterization of bed sediment in gravel-bed rivers is very demanding of labor and resources, and that careful planning is needed to ensure efficiency and meaningful results.”* Mosley, M. P., and D. S.

The main question is whether the protocol specified by the CCRMP is adequate for significantly precise results.

Having stated that we could accomplish the suggested sampling and reporting, it is important to note that such sampling, in order to be statistically meaningful, and provide an accurate characterization of the bed sediment "*in gravel-bed rivers is very demanding of labor and resources, and that careful planning is needed to ensure efficiency and meaningful results".*[8] The following discussion is a summary abstract of a paper that sought to answer what type of measurements are required for meaningful sampling.

In the past few years, there have been no measurements of the bed material load by the TAC for Cache Creek. Therefore, grain size distributions have not been calculated, either from bulk material samples or from pebble counts. One former set of measurements was done and recorded in the Technical Studies (Figure 10).

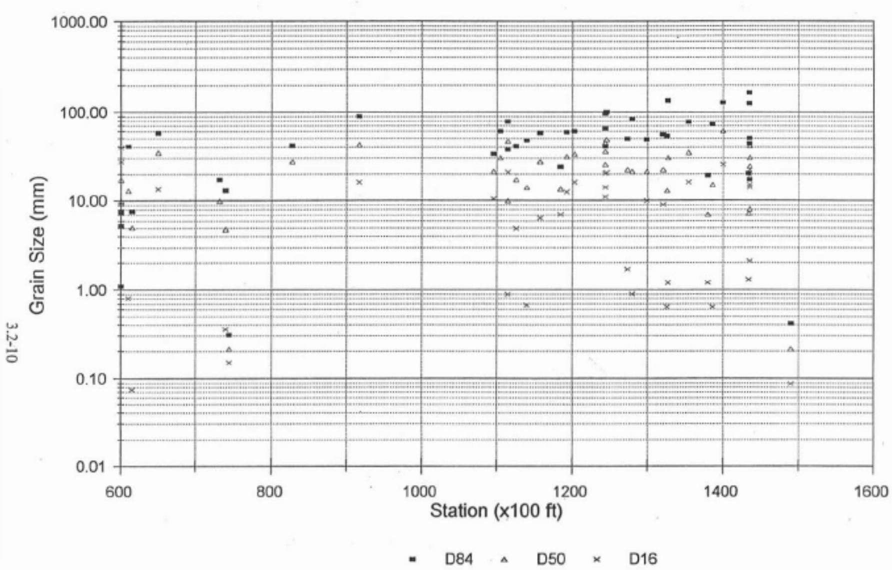


Figure 3.2-5 Grain Size Plotted Against Distance for D84, D50, and D16.
(Note the slight coarsening trend with distance upstream)

Figure 10 Grain size plotted against distance (Technical Studies, 1995)
Technical Studies (1995) 3.2-13
Station 600 is roughly the location of Highway 5; station 1500 is at the Capay Dam

Tindale. "Sediment Variability and Bed Material Sampling in Gravel-Bed Rivers." *Earth Surface Processes and Landforms* 10.5 (1985): 465-82. Print.

[8] Mosley, M. P., and D. S. Tindale. "Sediment Variability and Bed Material Sampling in Gravel-Bed Rivers." *Earth Surface Processes and Landforms* 10.5 (1985): 465-82. Print.

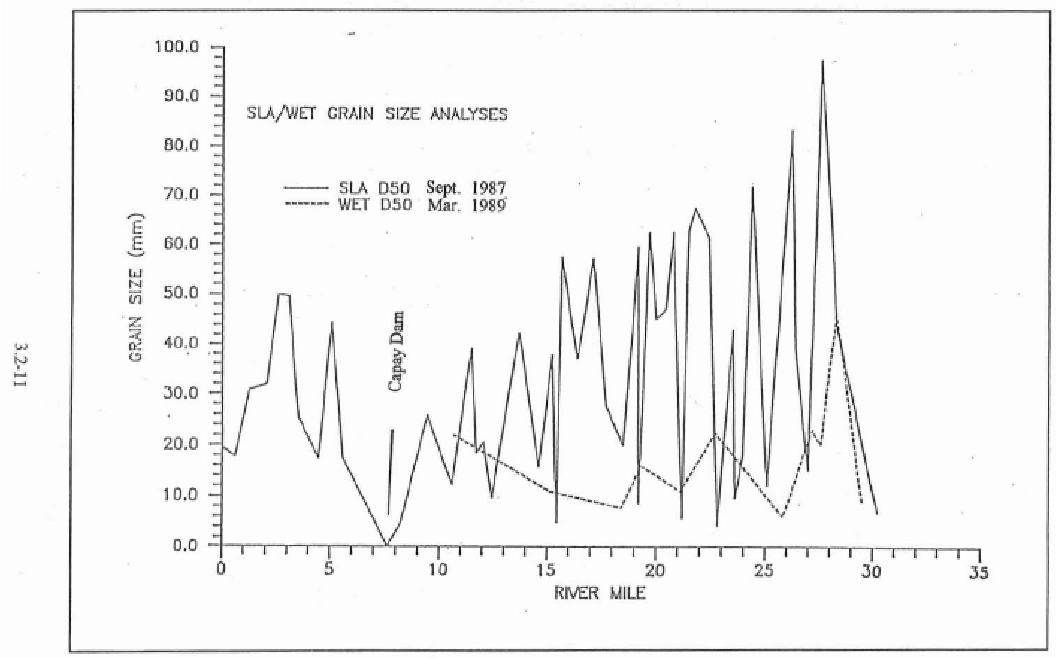


Figure 3.2-6 D_{50} of sampled sediment versus River Mile from SLA (1987) field investigation and from the WET (1989) study, Cache Creek (Note the downstream end of the study reach is located at the I-505 Bridge, not the I-5 Bridge).

Figure 11 D50 grain size versus River Mile

From Simons and Li Associates (1987) and Water Engineering and Technology (1989)

As Figure 10 and Figure 11 show, there is a great variability in the measured grain size on the bed of Cache Creek. Note particularly that two sets of samples two years apart, done by different groups show a consistent difference; WET (Water Engineering Technology) consistently measured significantly lower values than SLA (Simons, Li, and Associates). Although it is possible that the bed surface changed in character in those two years, it is likely that the different sampling efforts resulted in significantly different values. Note that this sampling was done mostly upstream of our study reach, and extends only about 7 miles downstream from Capay Dam.

Sampling the bed surface material can be done relatively easily, with small expense, and these data may be useful in future calculations of the sediment transport, even given the caveats about scientific precision. The TAC geomorphologist recommends that we develop a simple protocol for bed surface material sampling to provide the data called for in the CCIP, and that we carry out this sampling in 2012.

2.4 SEDIMENT TRANSPORT, SUSPENDED SEDIMENT AND BED LOAD

There are many terms used to describe the sediment material that is transported in a river, and there is more than one system of nomenclature describing similar characteristics. This can lead to confusion even among a group of experts in the field. A simple explanation follows, which is intended to inform the following discussions of “sediment transport” in Cache Creek. For the purposes of this report, there are two important components – the material that ultimately composes the bed of the stream, and the material that washes through the system. In Figure 12, these are called “bed material load” and “wash load.” The important component for Cache Creek aggregate purposes is the bed material load, because this controls what forms the channel, what is deposited for vegetation, and what controls flood capacity. The wash load is an important component when considering water quality. One of the main sources of confusion is that the total sediment load in a river can also be classified by the physical mechanisms of transport, which are separated into three components: 1) wash load, 2) bed load, and 3) suspended bed material load (often simply called suspended load) (Figure 12). In the following discussions, "suspended load" will be used to mean suspended bed material load.

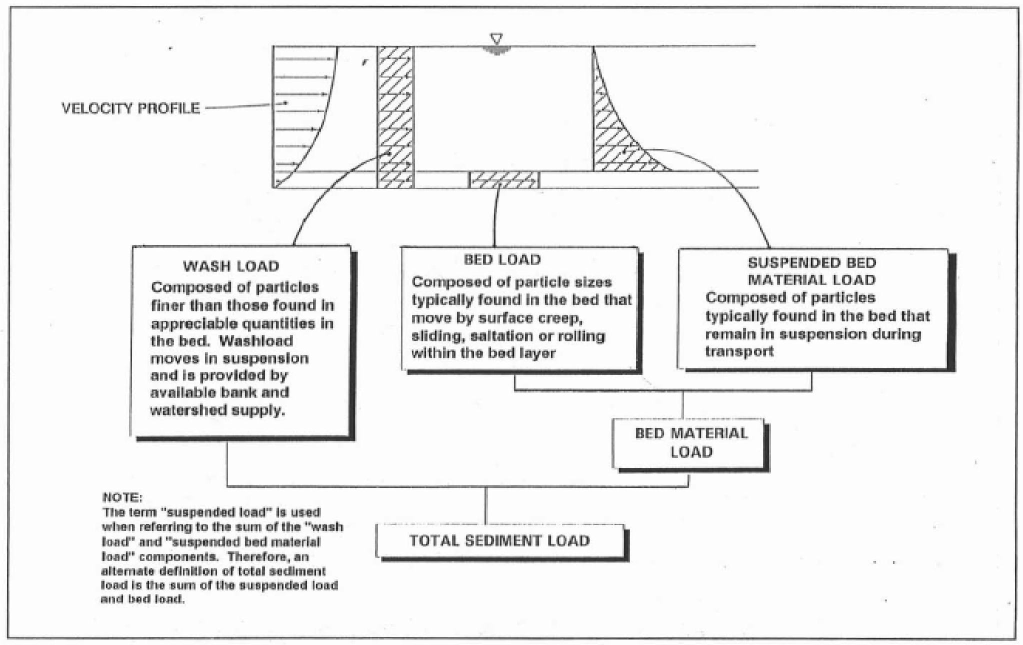


Figure 3.2-7 The components of total sediment load (modified from Mussetter et al., 1994)

Figure 12 Description of sediment load in Cache Creek

(Technical Studies and Recommendations for the Lower Cache Creek Resources Management Plan, 1995)

In the 2010 annual report, sediment transport calculations were made based on sediment transport rating curves developed for Cache Creek based on pre-1996 data[9].

"Best-fit lines through USGS published suspended sediment loads plotted against discharge generated the following relationships:

$Q_s = 0.00018Q^{2.2}$ [Equation 1]

for flows less than 6,000 cfs. and

$Q_s = 0.2Q^{1.4}$ [Equation 2]

for flows greater than 6,000 cfs where Q_s =sediment discharge and Q = water discharge."

These equations were the basis of the suspended load sediment transport rating curve that was developed for Cache Creek.

[9] Technical Studies and Recommendations for the Lower Cache Creek Resources Management Plan, 1995. (Technical Studies)

Bedload measurements were also used to develop a relation between the suspended load and bedload[10]. The bedload was determined to be "*an average of 6 percent of the measured suspended load*." In the former study, they "*chose to calculate bedload as a fixed percentage of suspended load.*" In those studies they "*then applied the suspended and bedload transport functions to each mean daily flow for each annual runoff period and summed the annual totals*.[11]"

In order to estimate the sediment transport quantities for this annual report, a similar procedure was used to determine an estimate of the total sediment transport for the years 2005-2011, for which flow data were available. Flow values were taken for a water year from October 1 to September 30 of the following year[12]. Mean daily flow values were taken from the USGS gage at Yolo (USGS 11452500 CACHE C at YOLO CA). The Yolo gage was used because it had the only complete flow record for this time period. Because this gage tends to record flows that are slightly lower than most of flows for the CCRMP study reach, it is expected that the estimates in this annual report are slightly less than what they might be for the study reach as a whole.

Based on these data and the empirical relationship in the suspended load rating curve, total sediment transport was calculated in tons. The results for 2005-2011 are shown in Figure 13. As Figure 13 shows, 2006 had considerably more total sediment load transport than the other years, and 2011 was second in quantity. In order to compare these results with the flow values, the mean annual flow (determined from the same flow records) was plotted for 2005-2011 (Figure 14).

It is clear from the two graphs that the sediment transport follows the same pattern as the flow, as represented by the annual average of the mean daily flow.

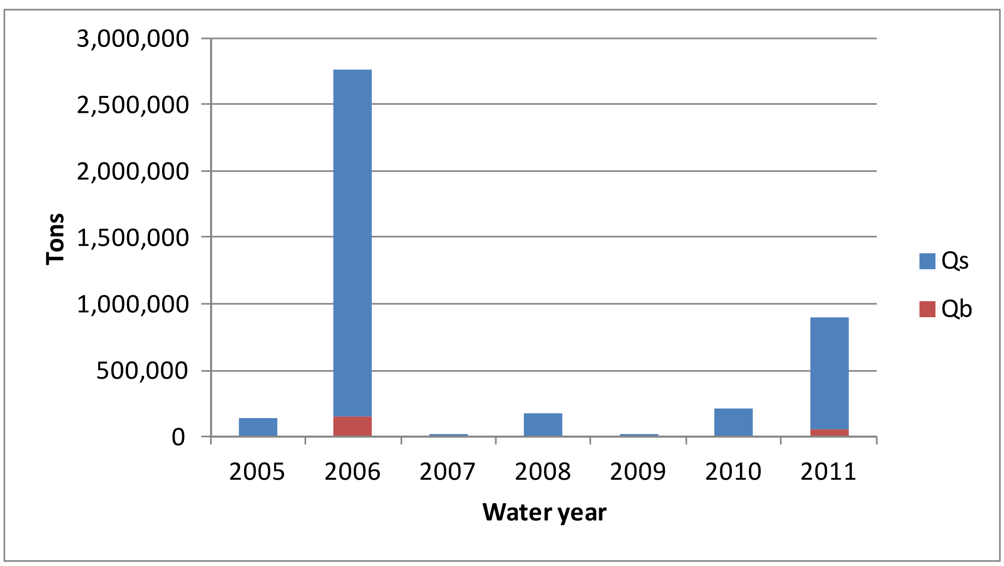


Figure 13 Total sediment transport in tons

QB is bedload; Qs is suspended load. The red represents the bedload portion of the total load.

[10] Technical Studies
[11] Technical Studies p. 3.3-24
[12] From Oct. 1. 2010 to Sept. 30, 2011 is called the 2011 water year.

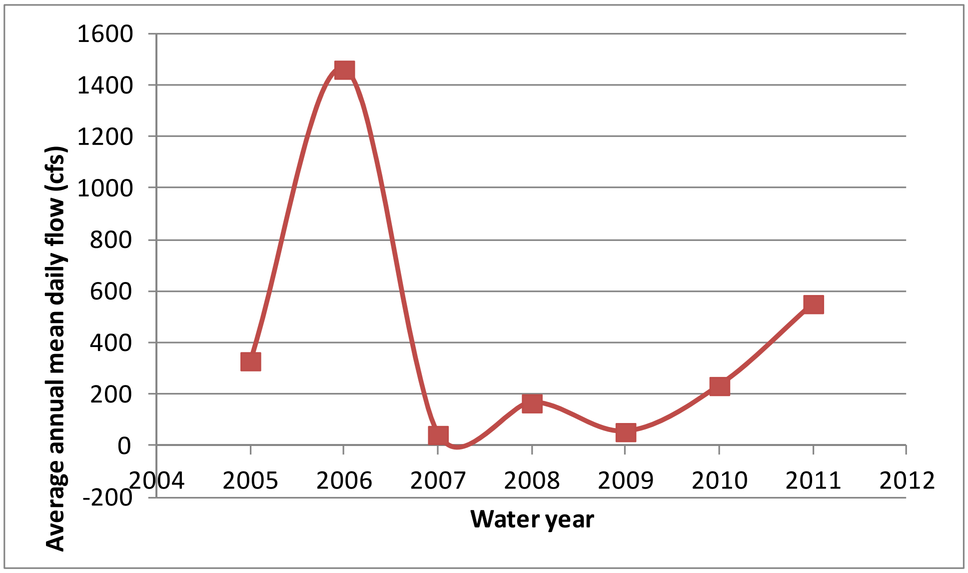


Figure 14 Annual average mean daily flows on Cache Creek at the Yolo gage

Because there is a great variation in observed sediment transport at specified flows, and because actual transport in any year might differ from an empirical estimate, another useful way to consider the patterns over a number of years is to consider the **relative** total quantities from year to year. For example, the data in Figure 13 were also plotted **non-dimensionally**, where each value was considered to be a percentage of the maximum (the load in 2006).

The results (Figure 15 and Table 3) show the total load in 2006 was 10 to 20 times the load in most of the other years.

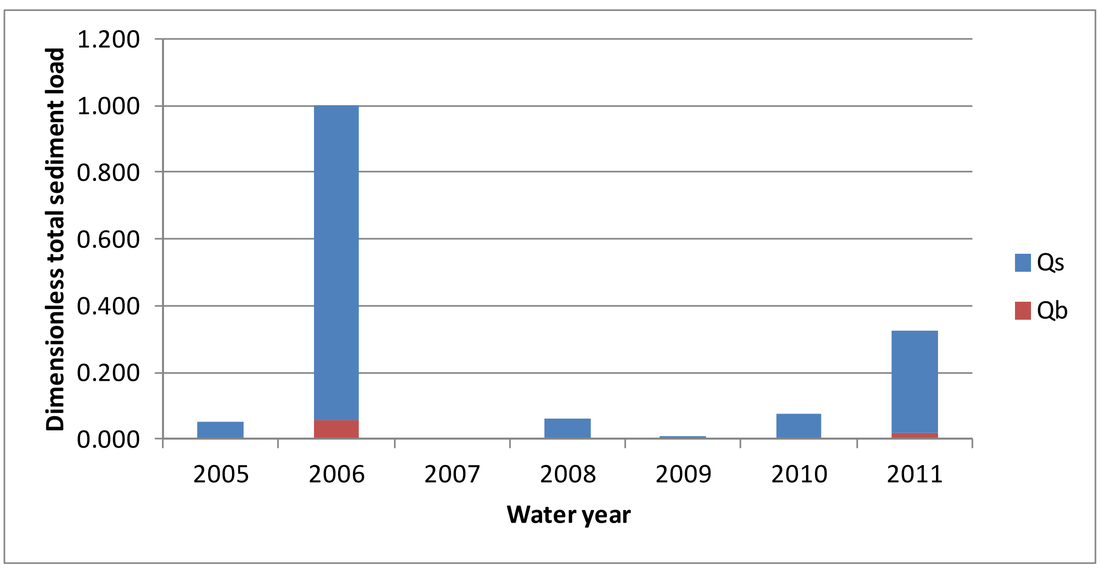


Figure 15 Total dimensionless sediment transport

Water year	Total load
2005	5%
2006	100%
2007	0%
2008	6%
2009	1%
2010	8%
2011	32%

Table 3 Total dimensionless sediment transport

Values are given as a percentage of the 2006 load

Because the material of interest to the CCRMP is the material that can be deposited in the channel (i.e. sand and gravel), the total load was also separated into fines (which wash through the system) and sand and gravel.

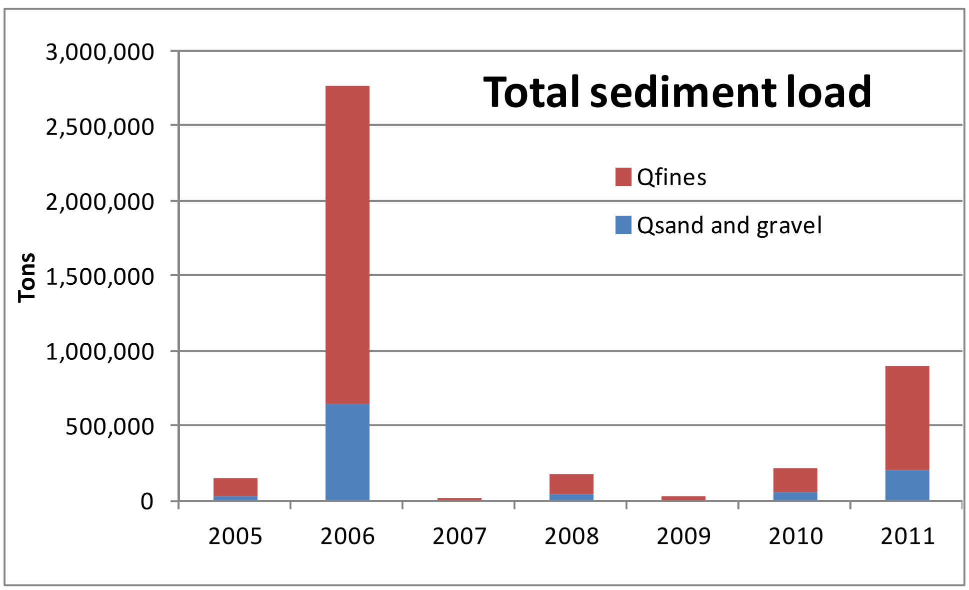


Figure 15 b Total sediment transport in tons

2.5 ANNUAL SEDIMENT REPLENISHMENT

2.5.1 2006-2010 and 2010-2011 RATES OF ELEVATION CHANGE

Table 4 shows the results of a DTM analysis that was performed by a company contracted to calculate the cut and fill (Towill[13]). Surface elevations from 2006 were compared with similar 2010 data in order to estimate the "cut and fill" in that time period. For the purposes of this annual report, it is assumed that the "no buffer" case in the 2006-2010 analyses well represented the active bed of the channel. The data show 1,270,826 cubic yards of change in "net mass".

	No Buffer				
Area	**Fill**	**Cut**	**Net Mass**	**Planimetric Area (Total)**	**Planimetric Area (Total)**
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Sq. Ft.	Acres
1	123,474.0	3,686.4	119,787.6	2,985,833	68.5
2	365,724.5	56,413.4	309,311.1	16,570,776	380.4
3	334,548.4	71,056.6	263,491.8	12,161,446	279.2
4	167,293.2	28,758.0	138,535.2	5,018,624	115.2
5	271,888.0	36,578.5	235,309.5	10,184,357	233.8
6	225,219.7	66,916.1	158,303.6	6,313,749	144.9
7	56,584.8	10,497.2	46,087.6	1,051,819	24.1
Total	1,544,732.6	273,906.2	1,270,826.4	54,286,604	1,246.2

	50' Buffer				
Area	**Fill**	**Cut**	**Net Mass**	**Planimetric Area (Total)**	**Planimetric Area (Total)**
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Sq. Ft.	Acres
1	153,522.3	11,531.2	141,991.1	4,160,509	95.5
2	389,773.4	59,096.9	330,676.5	118,114,875	2,711.5
3	361,554.3	75,689.0	285,865.3	13,154,623	302.0
4	206,759.4	32,506.6	174,252.8	6,173,480	141.7
5	295,456.2	41,816.1	253,640.1	11,629,055	267.0
6	269,214.5	73,440.9	195,773.6	7,988,506	183.4
7	69,442.9	18,149.7	51,293.2	1,667,552	38.3
Total	1,745,723.0	312,230.4	1,433,492.6	162,888,601	3,739.4

Table 4 Cut, fill and net mass for 2006-2010 (Towill, 2010)

Comparable data for the 2011-2010 analyses are shown in Table 5.

[13] Towill, Project Report. 2010 Aerial Mapping Project for the Lower Cache Creek Study Area in the County of Yolo, CA. 2010.

Area	Fill Volume	Cut Volume	Net Mass	Total Area	Total Area
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Sq. Ft.	Acres
1	101,304.4	284,539.9	-183,235.5	22,082,744.2	507.0
2	134,061.0	328,319.0	-194,258.0	21,411,939.0	491.6
3	108,604.6	382,060.6	-273,456.0	16,577,753.2	380.6
4	83,737.2	209,316.7	-125,579.5	8,454,897.1	194.1
5	117,149.5	297,582.2	-180,432.7	16,636,959.4	381.9
6	158,490.6	228,465.2	-69,974.6	10,121,945.1	232.4
7	13,533.9	25,955.3	-12,421.4	1,625,668.7	37.3
Totals	**716,881.2**	**1,756,238.9**	**-1,039,357.7**	**96,911,906.7**	**2,224.8**

Table 5 Cut, fill and net mass for 2010-2011 (Towill, 2011)

2010-2011 Analyses

The aerial extent used to calculate the "cut and fill" in the 2010-2011 surveys is very close to the CCRMP boundary area. This differs from the aerial extent used in 2006-2010 which was much more limited in the Capay Reach, and generally comes to the top of the bank. In order to compare rates of change between the two data sets, the most appropriate comparison is using a rate, which is normalized by dividing the net volume change by the area and the time period. This gives a spatial and temporal rate in cubic-yards-per-acre-per-year. All rates are given as relative volumetric increase. Accordingly, if there was a loss in volume, the value will appear as a negative value.

Net change in volume as reported for 2010-2011 was plotted for each stream reach in the CCRMP area (Figure 16). Because some reaches are significantly larger than others, the spatial/temporal rate of volumetric change in cubic yards/acre/yr was also calculated (Figure 17).

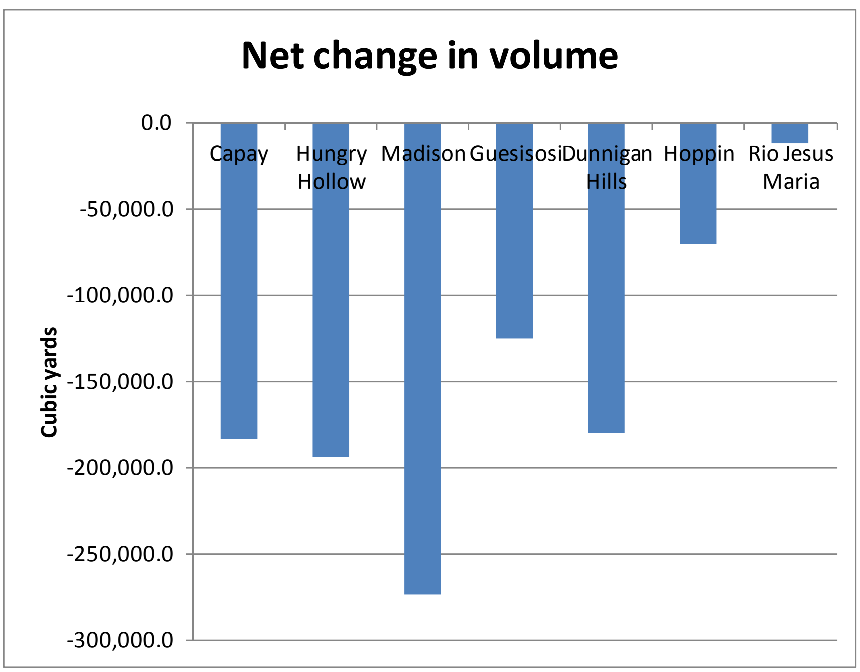
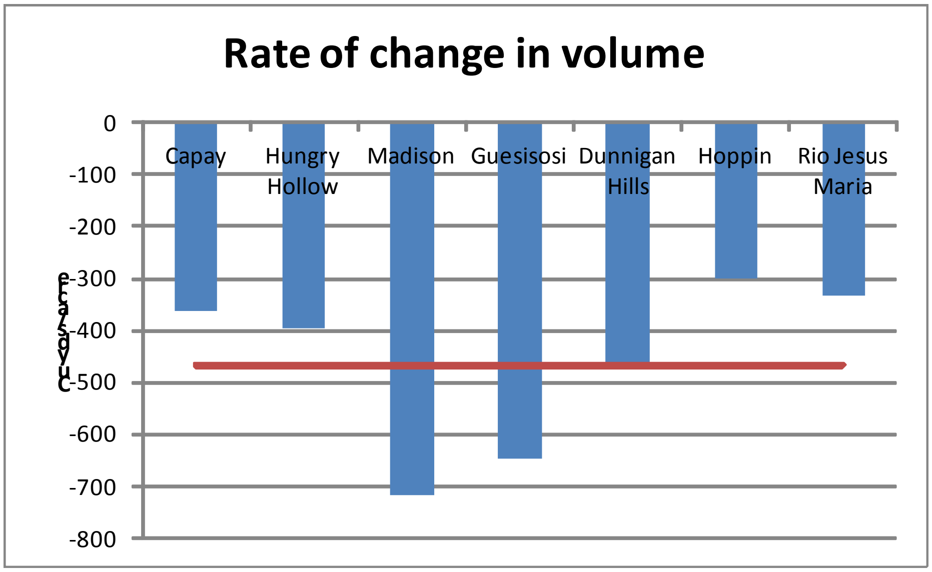


Figure 16 Net change in volume by reach 2010-2011



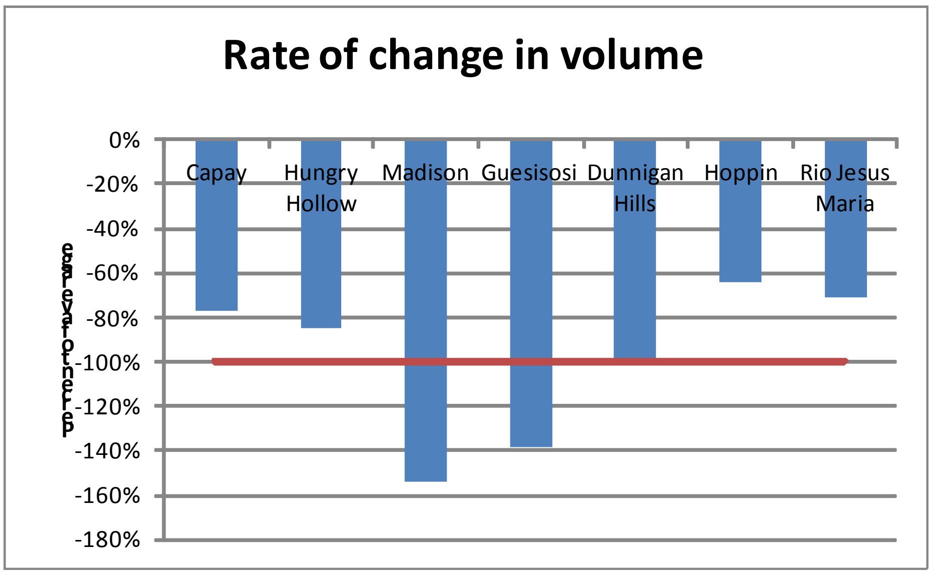


Figure 17 Rate of change in volume per acre by reach 2010-2011

The red line is the average value.

	2010-2006	2011-2010
Capay	437	-361
Hungry Hollow	203	-395
Madison	236	-719
Guesisosi	301	-647
Dunnigan Hills	252	-472
Hoppin	273	-301
Rio Jesus Maria	477	-333
AVERAGE	**255**	**-467**

Table 6 Rates of change in volume by stream reach (cubic yards/acre/year)

2.5.2 2006-2010 and 2010-2011 RATES COMPARED

The data in Table 6 on the annual rate of change in volume shows that there was a change in pattern from yearly increase in volume to yearly decrease in volume from 2010 to 2011. The reason for these differences is likely to be because the water surface elevation, which is likely to have determined the elevations used for "cut and fill" in the channel, differed between 2010 and 2011. In order to ensure consistent reliability of the data and analysis related to annual sediment volumes, a protocol needs to be developed so that the "net mass" calculations indicate the difference in the bed surface elevations from year to year. In addition, different areas were used to measure the aerial extent of change in "net mass".

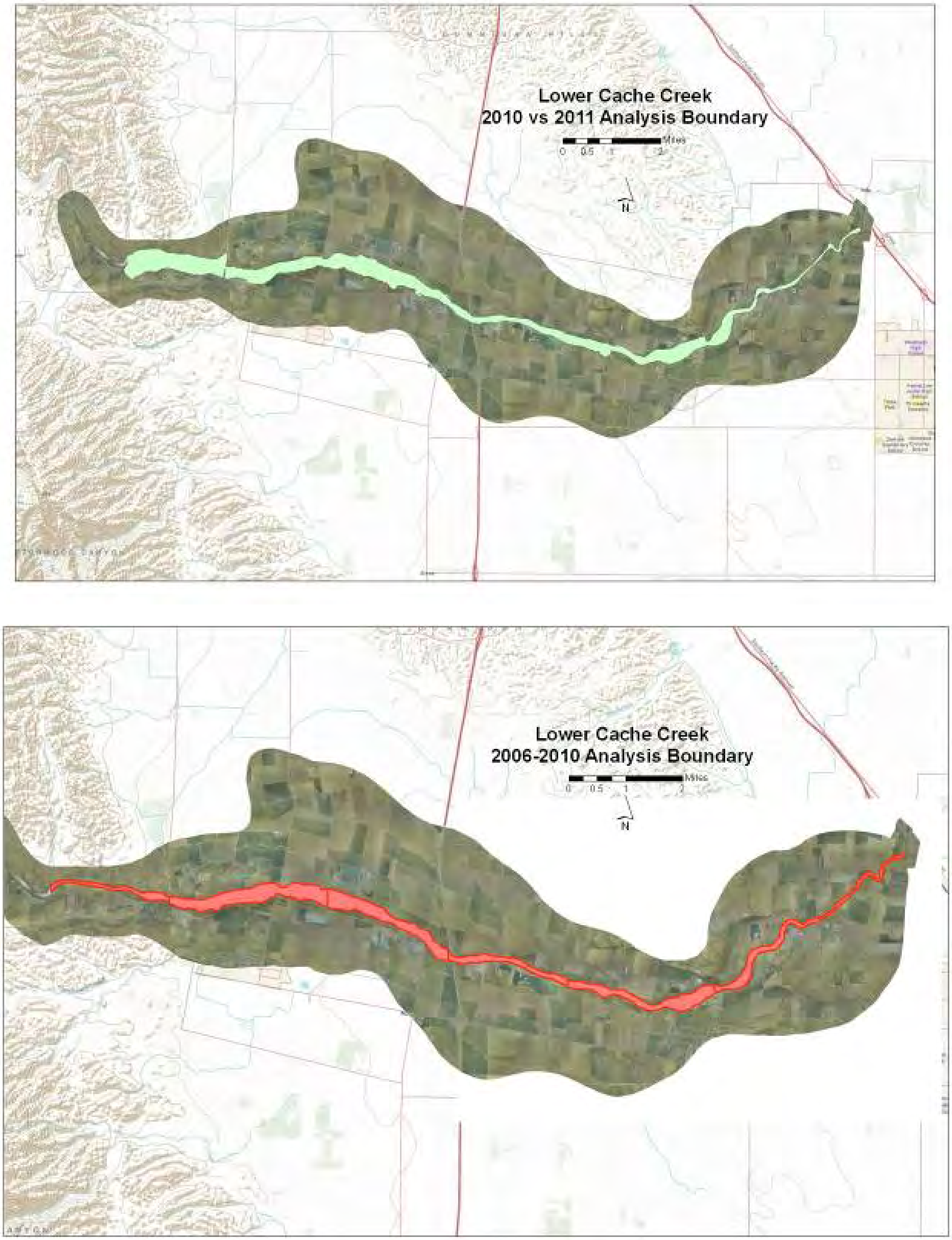


Figure 18 CCRMP aggradation analyses extents

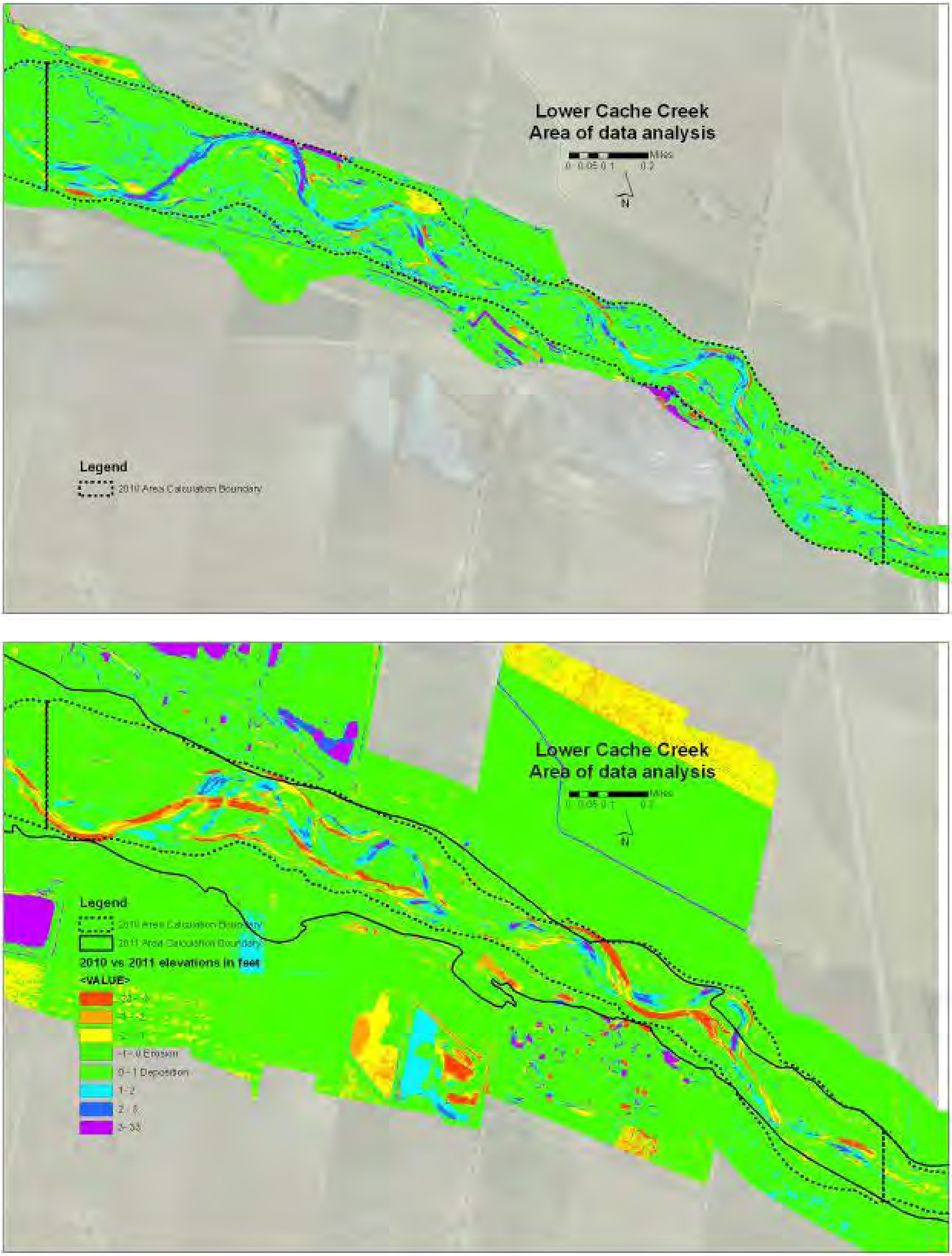


Figure 19 RM 22-21 Detailed example of different extents for volume change calculation

Figure 19 shows a section of the CCRMP and the aggradation "cut and fill" analysis done in 2010 and in 2011 by Towill. The figures are shown to present two main points: 1) that the extents used for measuring the cut and fill were significantly different, and 2) that the locations that eroded/deposited can be seen graphically on each map.

First, considering the extents, the dotted line represents the area within which the areal extent of volume change was measured in 2010. The entire colored figure in the lower image represents the area considered in 2011.

Second, the patterns of volume change were considered within the channel boundaries, which is within the dashed black line on both figures. The upper figure, which shows the volume increase pattern from 2006 to 2010, is easily read graphically, and shows that most of the increase in volume occurred within the active stream channel. Similarly, the lower figure shows that most of the decrease in volume occurred within the active channel.

More analyses need to be done to determine how these volumetric changes actually relate to the change in the quantity of gravel and sand in the creek. The different water surface elevations may account for most of the change in volume that is reported. An accurate understanding of this is necessary in order to correctly interpret trends in channel capacity.

2.5.3 ANNUAL SEDIMENT REPLENISHMENT ANALYSIS

Ideally, the data that was presented by Towill could be used directly for calculations of sediment aggradation or degradation. Because of the confounding effect of different water surface elevations in 2010 and 2011—which appears to have determined the elevations reported for "in-channel" cut and fill—the cut and fill data cannot be effectively used to analyze the annual sediment replenishment.

The sediment transport calculations above show that 2011 had the second highest rate of sediment transport since 2006 (Figure 15 and Table 3). This suggests that there was enough material for deposition and sediment replenishment, but at this time additional work is necessary to document whether this occurred in 2011.

2.6 BED SURFACE MATERIAL ARMORING

Armoring of the bed surface material refers to a coarse layer of material occurring on a surface layer of the channel bed which covers layers of bed material which are smaller in size. Because larger material requires more force from flowing water to mobilize (i.e. be transported), the surface layer in essence "armors" the finer subsurface material. Armoring is a natural occurrence in most gravel and sand bed rivers. In order to measure bed armoring, samples of the surface layer and of the subsurface layer are analyzed for size distribution. Bed armoring has been correlated with the balance between the sediment supply and the amount transported. Bed armoring data are also useful if detailed sediment transport calculations are to be made, which is not possible at this time. No known recent measurements of bed surface armoring on Cache Creek have been made that would allow the TAC to estimate bed armoring. A review of existing bed armoring data and a recommendation on how to proceed in the future will be discussed at a TAC meeting in 2012.

2.7 MATERIAL EXTRACTED IN-CHANNEL

There was no material extracted in-channel in 2011.

2.8 REACH OBSERVATIONS

2.8.1 REACH OVERVIEW

The original Technical Studies identified 9 reaches of lower Cache Creek that were distinguished as geomorphically distinct. Seven of those reaches, as identified below, fall within the CCRMP boundary. The Technical Studies nomenclature is used in this annual report.

2.8.2 LONGITUDINAL WATER SURFACE PROFILES (SLOPES) BY REACH

The slope (longitudinal water surface profile) is important because it influences stream processes such as sediment transport. In general it is preferable to use the longitudinal bed surface profile. However, because the DTM data do not penetrate through the water surface, water surface elevations at low flow are used instead. The slopes over long distances will be identical for both the bed surface and the water surface. Sediment transport is proportional to a power function of the slope. Lower slope reaches, and areas within reaches which have lower slopes, will tend to deposit more material. Understanding the local differences in slope, and how those may change over time, is a way to assess and understand the reach specific geomorphic dynamics, sediment transport dynamics, and perhaps depositional patterns of Cache Creek. In the Technical Studies, basic geomorphic characteristics were identified for each reach by Northwest Hydraulics Consultants (NHC). Included in these characteristics were the reach length, the slope, and other factors (Table 6). The DTM data for both 2010 and 2011 also included reach length and slope, enabling analysis and comparison with the values from the 1995 Technical Report.

The slopes for the 2010 and 2011 DTM data are shown in Table 7. The individual slopes are shown graphically in the specific reach-by-reach descriptions below. The summary of their values is shown in Table 7.

	NHC		2010 DTM		2011 DTM		2011-2010
	Length (mi)	**Slope (ft/ft)**	**Length (mi)**	**Slope (ft/ft)**	**Length (mi)**	**Slope (ft/ft)**	**Elevation change (ft)**
Capay	2.1	0.0020	2.11	0.0016	2.11	0.0016	-0.97
Hungry Hollow	2.8	0.0021	3.33	0.0022	3.30	0.0022	-1.21
Madison	2.5	0.0023	2.92	0.0017	2.61	0.0018	-1.37
Guesisosi	2.3	0.0012	2.35	0.0014	2.37	0.0016	-1.48
Dunnigan Hills	2.8	0.0019	3.00	0.0015	3.02	0.0015	-1.14
Hoppin	3.3	0.0014	3.72	0.0012	3.77	0.0013	0.10
Rio Jesus Maria	1.4	0.0013	1.03	0.0014	1.03	0.0013	-1.62
Total length	17.2		18.46		18.21		
Average		0.0018		0.0016		0.0016	-0.97

Table 7 Slopes by reach

(Technical Studies (1995) and analysis of Towill 2010 and 2011 DTM data)

DISCUSSION

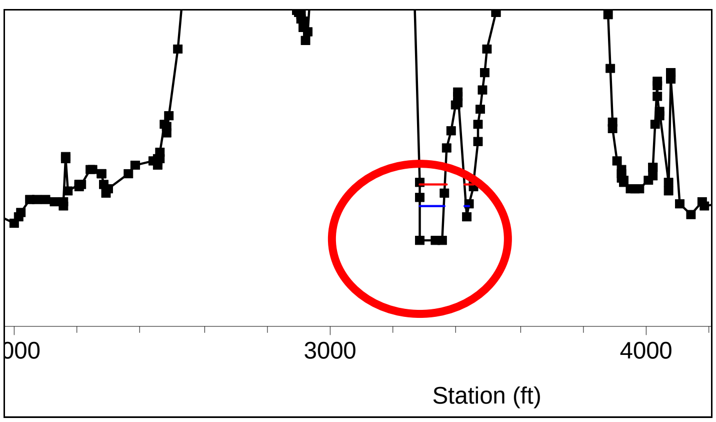
Table 7 shows that the slopes have stayed almost the same between 2010 and 2011, with a few minor differences. The Madison reach has a greater slope in 2011, probably because the channel trace was less sinuous than in 2010 and therefore shorter. A shorter sinuous channel trace over the same distance will be steeper. The Geusisosi (0.0016 in 2011 versus 0.0014 in 2010) and Hoppin (0.0013 in 2011 versus 0.0012 in 2010) reaches were also steeper, although they were not significantly different in length. The Rio Jesus Maria reach was slightly less steep in 2011 (0.0013 in 2011 versus 0.0014 in 2010).

The reach-weighted average slope for the entire CCRMP area remained the same at 0.0016.

The longitudinal profile (slope) plots for 2010 and 2011, which are shown individually below for each reach, also show that the elevation where the longitudinal profiles were taken has decreased in 2011. The elevations in all reaches except the Hoppin reach were, on the average, about a foot lower in 2010 than in 2011.

The different water surface elevations at which the data were collected could account for the difference in elevations. This was investigated by means of a HEC-RAS analysis. The 2010 data were collected at a discharge of roughly 300 cfs, and the 2011 data were collected at 100 cfs.

Based on a HEC-RAS analysis of 153 cross sections extending from the Road 94B Bridge to the Highway 5 Bridge, the average difference in water surface elevation was 1.23 +/- 0.33 (standard deviation) feet (Figure 20 and Table 8). This means that the water surface elevation at 100 cfs (2011 data) would be slightly more than a foot lower than the water surface elevation at 300 cfs (2010 data).



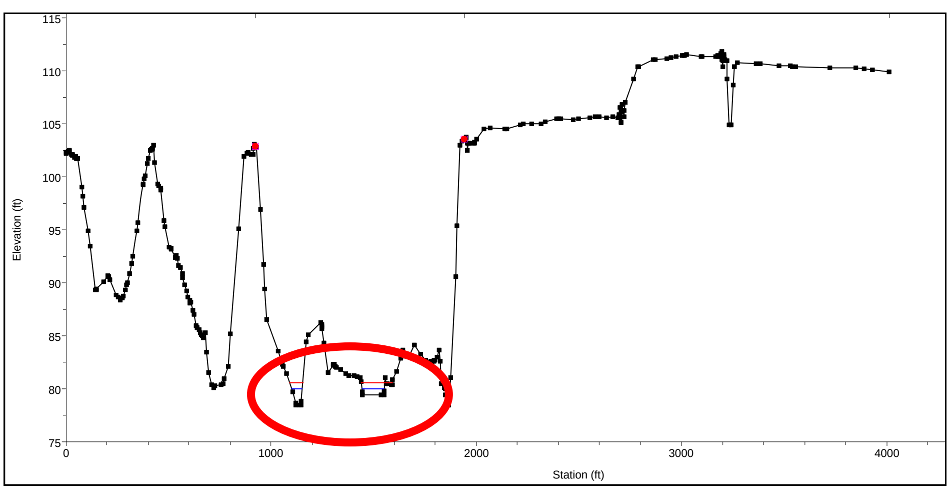


Figure 20 Elevation changes in sample HEC-RAS cross sections

The red line shows the water surface elevation at 300 cfs (2010) and the blue line shows it at 100 cfs (2011).

Elevation change estimates due to change in discharge 2010-2011	
Average (ft)	1.23
Count	153
St. dev.	0.33

Table 8 Modeling changes in water surface elevations on DTM's due to changes in Q

These data are from HEC-RAS modeling.

The comparisons suggest that the difference in elevations on the slope plots may be largely due to the water surface elevation difference between 100 and 300 cfs flow levels. Other analyses would be required to determine other possible causes, such as deepening of the thalweg.

2.9 REACH BY REACH COMPARISONS

The cut and fill data that are reported here are taken from the DTM analysis provided by Towill[14]. We are aware that there are potential inaccuracies associated with the 2006 data used for these comparisons, and will be exploring other data to compare with the results compiled by Towill in 2010 and 2011. In addition, the 2010 and 2011 comparisons (see in this report, immediately above) will be explored more fully to determine to what extent the reported results are from different water surface elevations in 2010 and 2011, rather than from changes in the bed surface elevation of the creek. Although bed degradation and aggradation may not be well represented by the cut and fill data, bank cut and fill is likely to be well represented. Where major "erosion" (> 3 feet) is reported near a steep bank, this is interpreted to mean that the bank was eroded.

The areas used for calculation of the net cut and fill differed between 2010 and 2011, with the area of cut and fill in 2011 measurements including one large area of overbank CCRMP lands in the Capay Reach. This makes strict quantitative comparisons between time periods somewhat difficult.

Given these caveats, the following discussion uses the data as presented by Towill.

2.9.1 CAPAY REACH (RM 28.45 TO 26.35)

The Capay Reach (Figure 21) currently extends approximately 2.1 miles from the Capay Dam to the Capay Bridge (RM 28.45 to 26.35). It had an average slope of approximately 0.0016 in both 2010 and 2011, which is the average for the entire CCRMP reach. The 2011 measured length is the same as that reported in 2010 and in 1995. The reach was reported to have rates of aggradation of 437 cubic yards per acre per year in 2006-2010, aggrading at about 170% of the average in the CCRMP area in that time period. In the downstream segment of this reach, the channel widens significantly suggesting a change in bed or bank conditions.

[14] Towill Surveying, Mapping, and GIS Services. 2011 Aerial Mapping Project for the Lower Cache Creek Study Area in the County of Yolo, CA. October 24, 2011.

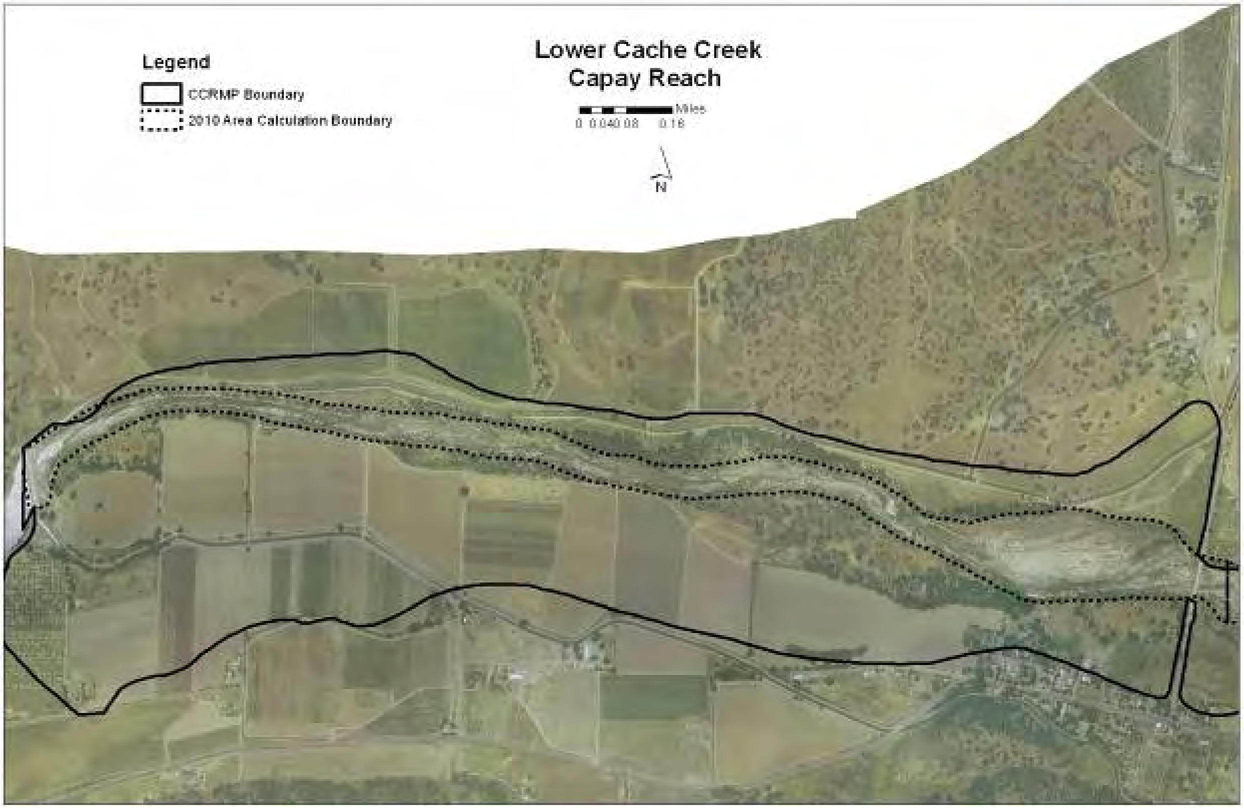
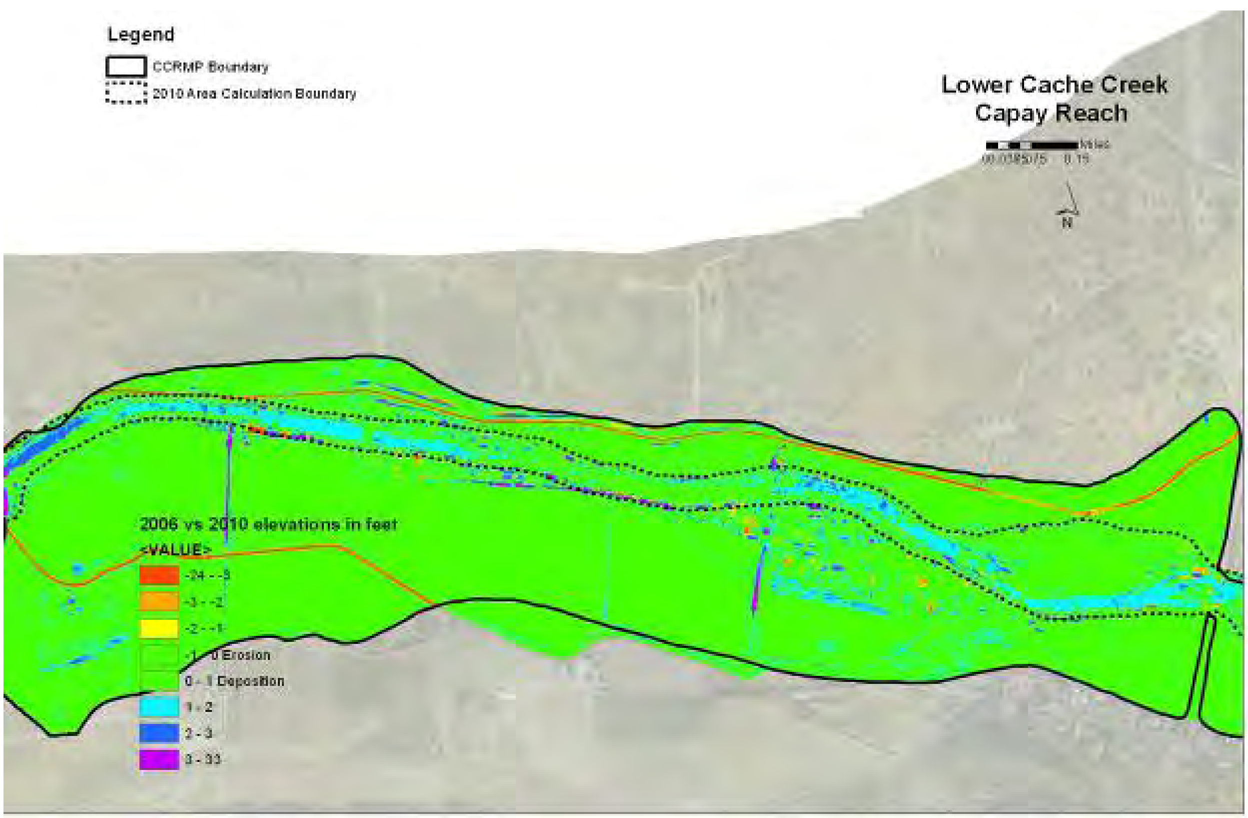


Figure 21 Capay reach RM 28.45 to 26.35



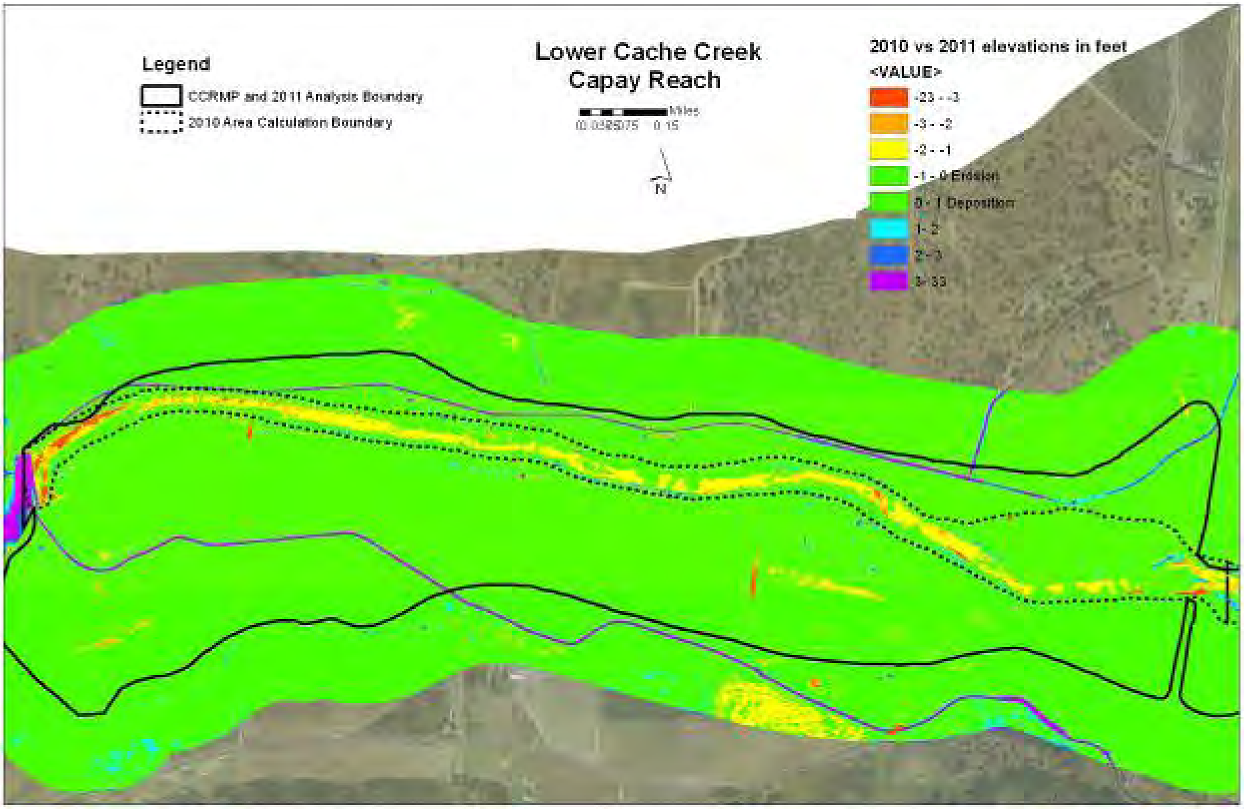


Figure 22 Capay reach RM 28.45 to 26.35 cut and fill maps

In 2006-2010 there was a reported 1-2 feet of fill along the river channel for most of the reach (Figure 22 upper image). In 2010-2011, a consistent 1-2 feet of cut was reported along the entire reach (Figure 22 lower image) and the rate of reported cutting was 361 cu. yds./acre/yr. Erosion reported in the bed of the channel may actually reflect the change in water surface level from one year to the next.

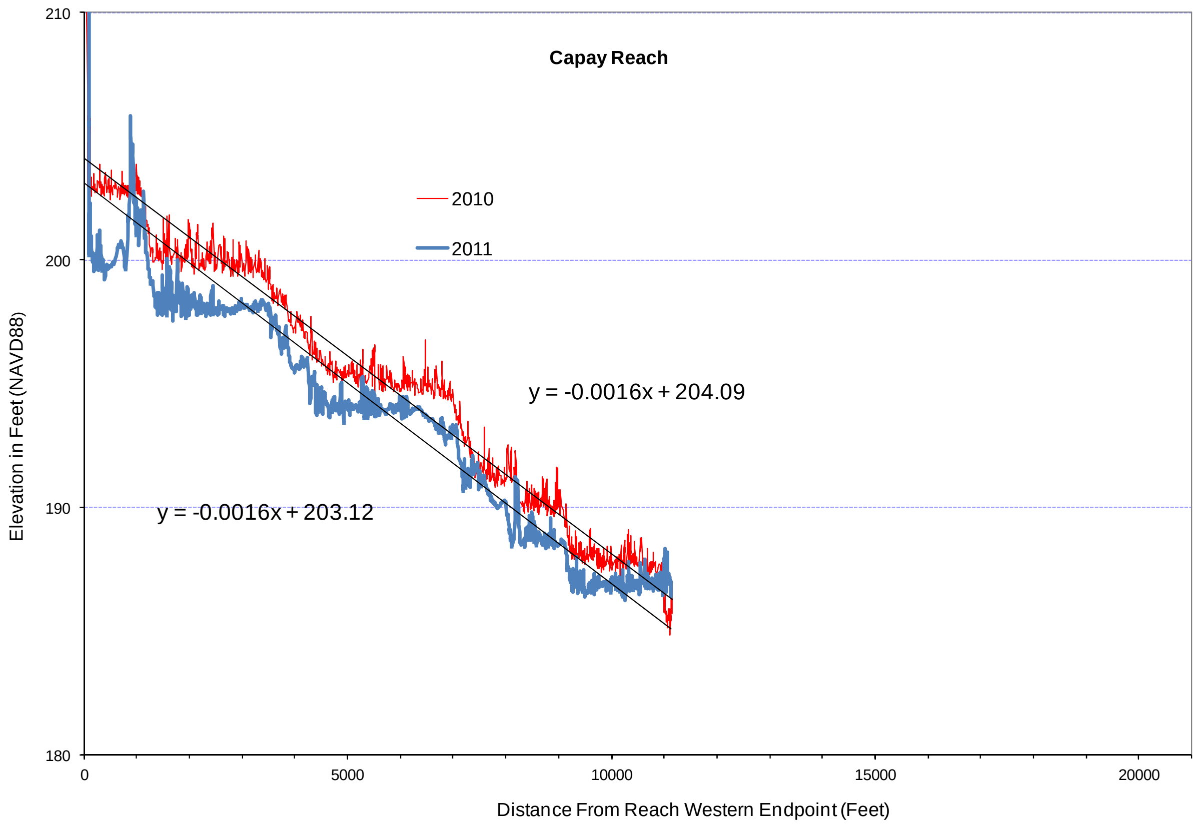


Figure 23 Capay reach longitudinal profile (slope) with analyzed trend line

The longitudinal profile (Figure 23) shows that there are 6 areas where the profile is essentially flat, with steeper sections in between. The difference in elevation in the two profiles may be due to the difference in water surface elevation.

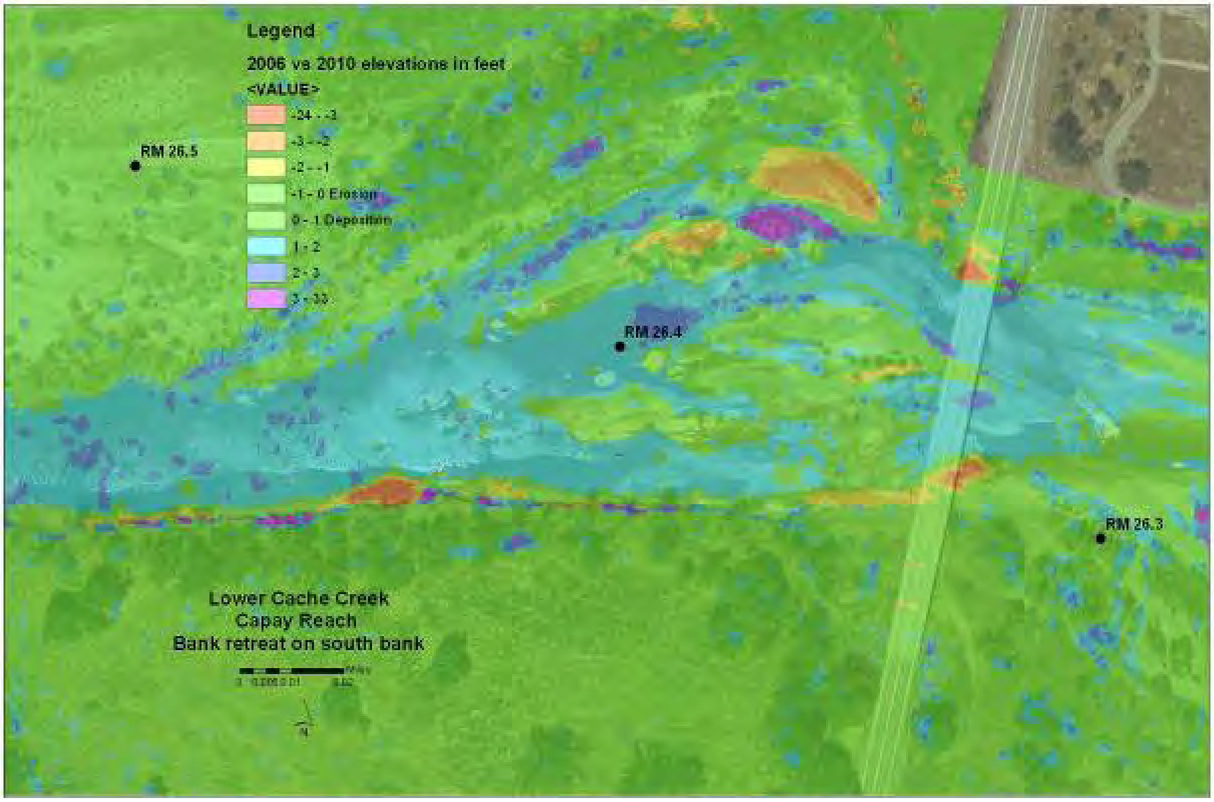
There are two components of the equation for the trend lines that are useful. The first is the slope itself. The second is the “intercept” or the value of y when x is zero. From the difference in the intercept values of the trend lines in 2010 and 2011, the average change in elevation can be roughly estimated. These values appear in Table 7 as the “elevation change” in the last column.

2.9.1.1 CHANNEL SHIFT AT RM 26.4

Upstream from the Capay Bridge, on the south bank, where there are steep banks with exposed soils, there is a terrace where the TAC was told that the local land owners are concerned about erosion (Figure 23 b).

Figure 24 shows the bank retreat patterns in red. In 2006-2010 the main area of bank retreat was between RM 26.5 and 26.4 on the south bank, with a smaller area underneath and downstream from the bridge (Figure 24 upper image). In 2010-2011, the patterns were similar, but there was more bank retreat immediately downstream and upstream from the bridge (Figure 24 lower image). The area between RM 26.5 and 26.4 on the south bank continued to shift in 2011. This area should be actively monitored for possible future action. No remedial action is recommended at this time

Figure 23 b Capay Reach detail of bank retreat on the south bank near Capay Bridge



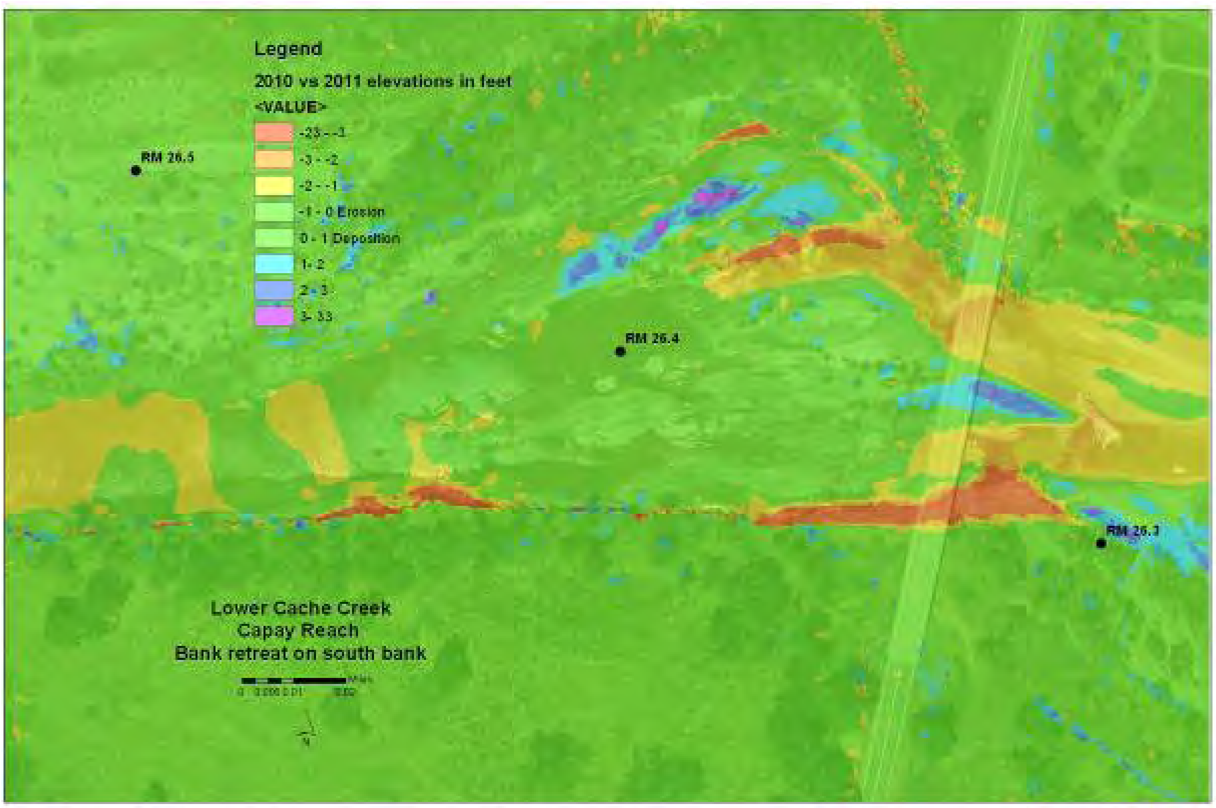


Figure 24 Capay Reach: bank retreat patterns on the south bank near Capay Bridge

Another area that shows significant elevation change between 2010 and 2011 is in the reach immediately downstream from the diversion dam. In addition, the 2010-2011 data show erosion in the bed immediately upstream from the PGE crossing and bank retreat on the south bank across from the concrete pillows that have been installed in the creek (Figure 25). Continued coordination with PGE is recommended to insure that new stabilization is consistent with the CCIP.

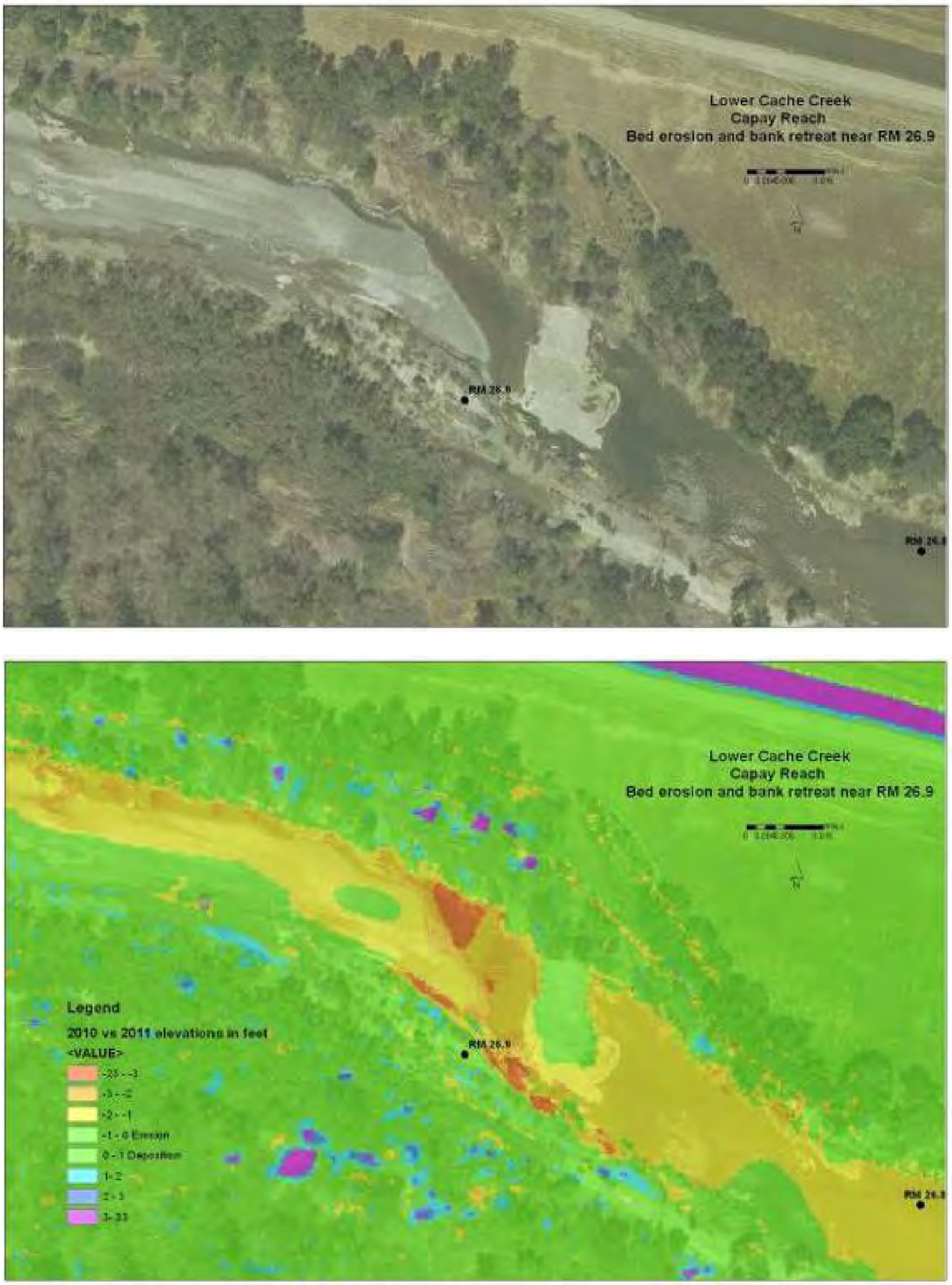


Figure 25 Capay Reach detail of erosion near PGE pipeline crossing RM 26.9

2.9.2 HUNGRY HOLLOW REACH (RM 26.35 to 23.50)

The Hungry Hollow Reach (Figure 27) currently extends approximately 3.3 miles, and has an average slope of approximately 0.0022, which is significantly steeper than the other CCRMP reaches. The slope in 2010 and 2011 was roughly the same as it was in 1995 (0.0021). The reach had the lowest rate of volumetric change in 2006-2010, changing in volume at about 80% of the average in the CCRMP area. The 2010-2011 data show a volumetric elevation loss of 395 cu yds/acre/yr in this reach.

The longitudinal profiles in the two time periods (Figure 26) are relatively parallel, with some minor changes in pattern. Near station 8000 in Figure 26 the elevation profile flattens where it was sloped in 2010.

The slope profiles show that the elevation was about 1.2 feet lower in 2011 than in 2010.

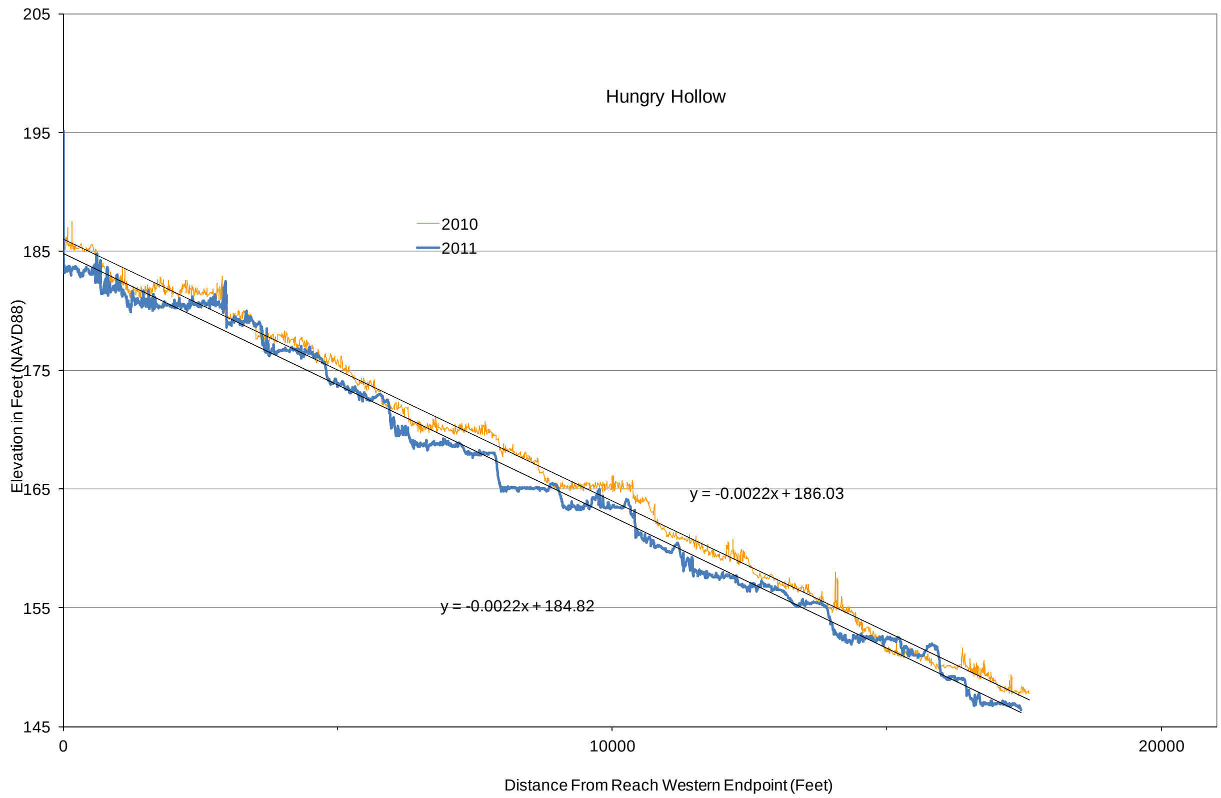
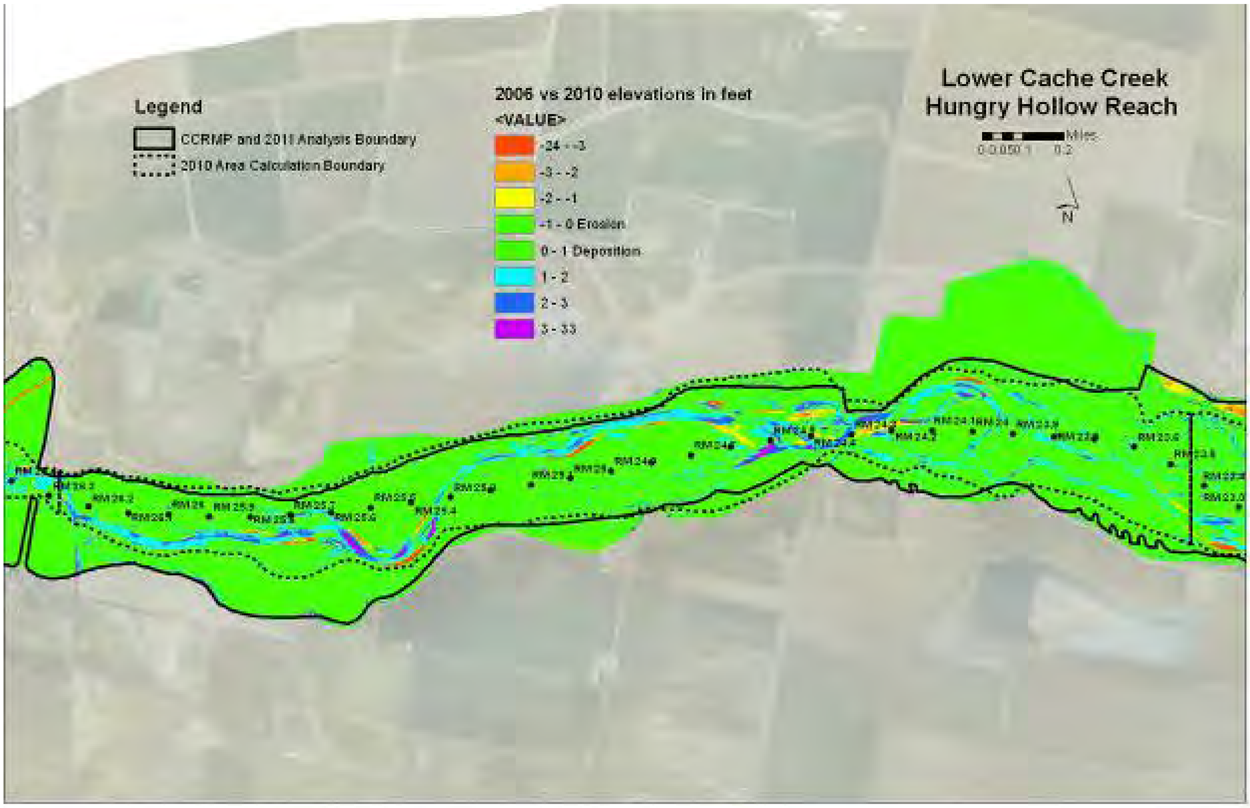


Figure 26 Hungry Hollow Reach RM 26.35 to 23.50 slope

Figure 27 Hungry Hollow Reach RM 26.35 to 23.50

In considering volumetric change, the cut and fill maps (Figure 28) show much more yellow and red in the channel itself in the 2010-2011 time period, indicating that the elevations in 2011 were less than in 2010.



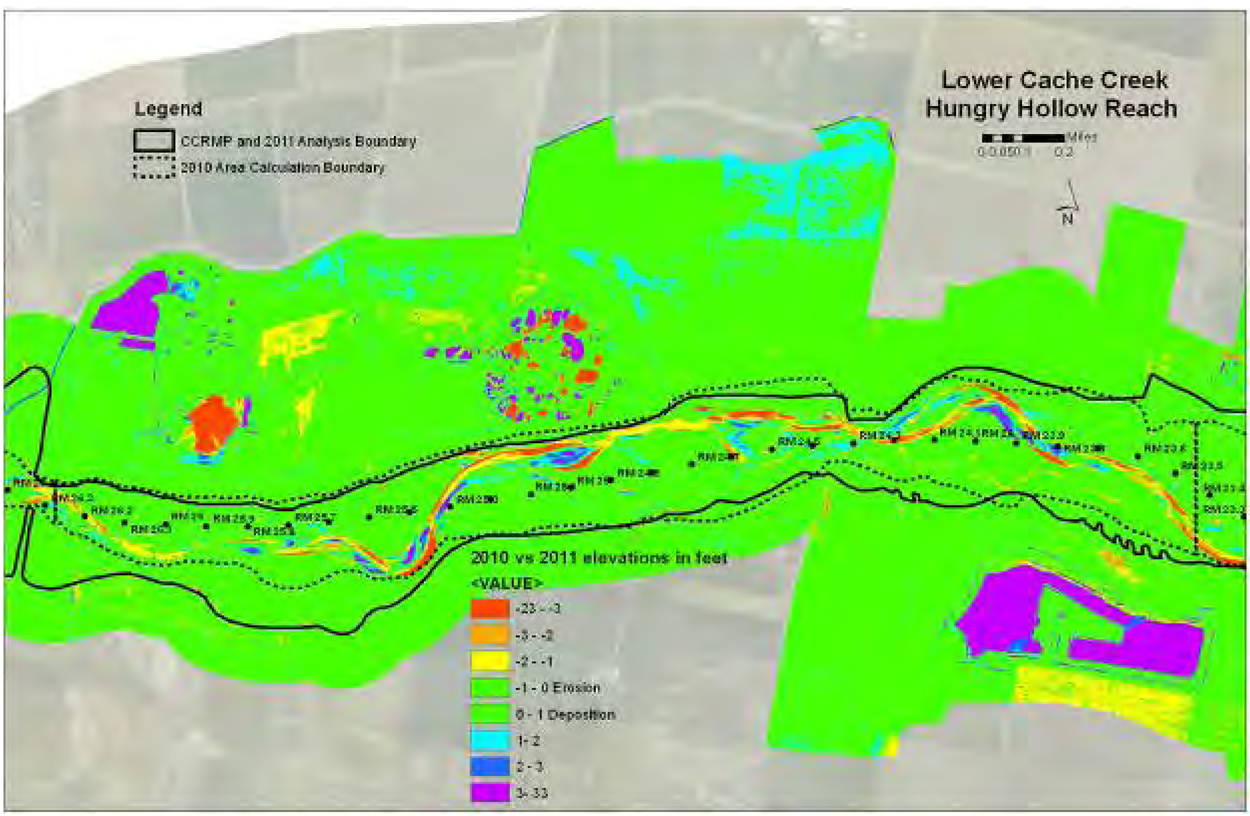


Figure 28 Hungry Hollow Reach RM 26.35 to 23.50 cut and fill maps

2.9.2.1 CHANNEL SHIFT NEAR RM 25.4- 25.5

The bank retreat near RM 25.4 -25.5 (Figure 29) has been noted on TAC creek walks. In this vicinity, a land owner has placed “launch-able” concrete (i.e. concrete slabs that are placed in such a position that when the bank retreats, the concrete will fall into the creek) attempting to restrain bank shift.

Cut and fill patterns for 2006-2010 and 2010-2011 show that the channel bend in this location is evolving in a typical pattern for fluvial bend evolution. The bend is translating downstream. As the forward limb of the bend moves downstream, there is a pattern of cutting into the terrace (red on Figure 30); as the rear limb moves downstream, it leaves a pattern of fill in its wake (purple on Figure 30). The fill makes newly created floodplain areas that are prime habitat for riparian vegetation. This is the type of dynamic process that can be utilized for natural regeneration of riparian habitat conditions.

A similar process is occurring, to a lesser degree, near RM 24.0 in this reach.

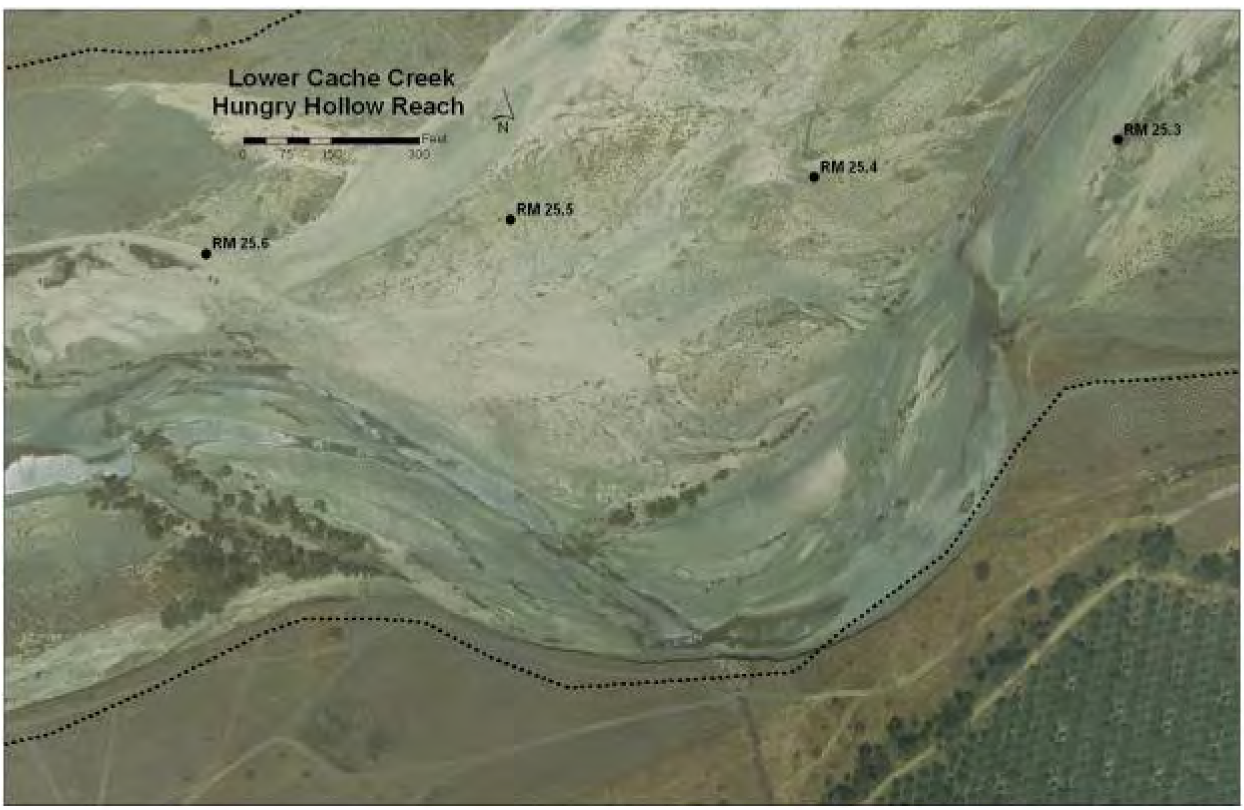


Figure 29 Hungry Hollow Reach RM 25.5-25.4 detailed photos showing bank migration

The top photo is from 2010, the bottom photo is from 2011.

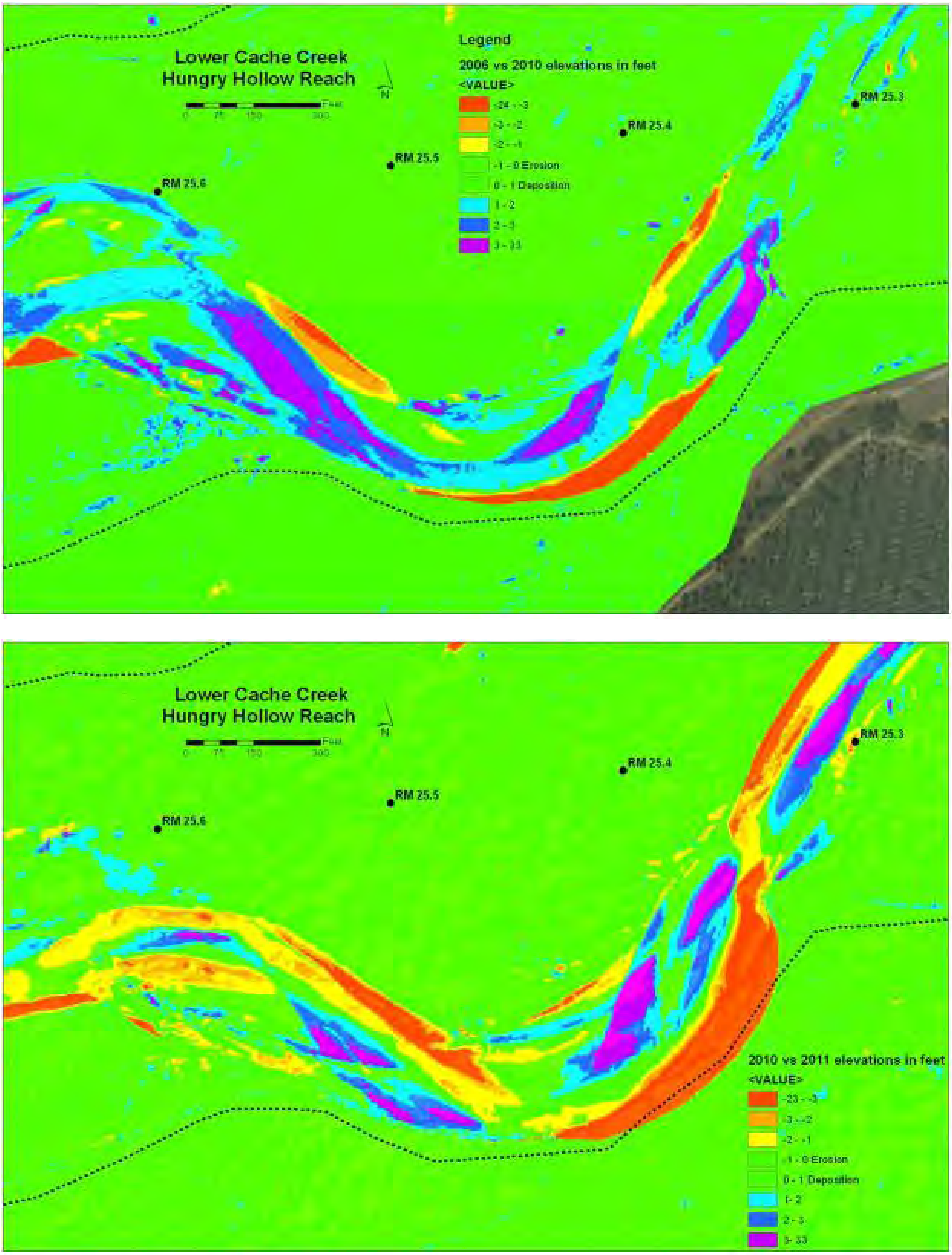


Figure 30 Hungry Hollow Reach RM 25.5-25.4 cut and fill maps

2.9.3 MADISON REACH RM (RM 23.50 TO 21.1)

The sinuous channel of the Madison Reach (Figure 32) currently extends approximately 2.6 miles from RM 23.5 to the I-505 Bridge. It has an average slope of approximately 0.0018, which is slightly more than the average of all the CCRMP reaches (0.0016). The 2010 measured length was 0.4 miles longer than what was reported in 1995, but the length returned closer to the 1995 value in 2011. This shortening is probably due to the fact that the low-flow channel in 2011 straightened when it "cut through" three separate bends. Because the channel no longer followed the more curved path, it shortened. The slope in 2011 is significantly less than it was in 1995 (0.0023), at which time it was the steepest of all the reaches. The slope in 2011 (0.0018) is slightly more than it was in 2010 (0.0017).

The longitudinal profile (Figure 31) shows that there were two areas in 2010, which are nearly next to each other, where the profile is essentially flat, with steeper sections of relatively uniform slope in the rest of the reach. In 2011, the flat areas appear to have changed location. This is probably due to the shifting of location of the pools and riffles as the channel changes shape with time.

The slope profiles suggest that the elevation was about 1.4 feet lower in 2011 than in 2010.

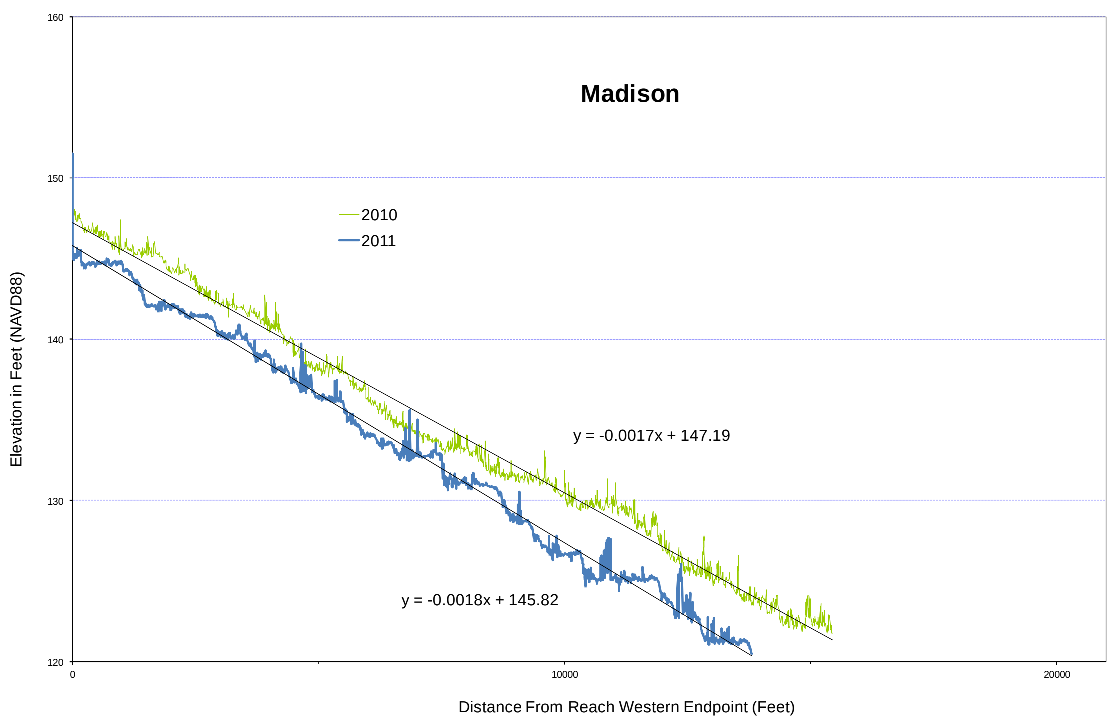


Figure 31 Madison reach RM 23.50 to 21.1 slope

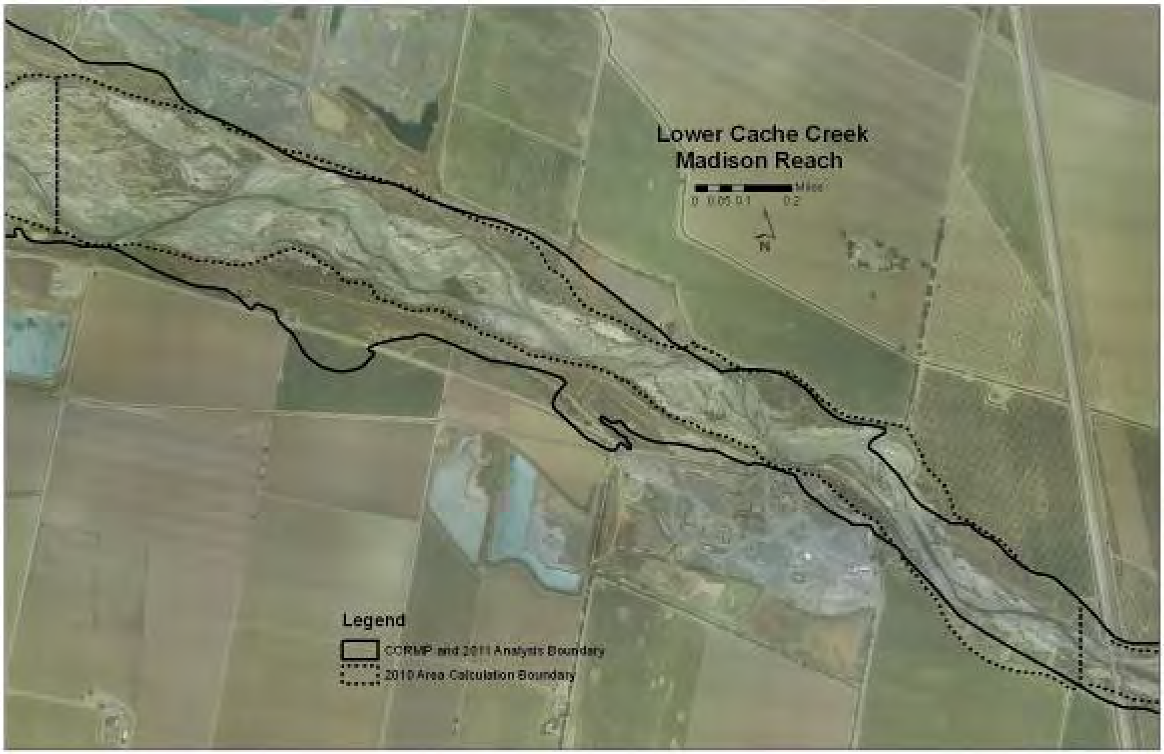
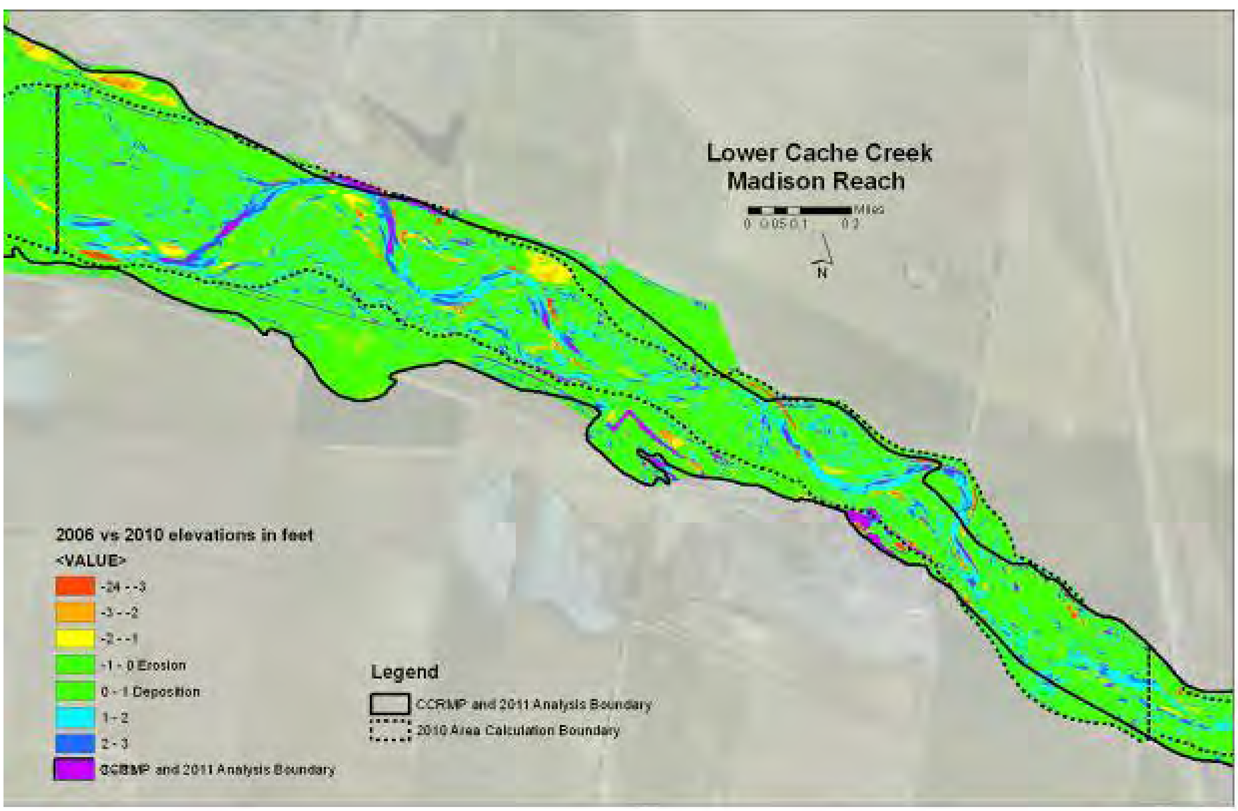


Figure 32 Madison reach RM 23.50 to 21.1



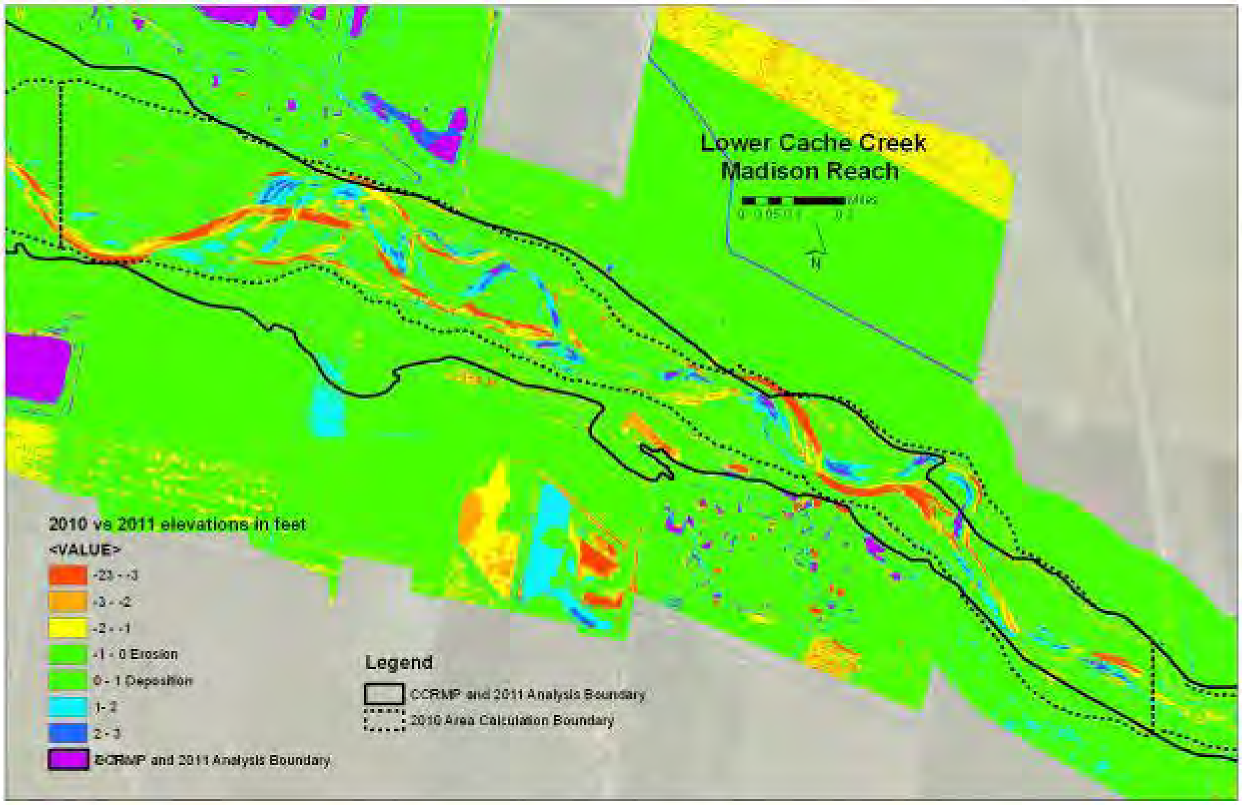


Figure 32 a Madison reach RM 23.50 to 21.1 cut and fill maps

As in the previous two reaches, the bed elevation changes show consistent 1-2 foot increase in elevation in the 2006 to 2010 time period (as shown by the blue colors in the mapping). The bed elevation changes in the 2010 to 2011 time period show 1-2 feet of lowering and even greater than three feet (red) in much of the reach. When the red color shows in the channel itself, it may represent erosion into the bed. In areas near a high bank, the red is interpreted to indicate the sloughing off of a rather high steep bank, and channel migration.

2.9.3.1 CHANNEL SHIFT NEAR RM 21.7-21.5 (OLD MADISON BRIDGE)

At the location of the former Madison Bridge site, pre-2006 erosion had removed almost 1000 linear feet of bank, laterally eroding up to 120 feet on the north bank. The creek also eroded the most upstream of the spur dikes located immediately downstream. The erosion removed most of the fine-grained material from two-thirds of the upstream-facing portion of the spur dike.

Anecdotal information suggests that over 20 acres of agricultural land was removed by channel shift processes previous to the land being purchased by the current owners, suggesting that this site has had a long history of channel shift.

The South Bank has been restrained near RM 21.7 (upstream from this site) and due to the constriction of natural channel meandering to the south, may be promoting accelerated rates of migration onto the north bank. The curvature of the creek bend at RM 21.5 is tight and appears to be tighter than it would be if the spur dikes had not been installed. The north bank adjoining the local property has a sharply curved bank that causes stream velocities to be high adjacent to the bank. Part of this curvature may be exacerbated by the dike immediately downstream.

It is possible that the channel bend will migrate past the spur dikes. It is also possible that the channel will continue to be constrained in this area, and that the combination of limited channel shift on the south bank near RM 21.8 and the restraint at RM 21.5 (causing an exaggerated curvature to the channel just upstream) will continue to accelerate bank erosion rates on the north side near RM 21.6.

Figure 33 Bank erosion at the outside bend of the meander near RM 21 (2008)

Figure 34 Active erosion at RM 21.6 north bank (2008).

Figure 35 Active erosion of upstream spur dike, RM 21.55 north bank (2008).

The 2008 Creek Walk summarized some previous work at this site:

> "Plantings of native grasses and trees during the 2002/2003 bank stabilization effort were successful (according to previous reports), but erosion continues to remove material from this site. The landowner provided irrigation necessary to get plants established. The County purchased native plants for the project and worked with the CCC to plant them. Plants were established at the top of bank, and have done relatively well (due to irrigation and good soil), but some were washed away with general erosion of the site. This is an actively eroding area, and the meander will continue to migrate northward and downstream. A large volume of riprap would be required to stabilize the north bank against the continuous erosive forces of the meander bend. This may be a case where it is more cost effective to look at more broad, sustainable solutions rather than try to protect a specific part of the Creek bank. Plants were originally installed on the steep, south facing and dry bank. For the most part, these plants perished. Meanwhile, severe erosion washed away any evidence of this well-intentioned effort.
>
> The broken concrete core of the spur dike constructed here was disturbed although large pieces remained in place. The spur dikes downstream of the damaged spur dike showed little sign of erosion. Vegetation between the spur dikes is thriving and several inches of sediment have accumulated over the 2007-2008 season. The spur dikes are buried, covered with vegetation that dates back to 2002, and are barely visible. Loamy soil up to about 2 feet thick blankets the areas between the spur dikes along the north bank.

> At this site, the possibility of in-channel mining was discussed as a method of reducing erosive forces on the bank. However, it is possible that this would only provide moderate or little relief of the erosive forces. A HEC-RAS investigation could be performed to study the effect of dredging a channel on the south side. Such a channel would redirect the flows away from the bank at low flows, but could possibly have little effect at higher flows that would inundate the dredged channel, and would create high stream velocities on the bank in question. Conservation easements are a better and more economic way for the landowner to manage such locations prone to be lost due to natural processes of channel shift."

In the past year, the active channel has shifted from the north bank, where the erosion has been taking place, to near the south bank. Although this shift alleviates some of the concerns related to the north-bank erosion, high flows are likely to continue to promote some degree of channel shift on the north bank.

TAC members have discussed the possibility that the groin immediately downstream from the active erosion may be exacerbating the erosion. One possibility is that removing that groin would lessen the erosion at this site.

In order to assess removing the groin, and other management possibilities, the TAC geomorphologist performed a series of preliminary modeling exercises to estimate what the channel is likely to do in the future. These estimates were done with a meander migration model that has been developed and widely used to asses channel shifting processes. The model was developed with site-specific information for Cache Creek, but was not calibrated in detail. This model was a useful tool for assessing alternative management scenarios in a qualitative manner.

The preliminary results suggest that the active bank retreat near RM 21.6 (Figure 39) will not be large with moderately large flows like the ones experienced in 2011.

An additional observation is that there is an area upstream near RM 22.0 on the north bank that is experiencing active bank retreat (Figure 36.) This can be seen on the cut/fill maps that were made from the Towill 2011 data (Figure 38). Figure 37 (upper image) represents 5 years of bank erosion and Figure 37 (lower image) represents a single year of bank erosion. The area near RM 22.0 has eroded significantly, and the meander modeling and the cut and fill maps suggest that the bank retreat will continue near RM 22.0. This bank retreat is occurring in a low flood plain terrace (Figure 38) and the curved bend is likely to continue to move downstream. As it progresses over the course of many years, it is likely to develop and build a new floodplain terrace (in its "wake"), which could create habitat for riparian vegetation, either actively restored or naturally regenerated.

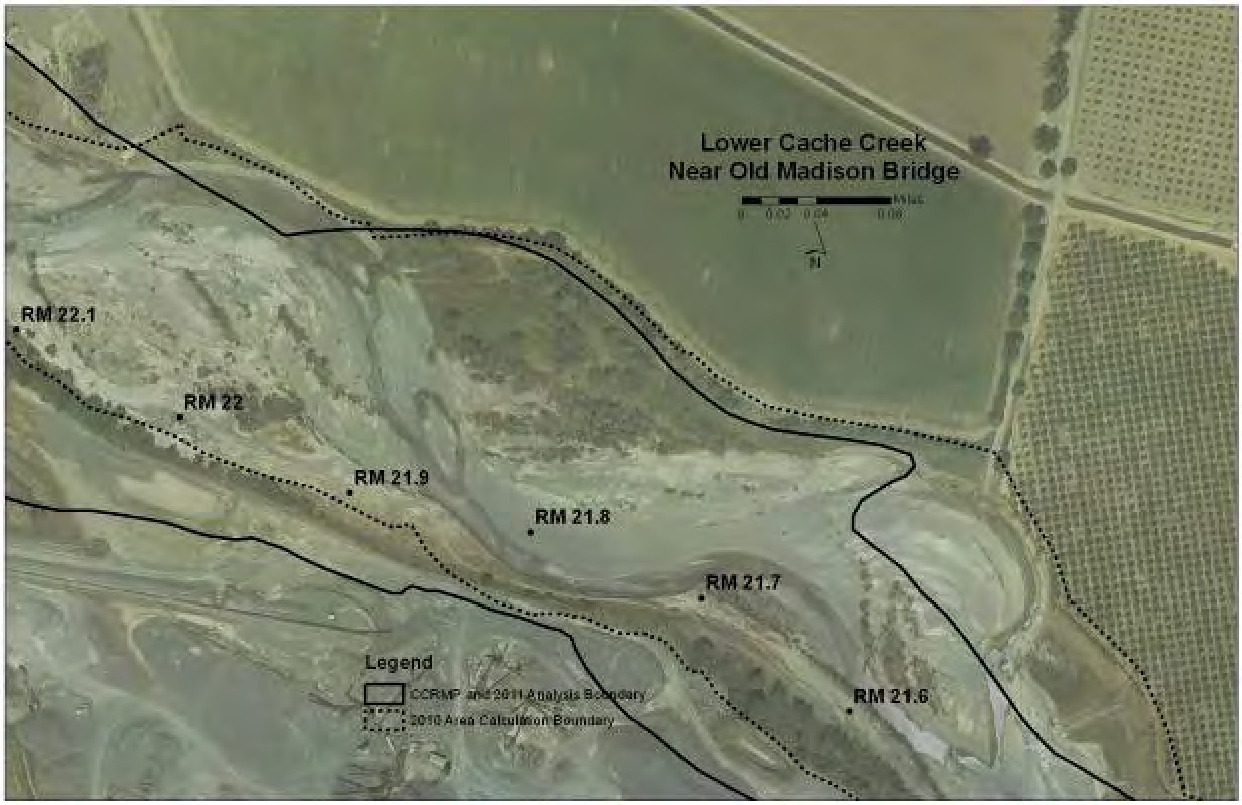


Figure 36 Old Madison Bridge site 2011 aerial photo

The observations made this year need to be evaluated. The current removal and potential rebuilding of the low floodplain terrace at this site is acceptable, and active management is not necessary at this time.

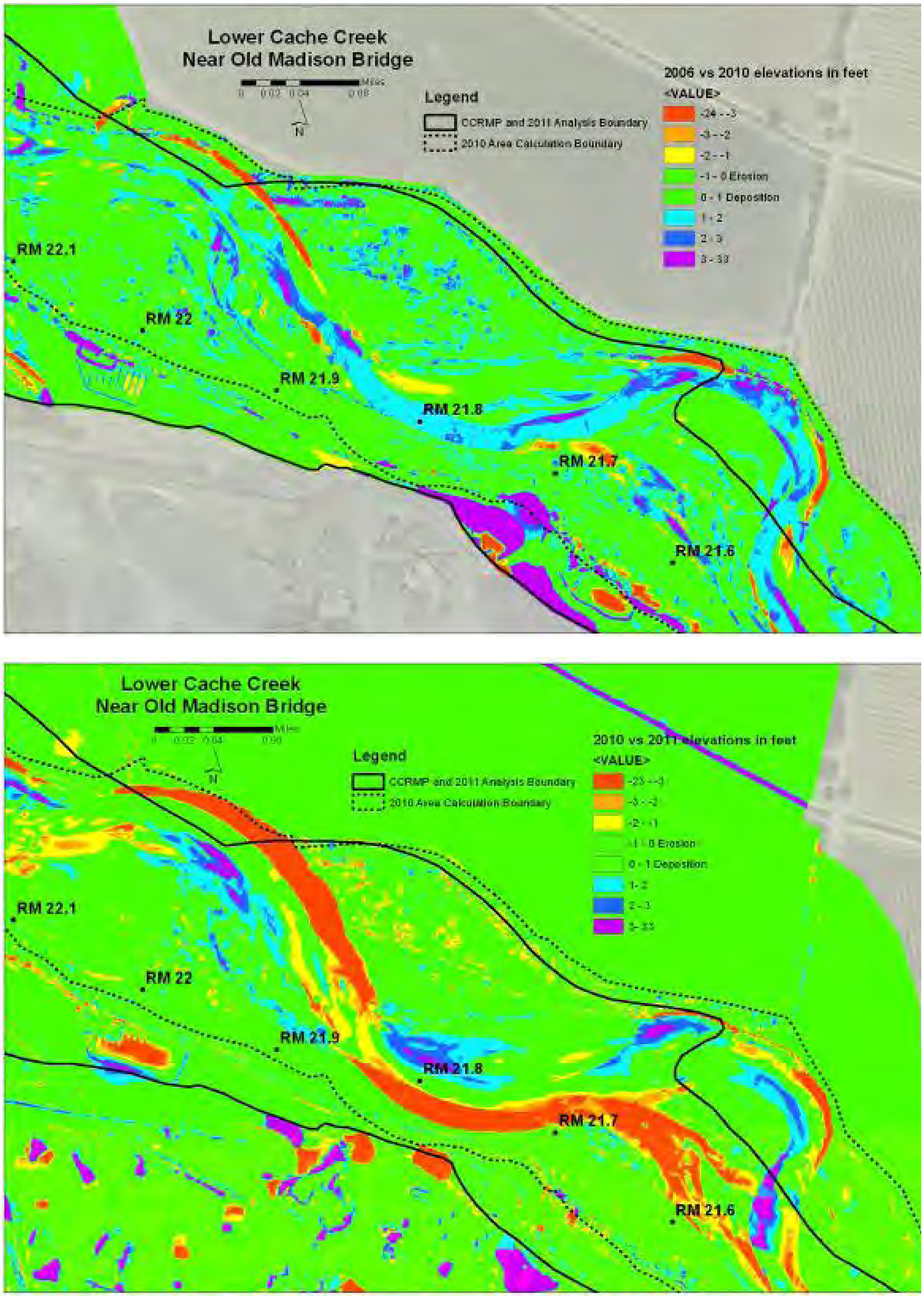


Figure 37 Old Madison Bridge site cut and fill maps

Figure 38 From Road 84b Bridge site looking upstream toward RM 22.0 (2011)

Figure 39 Road 84b Bridge site looking downstream (2011)

2.9.4 GUESISOSI REACH (RM 21.10 TO 18.85)

The Guesisosi Reach (Figure 41) currently extends approximately 2.4 miles from RM 21.10 (the I-505 Bridge) to a location upstream of Moore's siphon crossing. It currently has an average slope of approximately 0.0016, which is the average of the CCRMP reaches. The 2010 measured length was 0.05 miles longer than what was reported in 1995, and the sinuous channel was slightly longer in 2011, probably due to the increase in sinuosity. The slope in 2010 (0.0014) was slightly more than it was in 1995 (0.0012), at which time it was the least steep of all the reaches.

The longitudinal profile (Figure 40) shows that the elevations in the two time periods were roughly parallel. The slope profiles suggest that the elevation was about 1.5 feet lower in 2011 than in 2010.

The reported rate of change of volume was the largest of any reach (138% of the average for the CCRMP area).

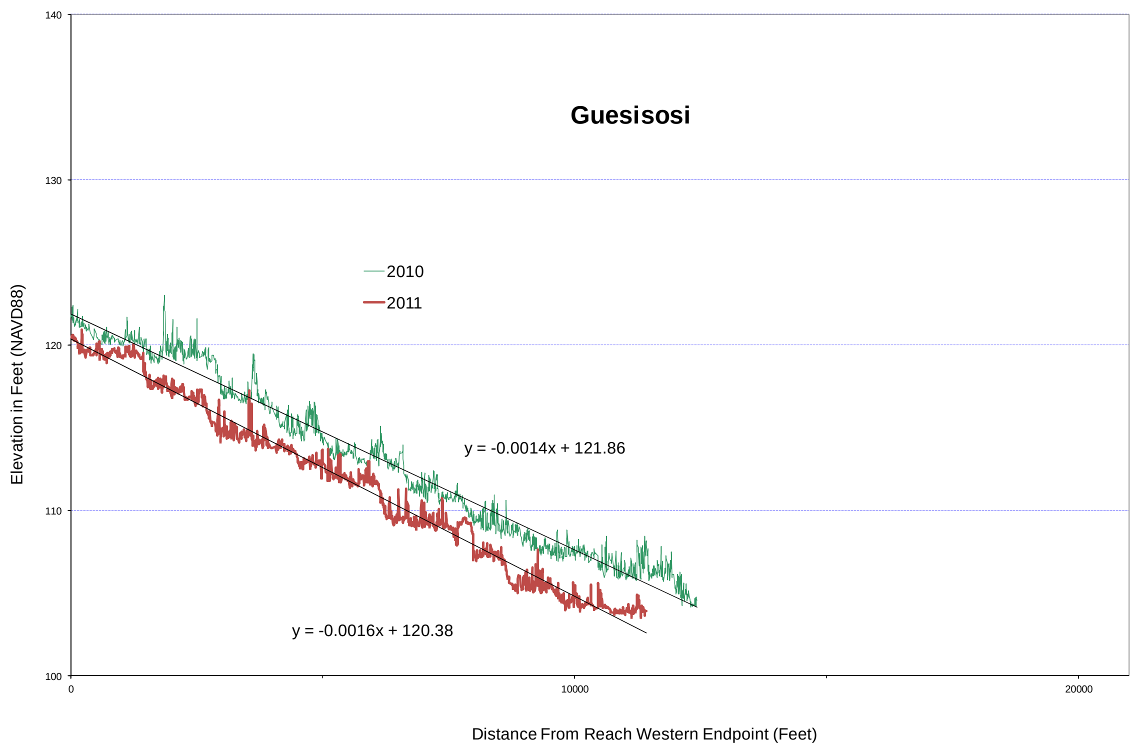


Figure 40 Guesisosi Reach RM 21.10 to 18.85 slope

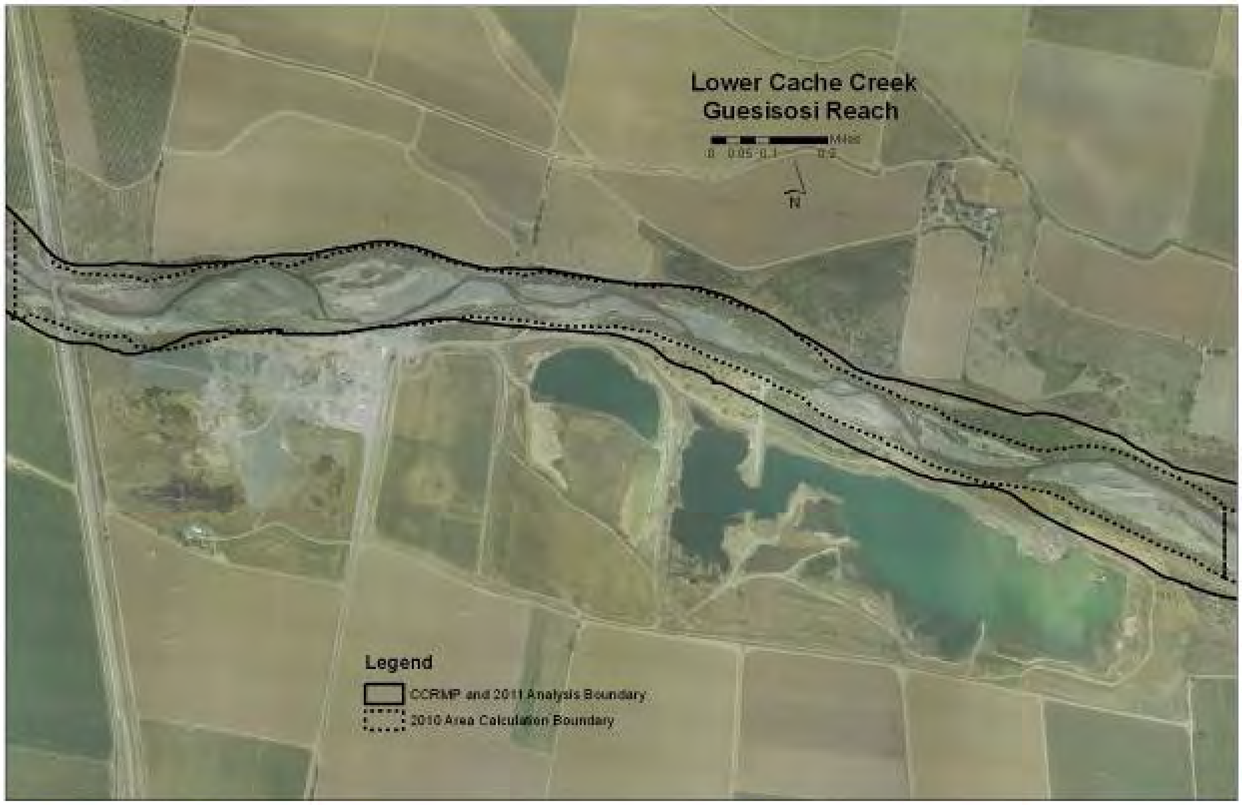
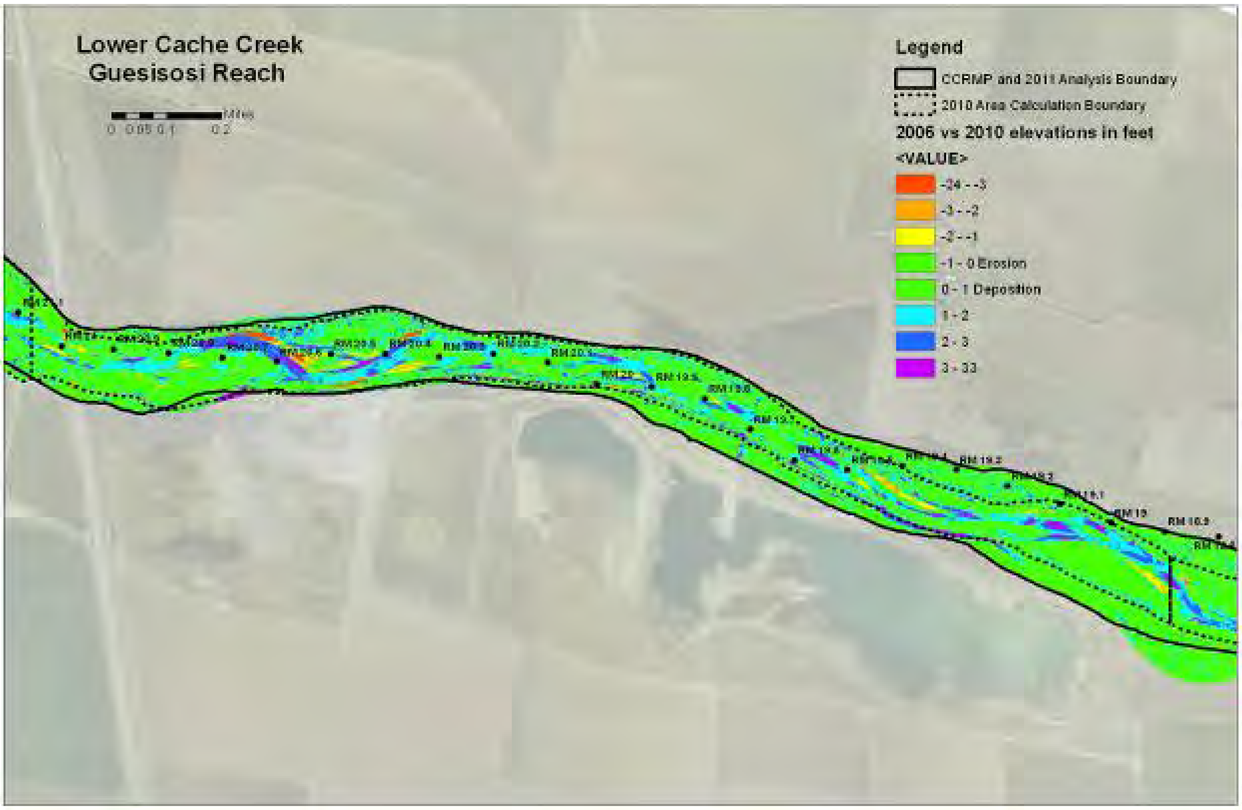


Figure 41 Guesisosi Reach RM 21.10 to 18.85



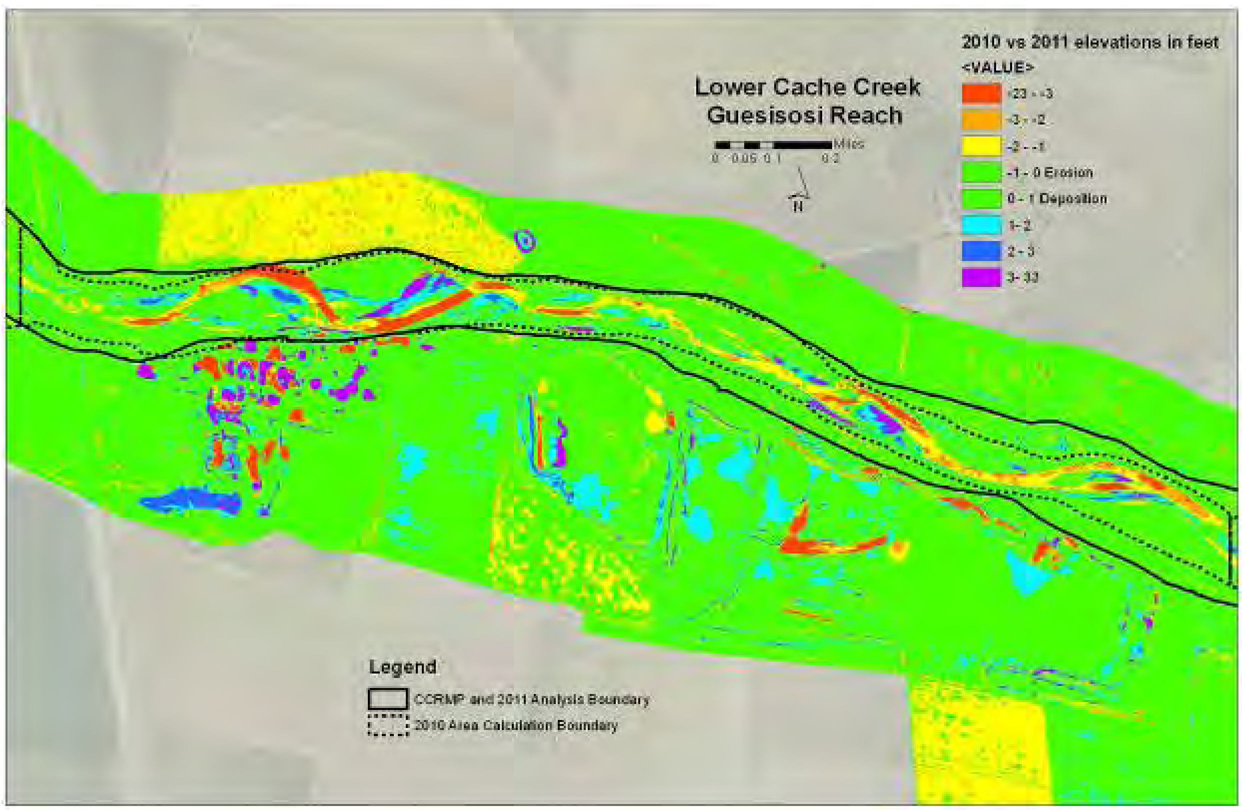


Figure 41 a Guesisosi Reach RM 21.10 to 18.85 cut and fill maps

The cut and fill images also show a consistent lowering of the elevation in the 2010-2011 time period, in contrast with the deposition seen in the 2006-2010 period.

2.9.4.1 CHANNEL SHIFT NEAR RM 20.6

There is a significant area of bank retreat near RM 20.6 (Figure 42 and Figure 43), where the channel bends are migrating downstream. As in previous reaches, this migration consists of cut on the outside curve of the channel and fill on the inside of the curve, where the curved channel is leaving a deposited floodplain in its former location.

Because these patterns of channel shift have persisted since 2006, it is reasonable to expect that the channel shifting will continue, with cut on the outside of the curve and fill in the former trace left on the inside of the bend. This natural process does not require active management at this time.

Figure 42 Guesisosi Reach near RM 20.6
The 2010 aerial is on top, the 2011 aerial is on the bottom.

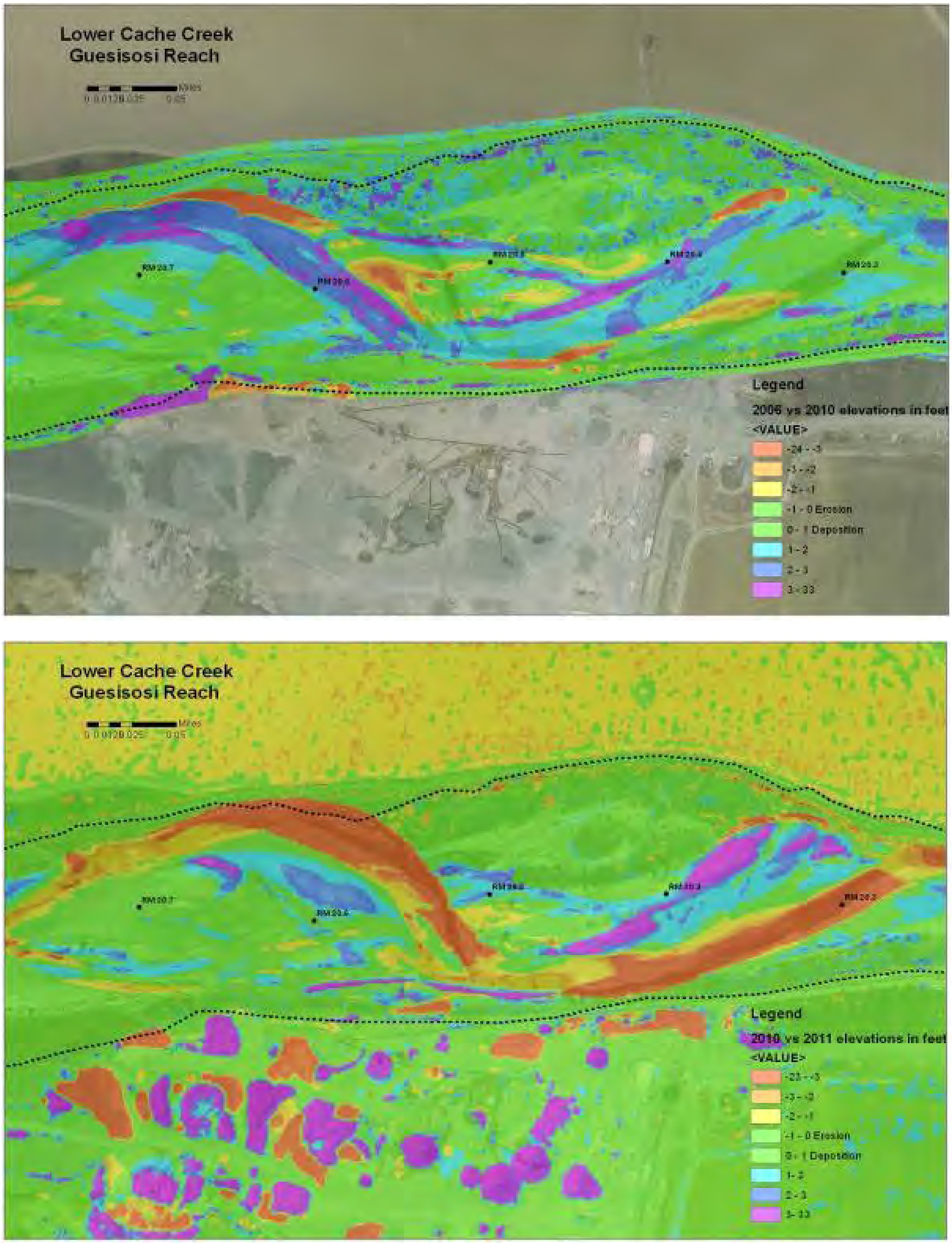


Figure 43 Guesisosi Reach near RM 20.6 cut and fill maps

2.9.5 DUNNIGAN HILLS REACH (RM 18.85 TO 15.9)

The Dunnigan Hills Reach (Figure 44) currently extends approximately 3.0 miles from RM 18.85 to Stevens Bridge (RM 15.9). It has an average slope of approximately 0.0015, which is slightly less than the average for the CCRMP reaches (0.0016), and is the same as it was in 2010. The longitudinal profile (Figure 45) shows a number of areas where the profile is essentially flat, with steeper sections of relatively uniform slope in the rest of the reach. These areas have persisted since 2010. The channel length was roughly the same in 2011 as it was in 2010.

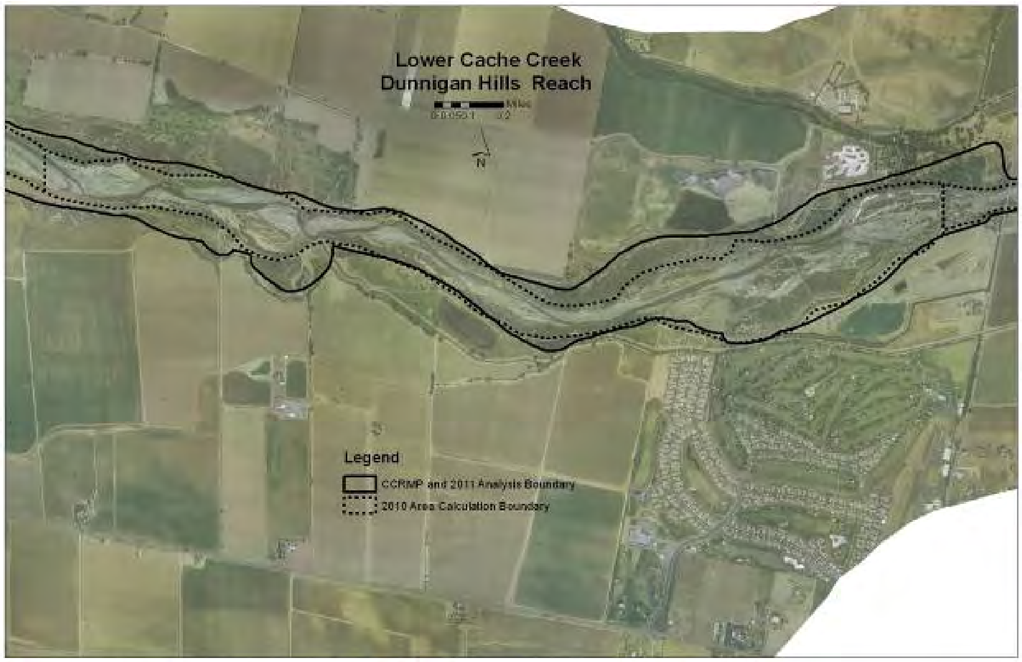


Figure 44 Dunnigan Hills RM 18.85 to 15.9

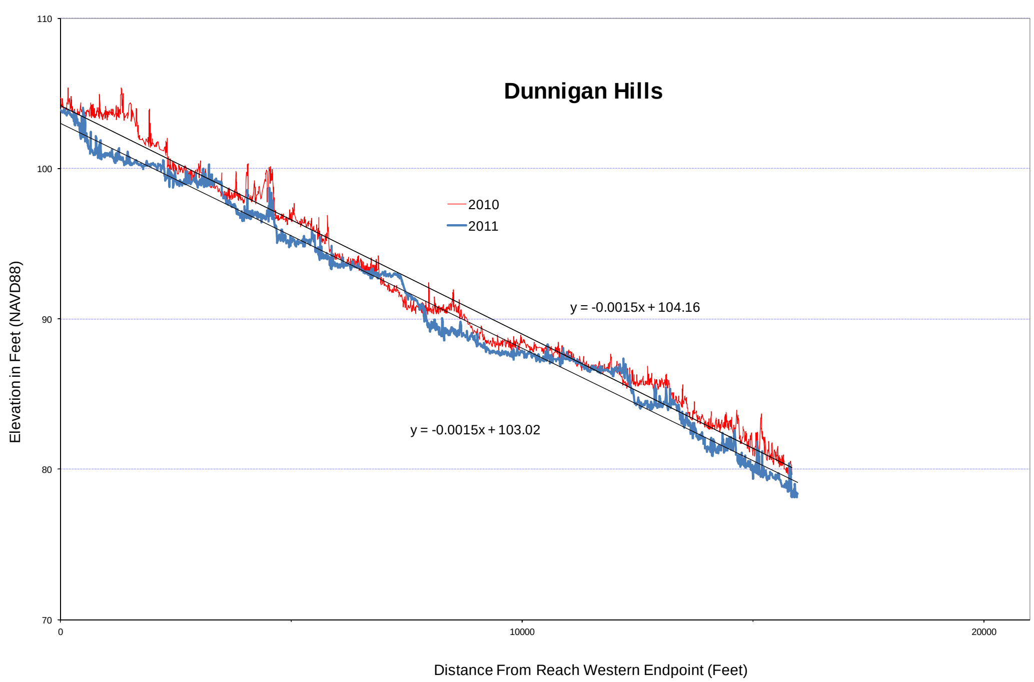


Figure 45 Dunnigan Hills RM 18.85 to 15.9 slope

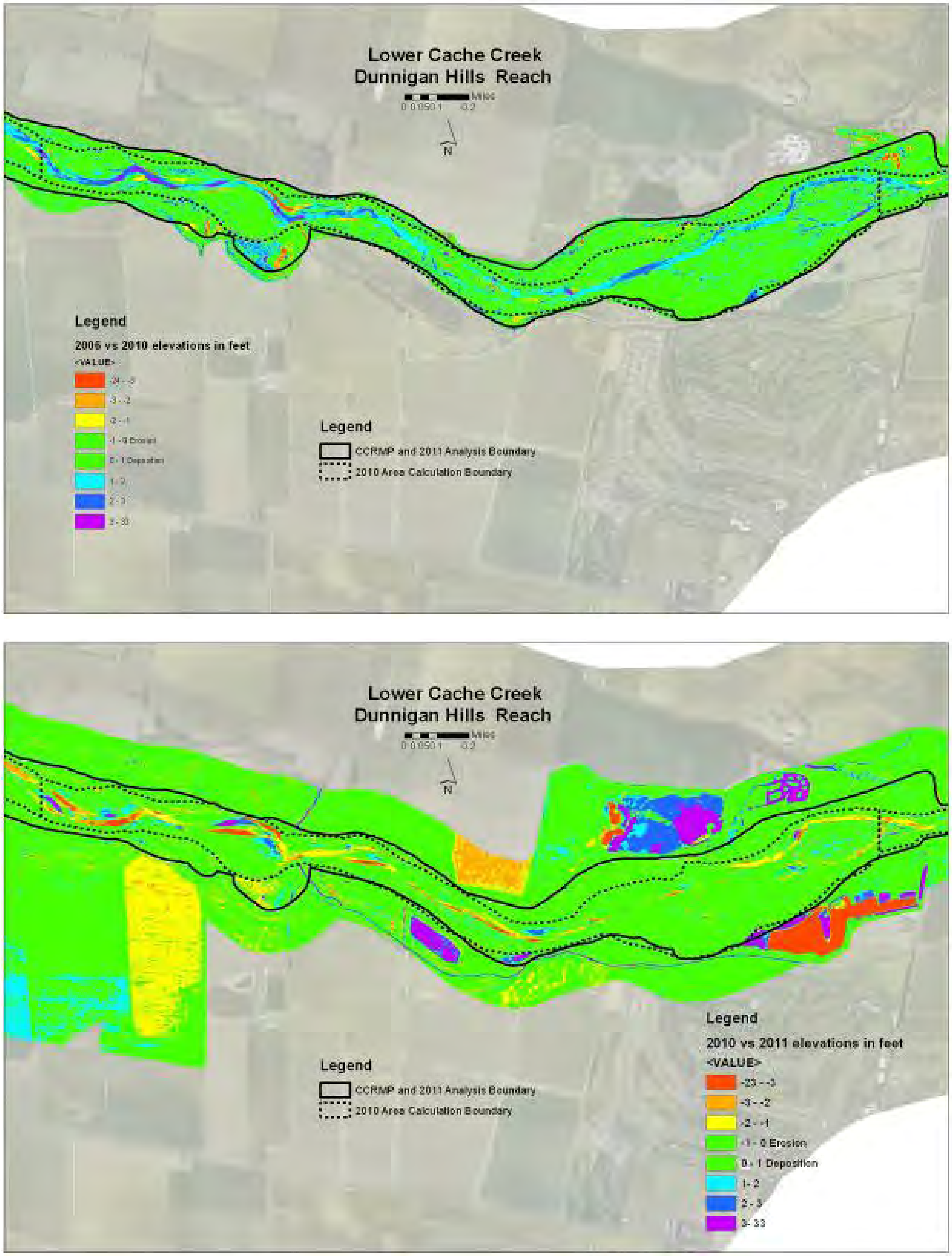


Figure 46 Dunnigan Hills RM 18.85 to 15.9 cut and fill

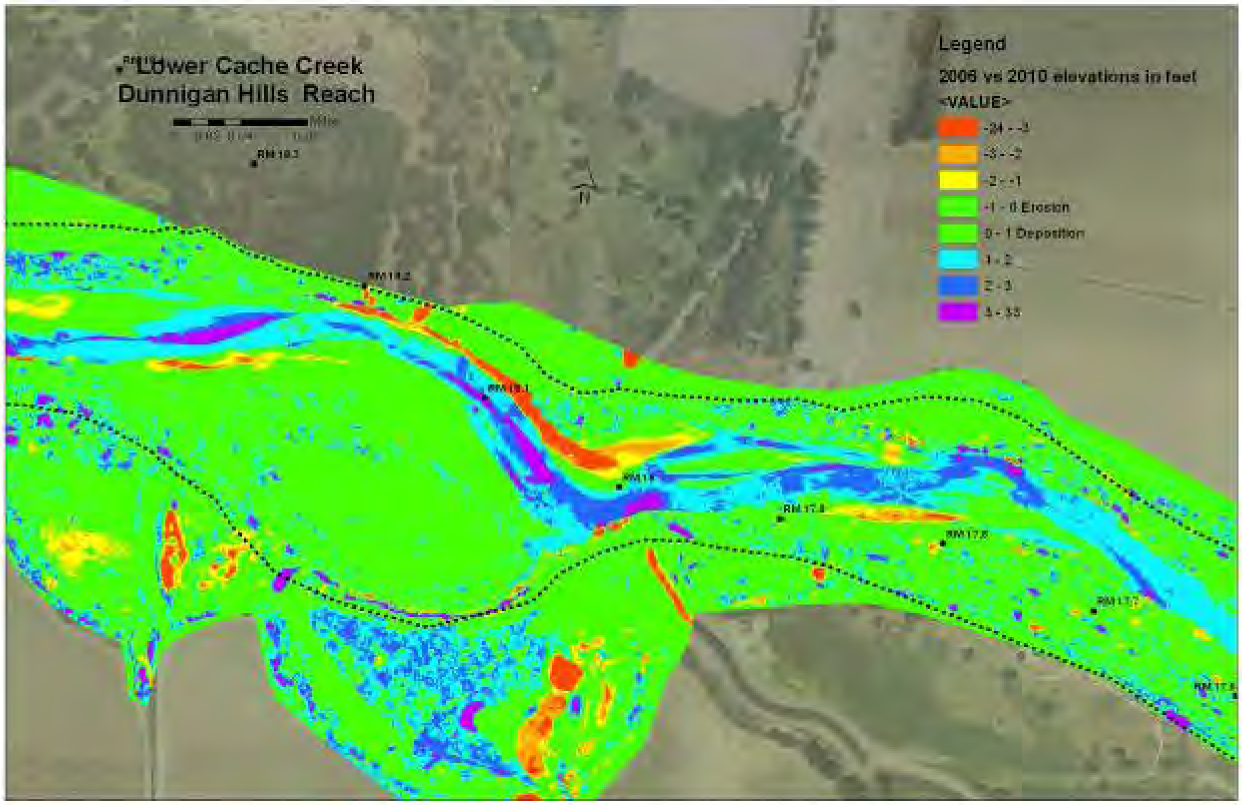
The cut and fill maps show the cut and fill patterns in the entire reach, where the 2010-2011 shows significantly more yellow and red in the channel, indicating that the elevation is less in 2011. The 2010-2011 cut/fill maps (Figure 46) show bank retreat immediately upstream from the Moore Siphon crossing near RM 18, which is discussed in detail below.

2.9.5.1 CHANNEL SHIFT UPSTREAM FROM MOORE SIPHON NEAR RM 18.5-18.0

During the 2011 Creek Walk, the TAC visited a site where a local landowner expressed concern about the channel dynamics and bank retreat at the bend immediately upstream from the Moore's Siphon (Figure 47).

Figure 47 Bank retreat upstream from Moore's Siphon (Horner photo)

Figure 48 Moore's Siphon and upstream area – aerial view



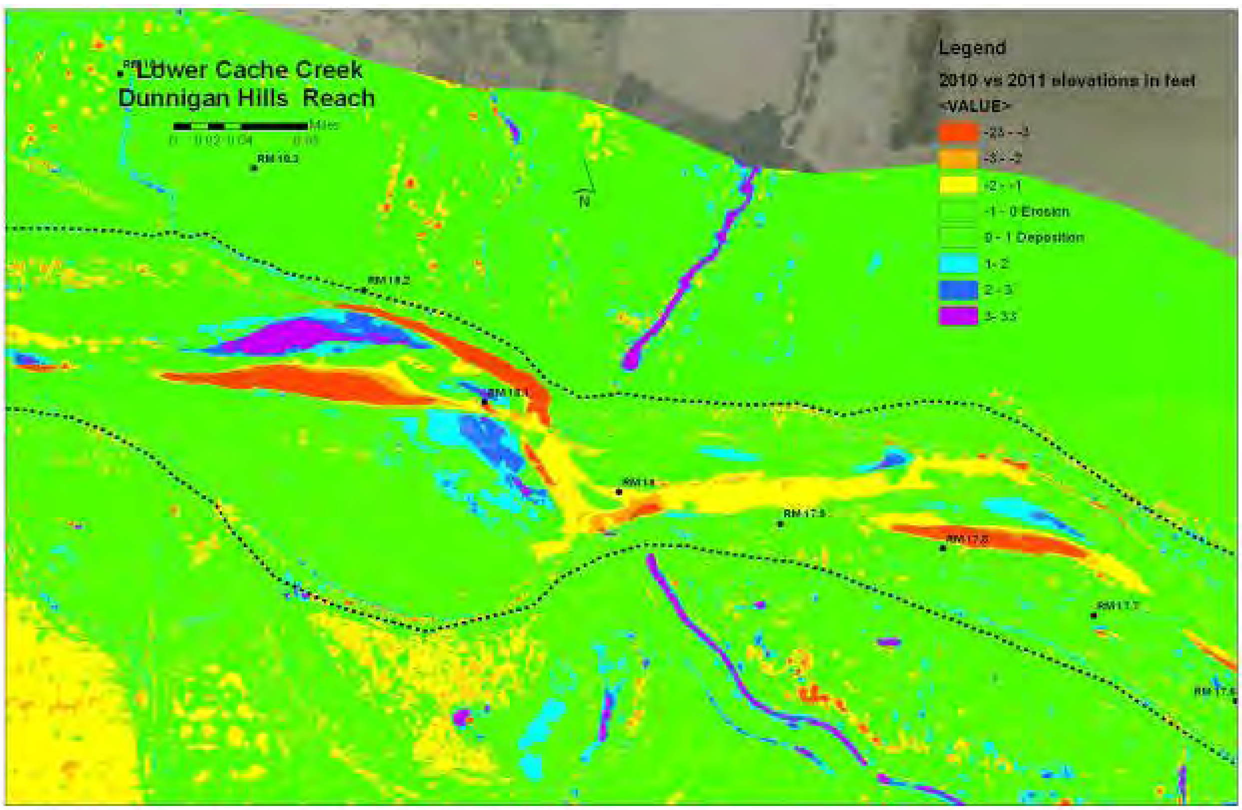


Figure 49 Moore's Siphon and upstream area – cut and fill maps

The land owner was concerned about the potential for further bank retreat of the channel on the north bank. A 10 to 12 feet tall vegetated bank forms a barrier on the north bank, separating the channel from a borrow pit that was originally dug as a passive restoration site (Figure 48) in 1986. As reported by a member of the aggregate industry, who was present at the time of the restoration, “It was just drug and scraped.” This is an ideal example of passive restoration where cottonwoods have grown over the last 25 years. The passive restoration at this site is similar to the Hayes Bow-Tie site, immediately upstream of this site, which utilized a haul road. From the point of view of the structure of the creek and riparian ecosystem in the RM 18 to 18.5 location pictured above, the possibility of water inundating the area of passive restoration (due to bank retreat and the vegetated barrier at this point), would enhance the riparian vegetation and continue the pattern of passive restoration.

2.9.6 HOPPIN REACH (RM 15.9 to 12.6)

The Hoppin Reach (Figure 50) currently extends approximately 3.8 miles from Stevens Bridge (RM 15.9) to RM 12.6. It has an average slope of approximately 0.0013, which is less than average for the CCRMP reaches. The slope in 2011 (0.0013) was slightly more than it was in 2010 (0.0012) but still less than it was in 1995 (0.0014).

Unlike the plots of changing longitudinal profile seen in the other reaches, the Hoppin Reach’s elevation in 2011 was roughly the same as it was in 2010 (Figure 50 a). The longitudinal profile (Figure 50 a) shows areas where the profile is essentially flat, with steeper sections of relatively uniform slope in the rest of the reach.

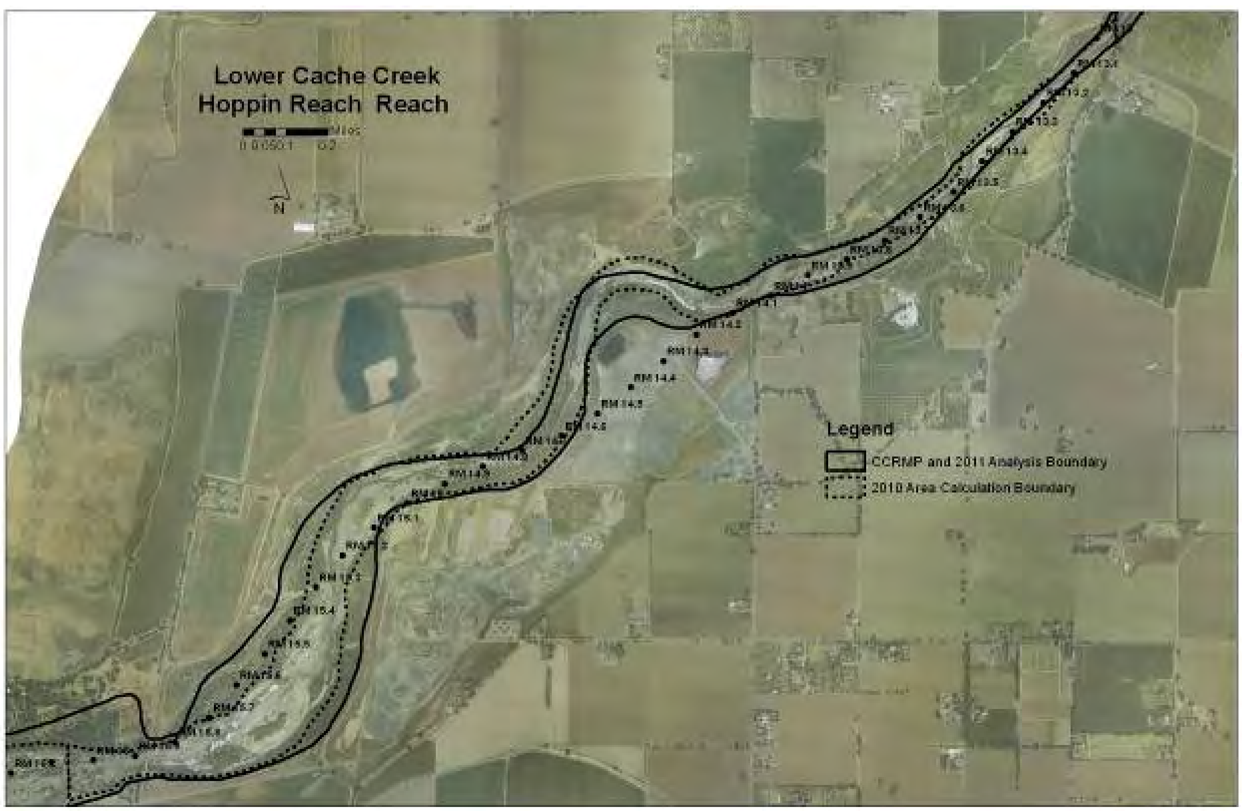


Figure 50 Hoppin Reach RM 15.9 to 12.6

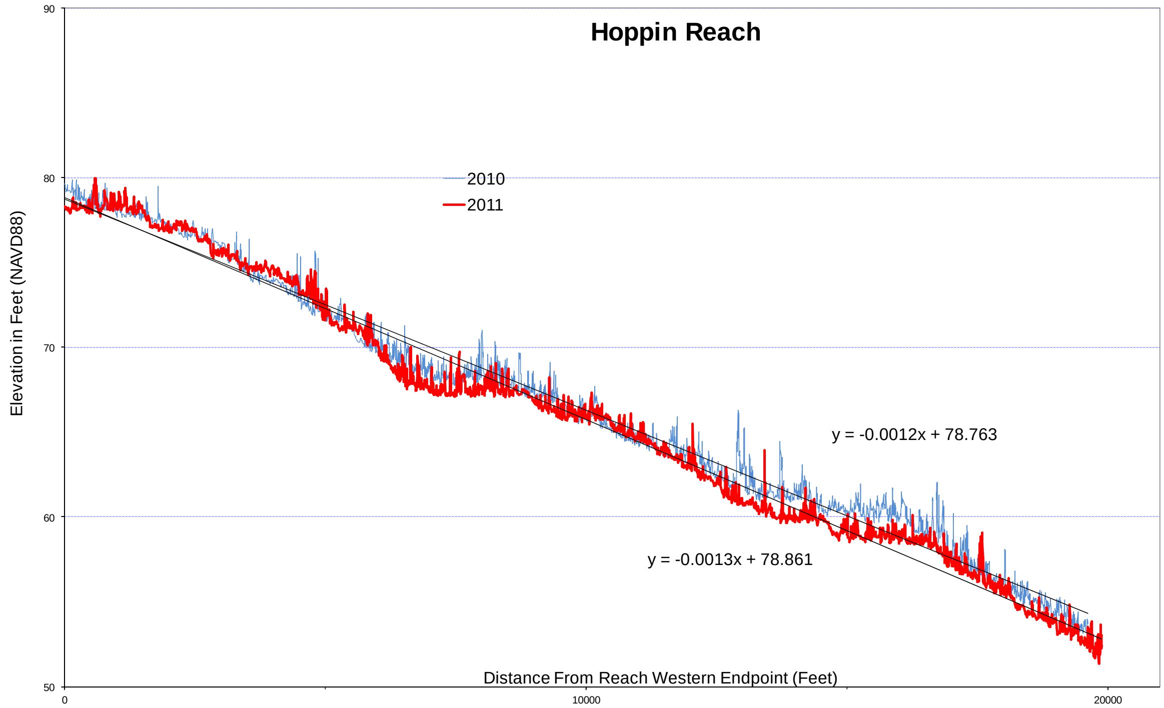
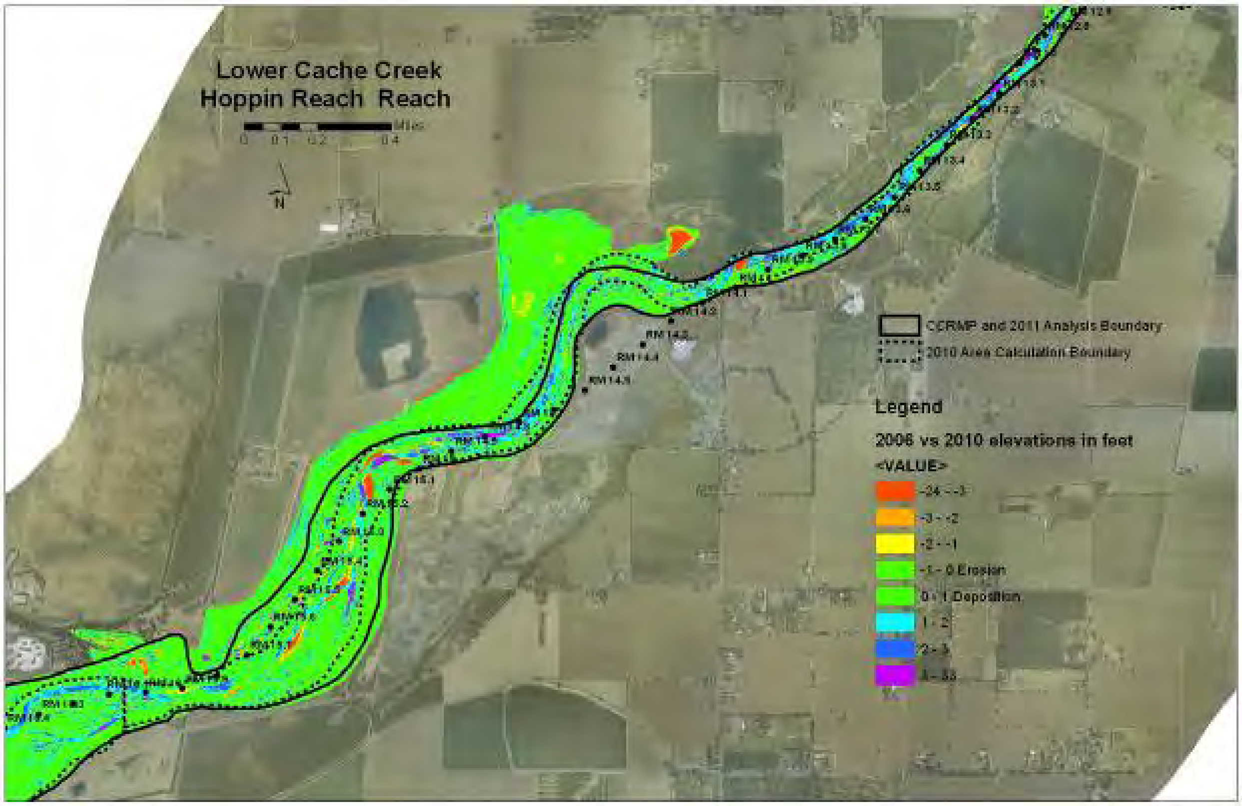


Figure 50 a Hoppin Reach RM 15.9 to 12.6 slope

In the 2006-2010 analysis (Figure 51 upper), there is little consistent cut or fill.

In 2010-2011, the cut and fill area is mixed, with some red (> 2 ft of erosion) and dark blue (>2 feet of deposition) in the upstream portion; fairly green in the middle section (not much change) and equal yellow and green in the downstream 1/3 of the reach.

From RM 15.7 downstream to RM 15.0, the channel was relatively dynamic between 2010 and 2011, as evidenced by the frequent patches of cut (red) and fill (purple) (Figure 51).



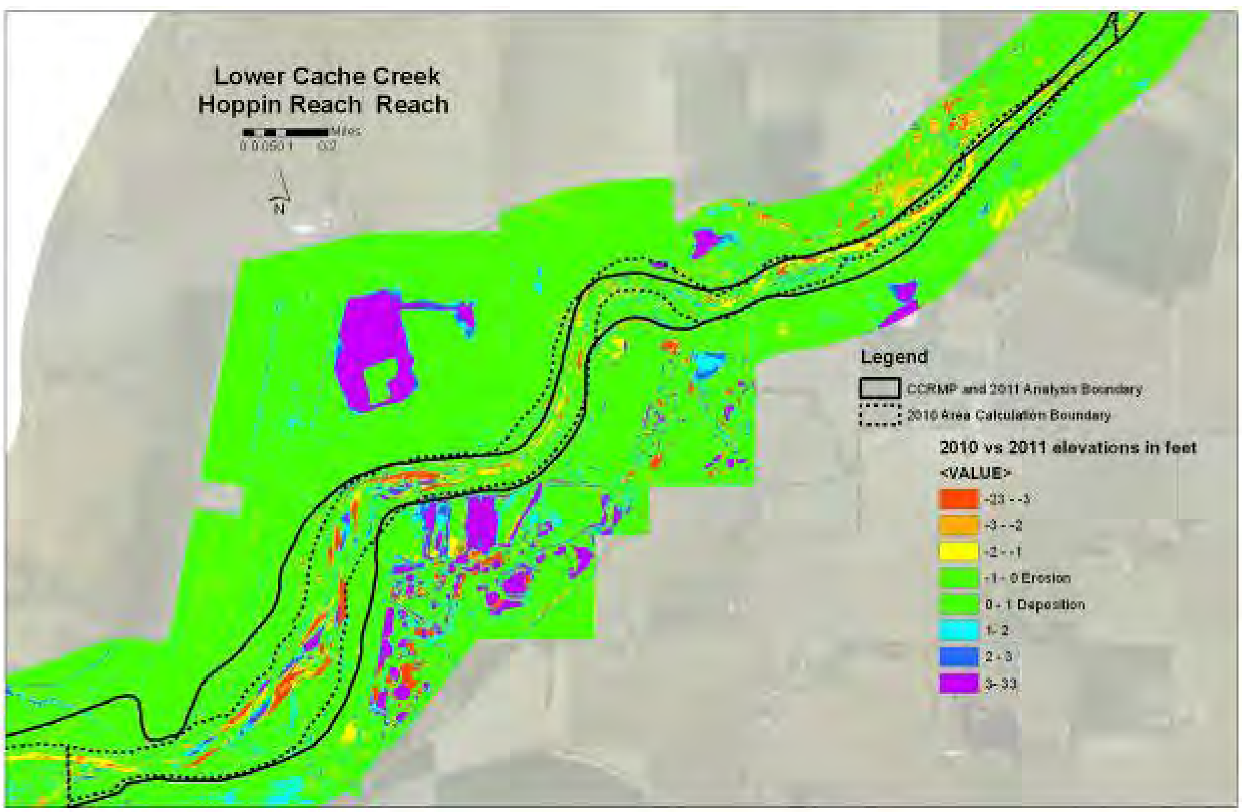


Figure 51 Hoppin Reach RM 15.9 to 12.6 cut and fill maps

2.9.7 RIO JESUS MARIA (RM 12.6 TO 11.7)

The Rio Jesus Maria Reach (Figure 52) currently extends approximately 1.0 miles from RM 12.6 to the CCRMP boundary at RM 11.7. It currently has an average slope of approximately 0.0013, which is slightly less than average for the CCRMP reaches. The slope in 2011 is slightly less than it was in 2010 and is the same value that it was in 1995 (0.0013). The elevation of the longitudinal profile decreased in 2011 by about 1.5 feet. The channel length remained the same from 2010 to 2011.

The channel in this reach is confined in narrow, relatively high banks, and was the subject of the 100-year flood potential study earlier in this report. The longitudinal profile (Figure 53) shows no flat areas.

Figure 52 Rio Jesus Maria RM 12.6 to 11.7

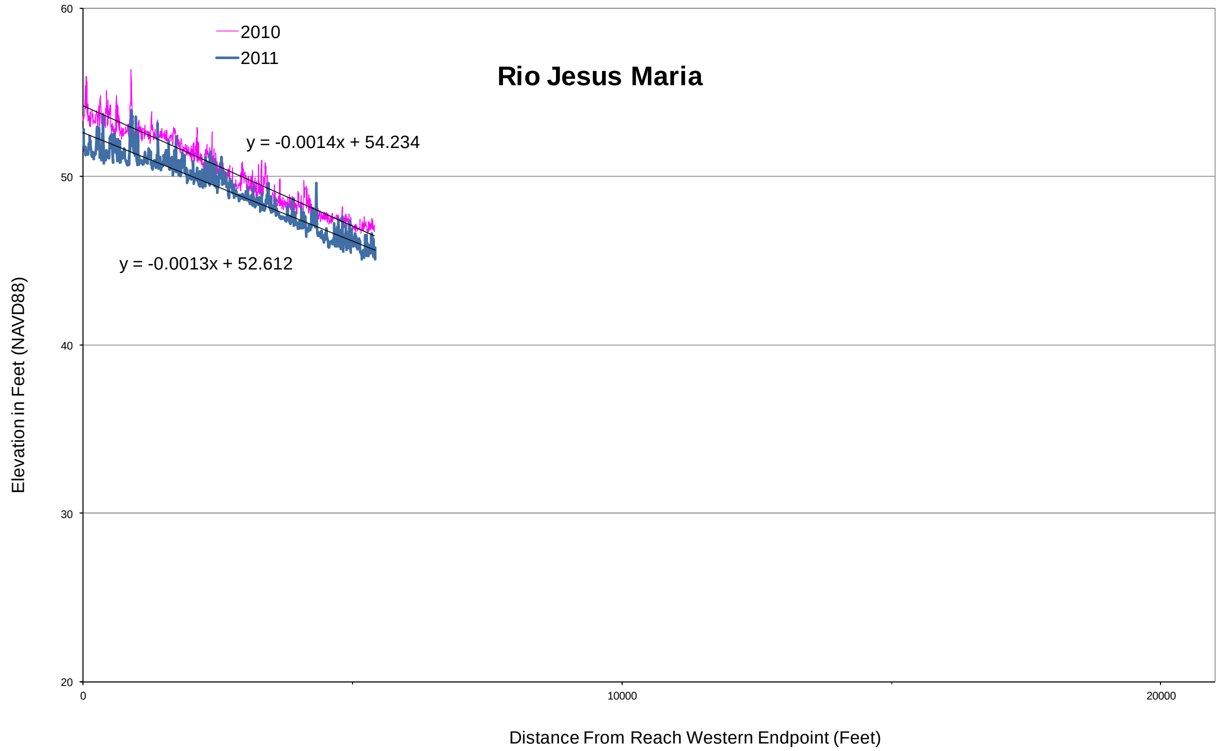
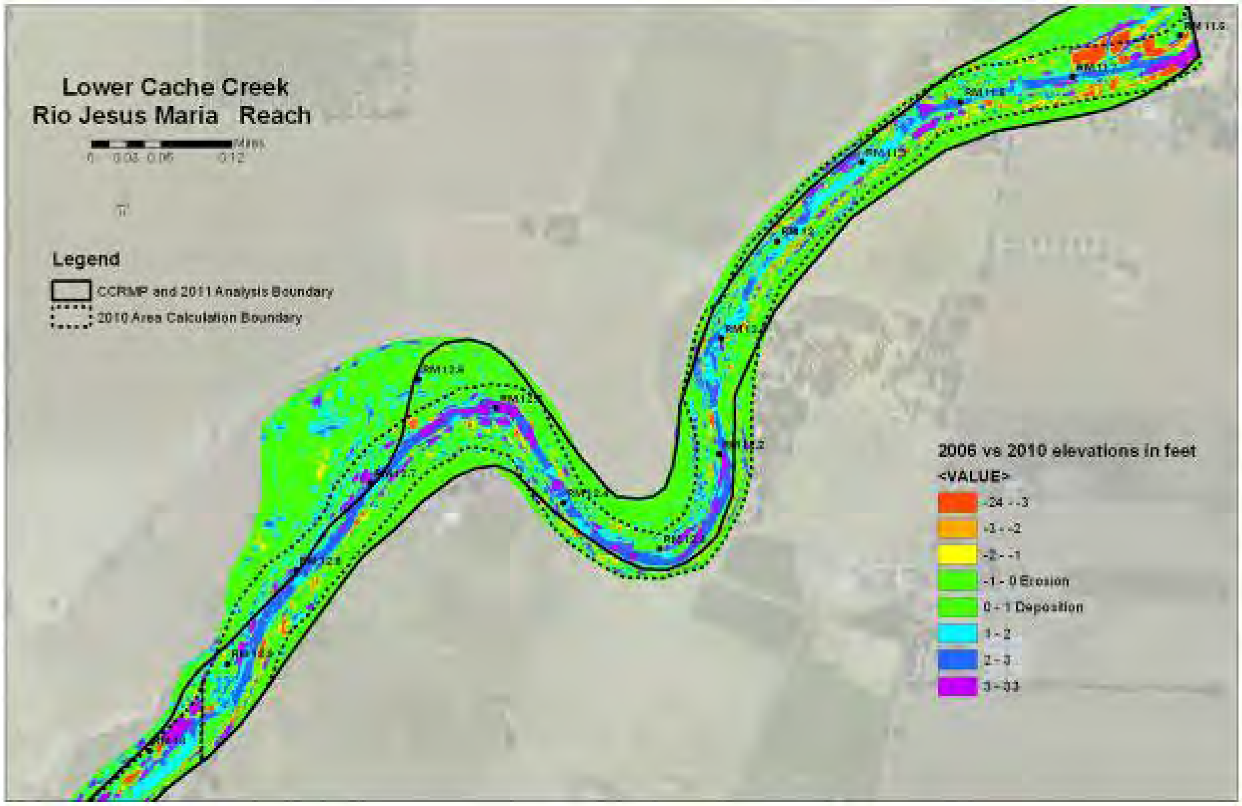


Figure 53 Rio Jesus Maria RM 12.6 to 11.7 slope

The cut and fill patterns (Figure 54) show that the pattern is relatively uniform throughout this reach, which is not surprising for a confined, incised reach like this. The 2006-2010 data show a gain in volume and the 2010-2011 data show a decrease in volume.



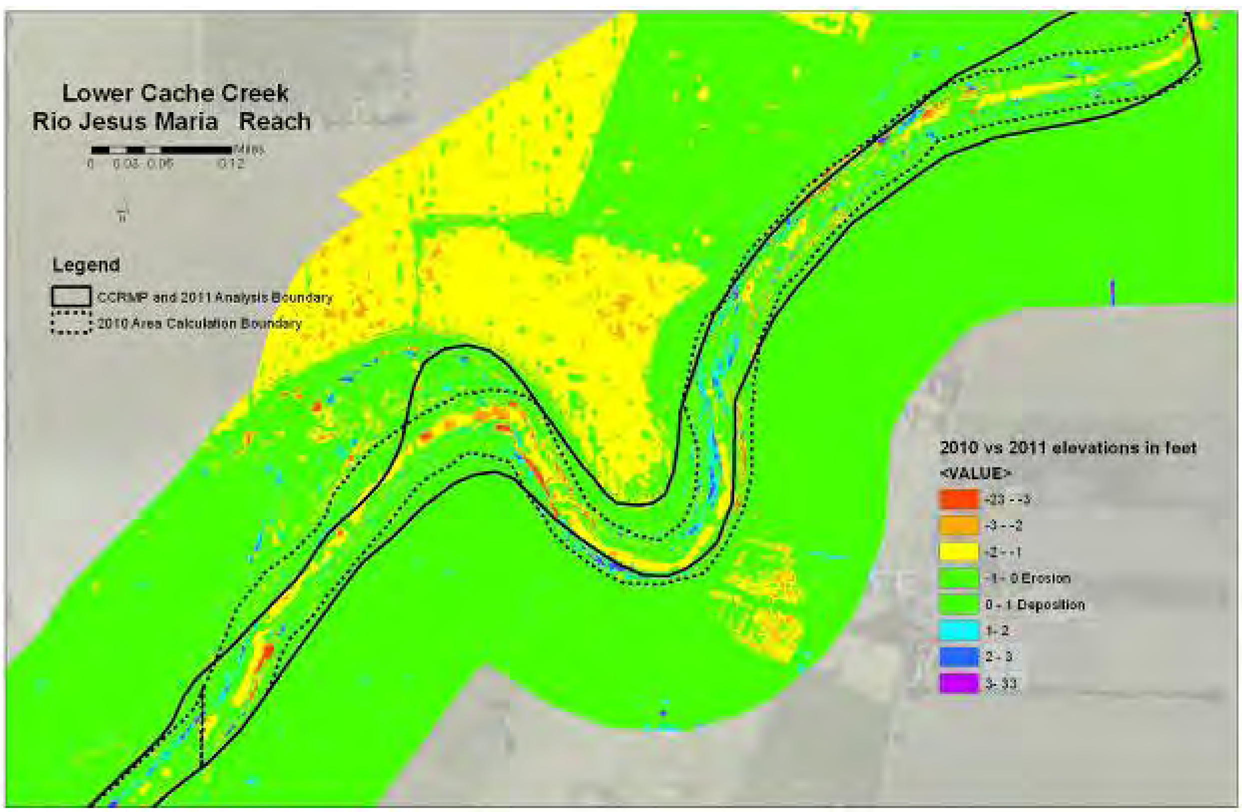


Figure 54 Rio Jesus Maria RM 12.6 to 11.7 cut and fill maps

2.10 BRIDGE CONDITIONS

Due to their importance in providing transportation links, as well as the public investment they represent, the protection of bridge structures is one of the highest priorities designated in the CCRMP (Performances Standards 2.4-12, 2.5-2, and 2.5-3). The study area includes four bridges, three of which are owned by the County and one by the California Department of Transportation (Caltrans). A brief summary of channel conditions, including information from Caltrans bridge inspection surveys at each bridge was provided in the 2010 annual report.

The following graphs show cross section channel bed profiles that were derived from the 2010 and 2011 DTM data. The locations are spaced 150 and 50 feet upstream from each bridge, and then 150 and 50 downstream from the bridges. These cross section profiles are plotted along with DTM data from 2001.

In general, the cross sections show that the areas immediately upstream and downstream from the bridges are relatively stable over time. The DTM data show relatively little aggradation or degradation. The elevation immediately in the vicinity of the thalweg is lower in 2011 than in 2010 in almost all cases, which is probably due to the difference between the two years in water surface elevations at the time LiDAR data were collected. Although the area appears to have scoured, it is not clear how much scour has occurred. The uncertainty emphasizes how important it is to have a history of pictures and bed profiles at a site.

2.10.1 CAPAY BRIDGE (COUNTY ROAD 85) RIVER MILE 26.35

The river width here is constricted by a factor of 0.5 as it flows under the current Capay Bridge, which was built in 1997. Heavy boulders have been imported to reinforce the outermost bridge abutments, with apparent success. The local land owners have expressed concern about erosion on the south bank upstream from the bridge, where there are steep banks with exposed soils. This concern was documented in detail above in this report.

Figure 55 Capay Bridge (County Road 85) River Mile 26.35

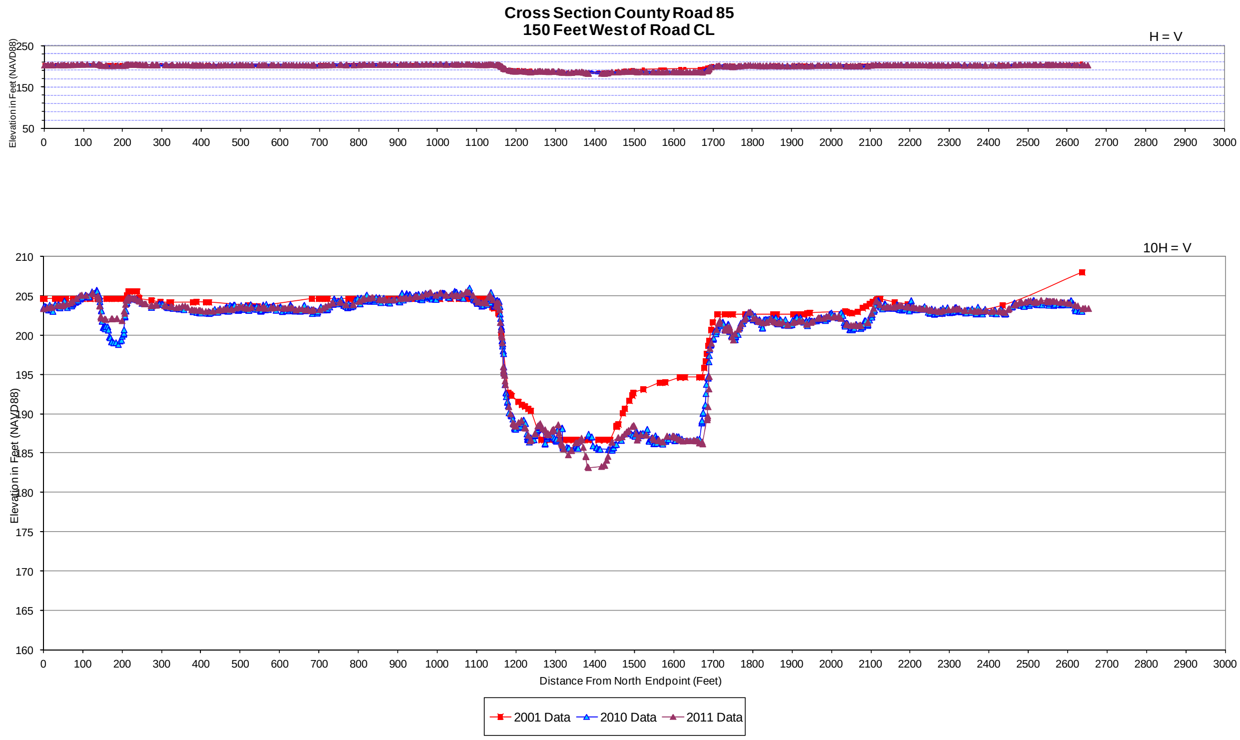


Figure 56 Capay Bridge (County Road 85) River Mile 26.35 150 West

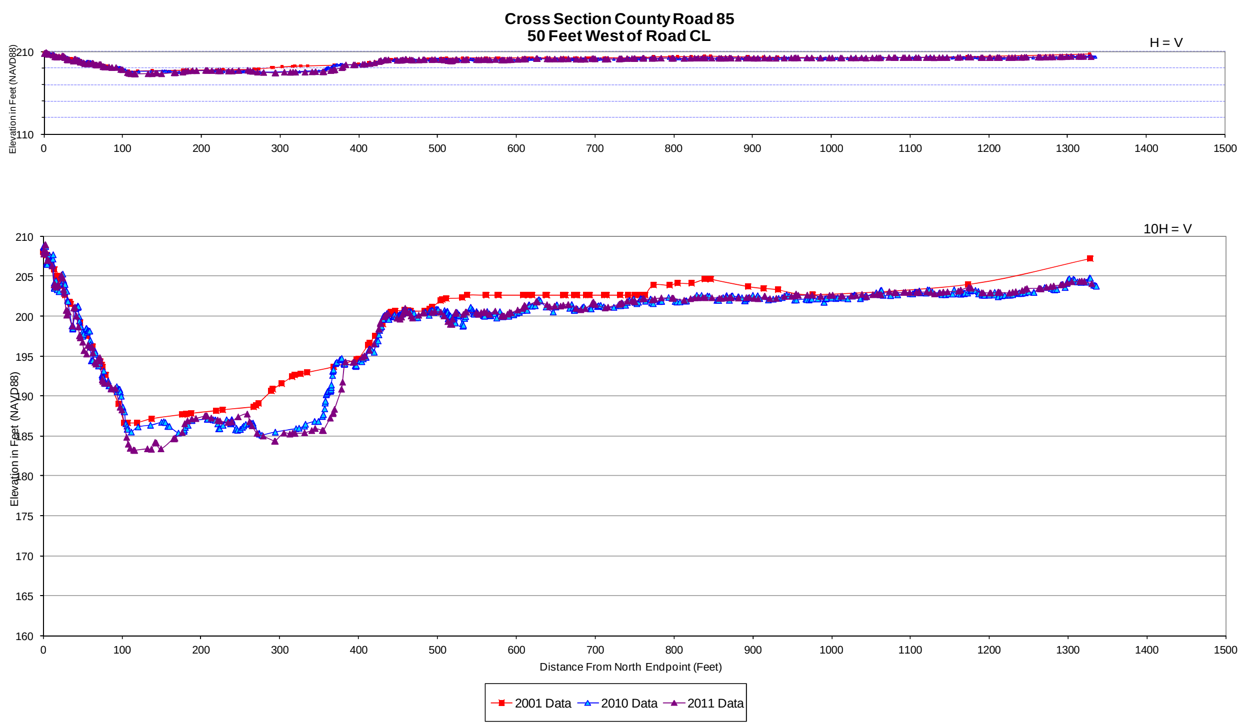


Figure 57 Capay Bridge (County Road 85) River Mile 26.35 50 West

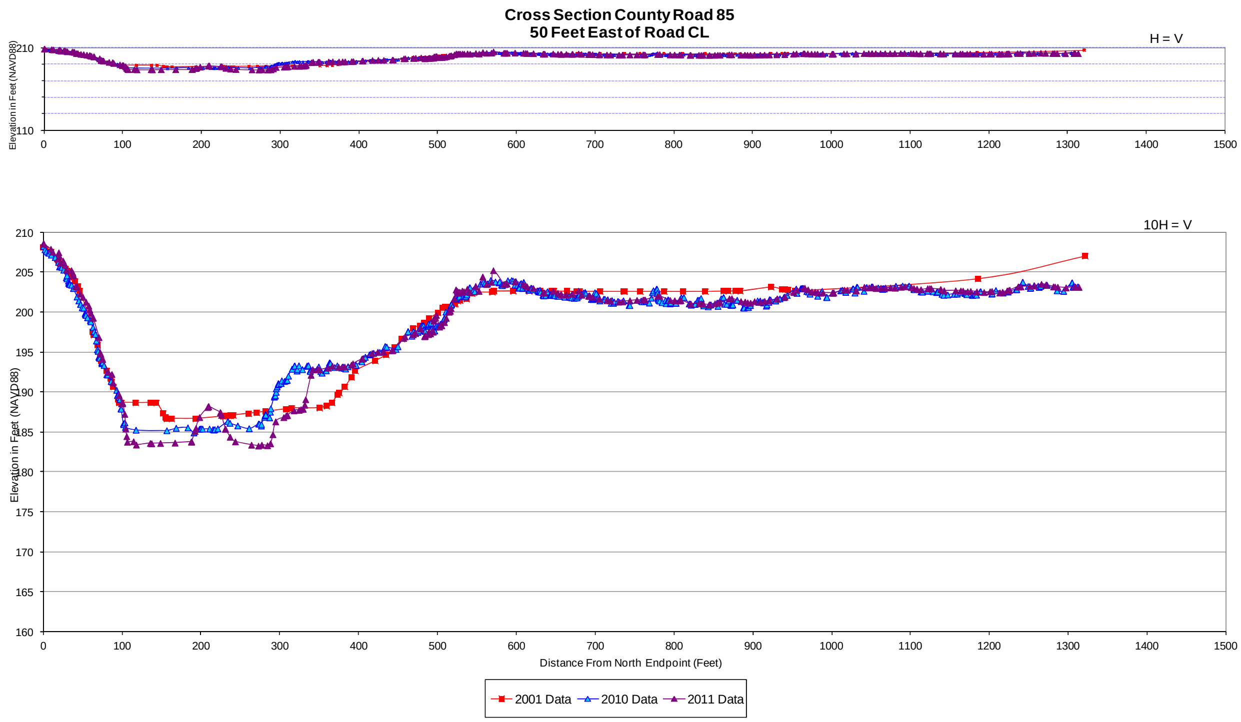


Figure 58 Capay Bridge (County Road 85) River Mile 26.35 50 East

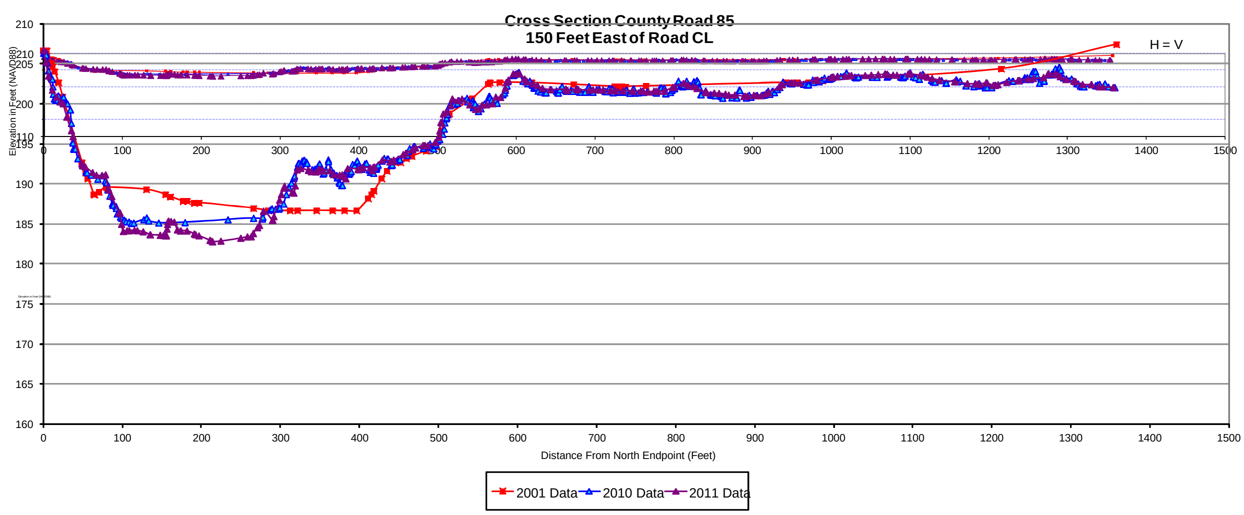


Figure 59 Capay Bridge (County Road 85) River Mile 26.35 150 East

2.10.2 ESPARTO BRIDGE (COUNTY ROAD 87) RIVER MILE 24.4

Low spur dikes are located upstream from the bridge, on the north bank. These spur dikes have trapped fine sediment, are vegetated, and seem to be working as control structures. The river's width is constricted by a factor of 0.3-0.5 as it flows under the bridge. Four large concrete abutments are located in the active channel. In this location, the north bank pier has eroded with a scour hole observed. Other piers seem to be buried under 6-10 feet of mobile stream gravels. It was observed that the main active channel of the creek at the bridge was on the south side of the channel boundary until four years ago, and during the last four years the channel was on the north side. The west (upstream) cross sections show some degradation between 2010 and 2011.

Figure 59 a Esparto Bridge (County Road 87) River Mile 24.4

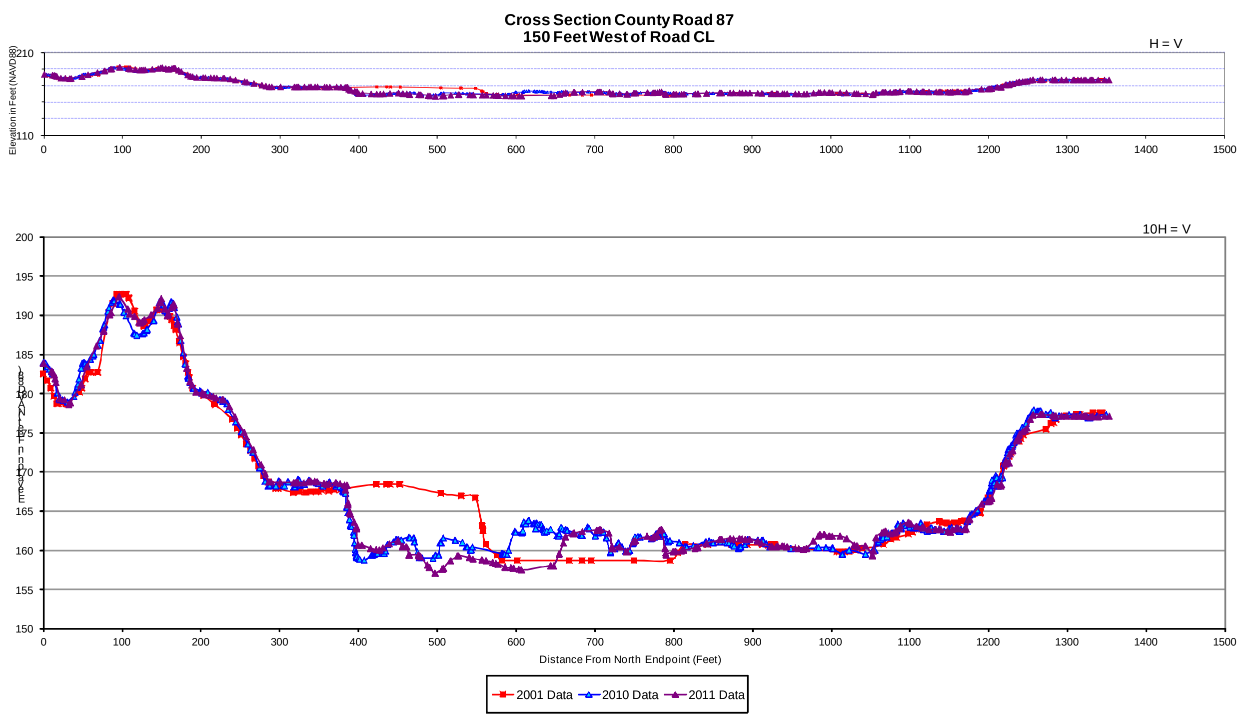


Figure 60 Esparto Bridge (County Road 87) River Mile 24.4 150 West

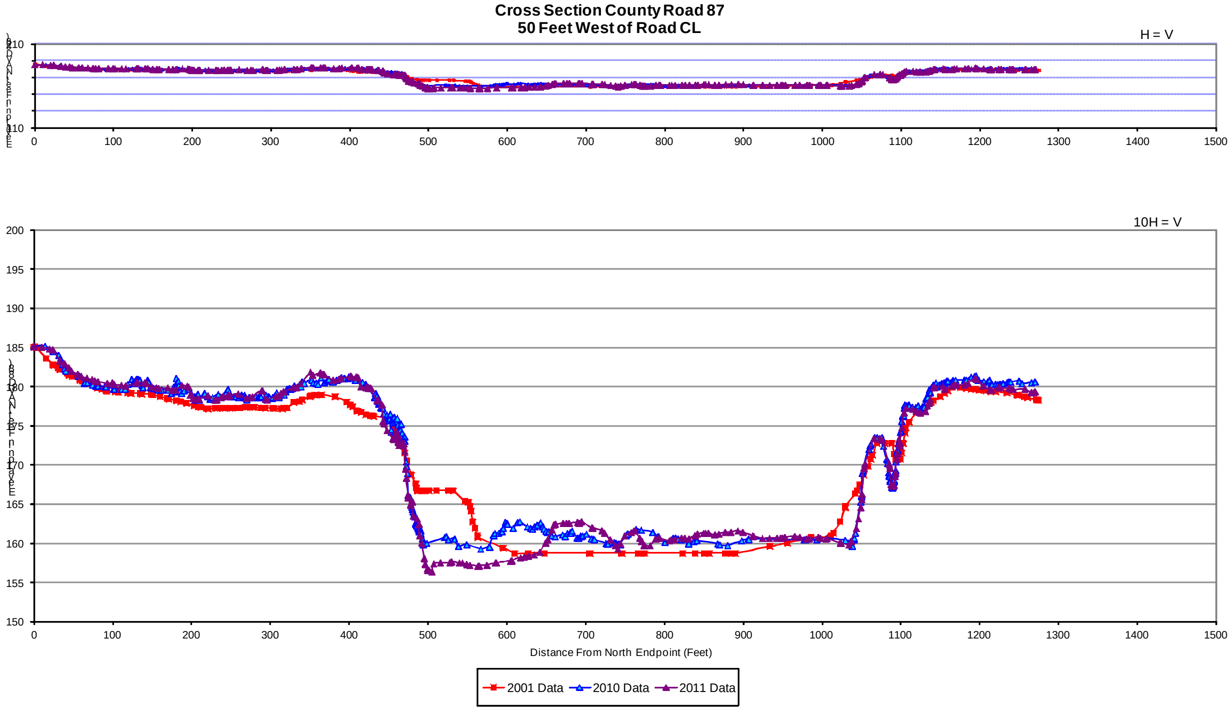


Figure 61 Esparto Bridge (County Road 87) River Mile 24.4 50 West

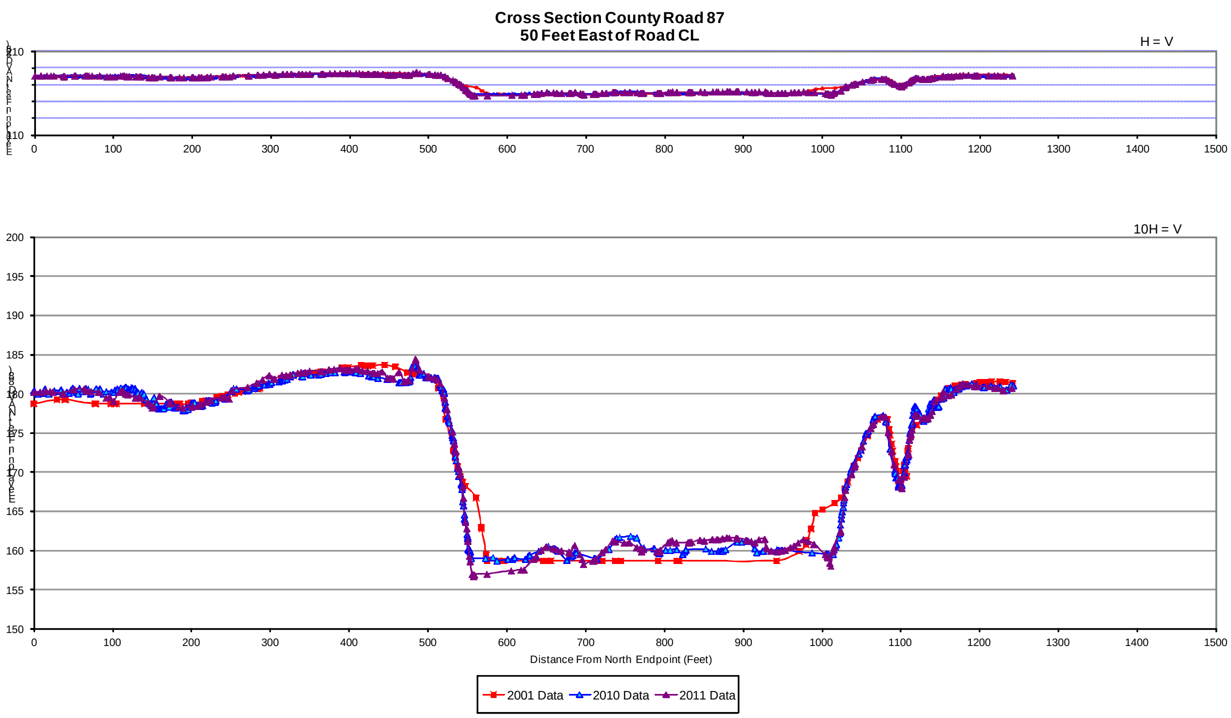


Figure 62 Esparto Bridge (County Road 87) River Mile 24.4 50 East

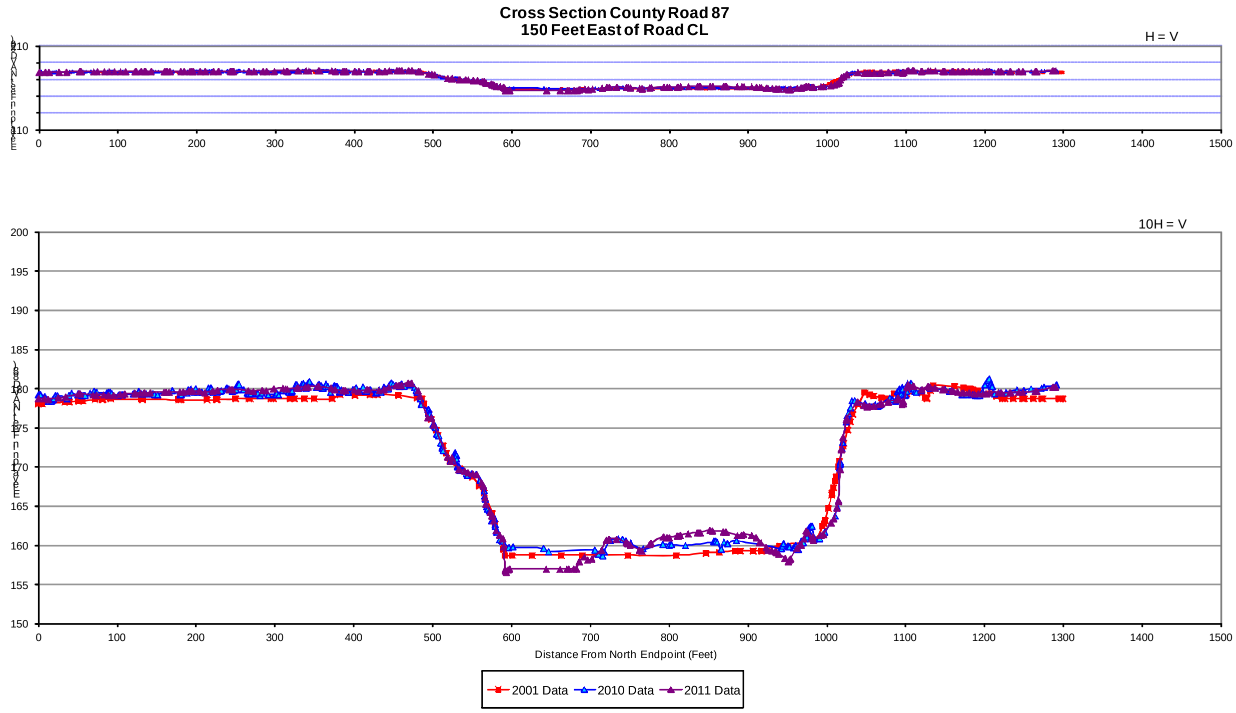


Figure 63 Esparto Bridge (County Road 87) River Mile 24.4 150 East

2.10.3 INTERSTATE 505 BRIDGE (RIVER MILE 21.0)

The channel is constricted by a factor of 0.5 to 0.7 times the normal width as it passes under the Highway I-505 Bridge. This bridge has an unusual longitudinal vane (pier) construction on the abutments that interferes with flow that is not perpendicular to the bridge. As a result, scour pools have formed around each abutment. Although the area appears to have scoured, it is not clear how much scour has occurred. The uncertainty emphasizes how important it is to have a history of pictures and bed profiles at a site; a practice which is a requirement of the program and has been resumed.

Figure 64 Interstate 505 Bridge (River Mile 21.0)

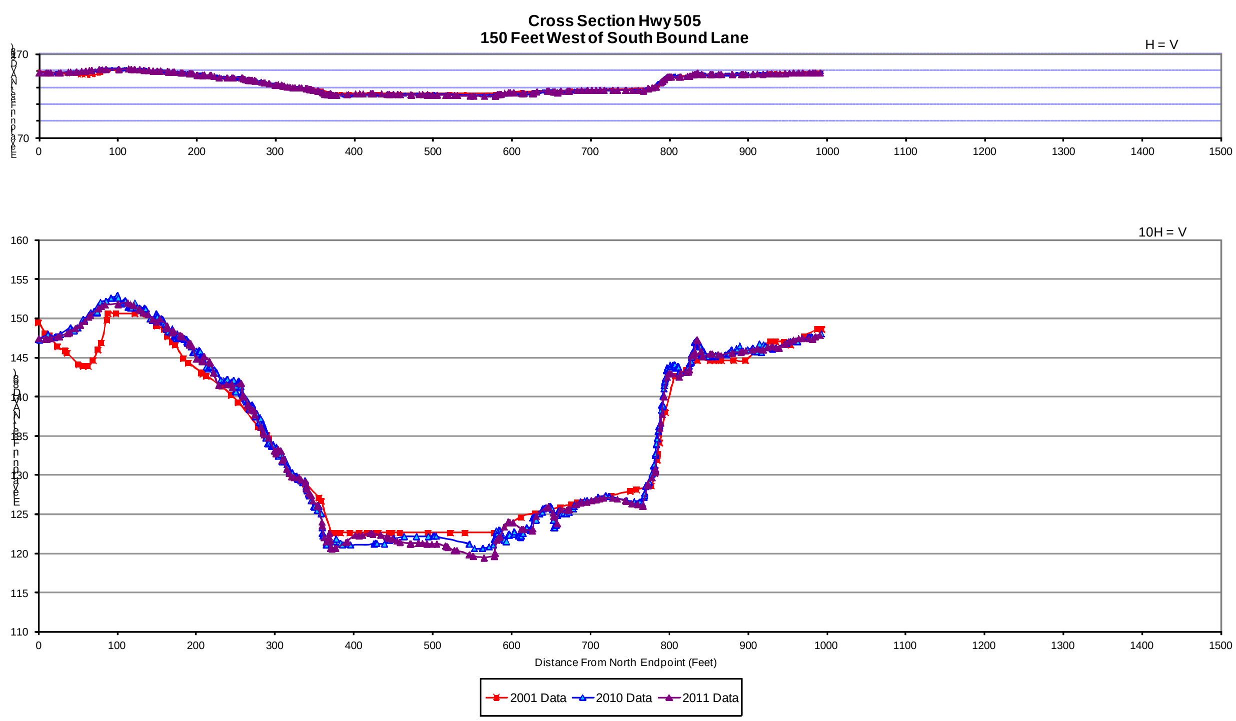


Figure 65 Interstate 505 Bridge (River Mile 21.0) 150 west

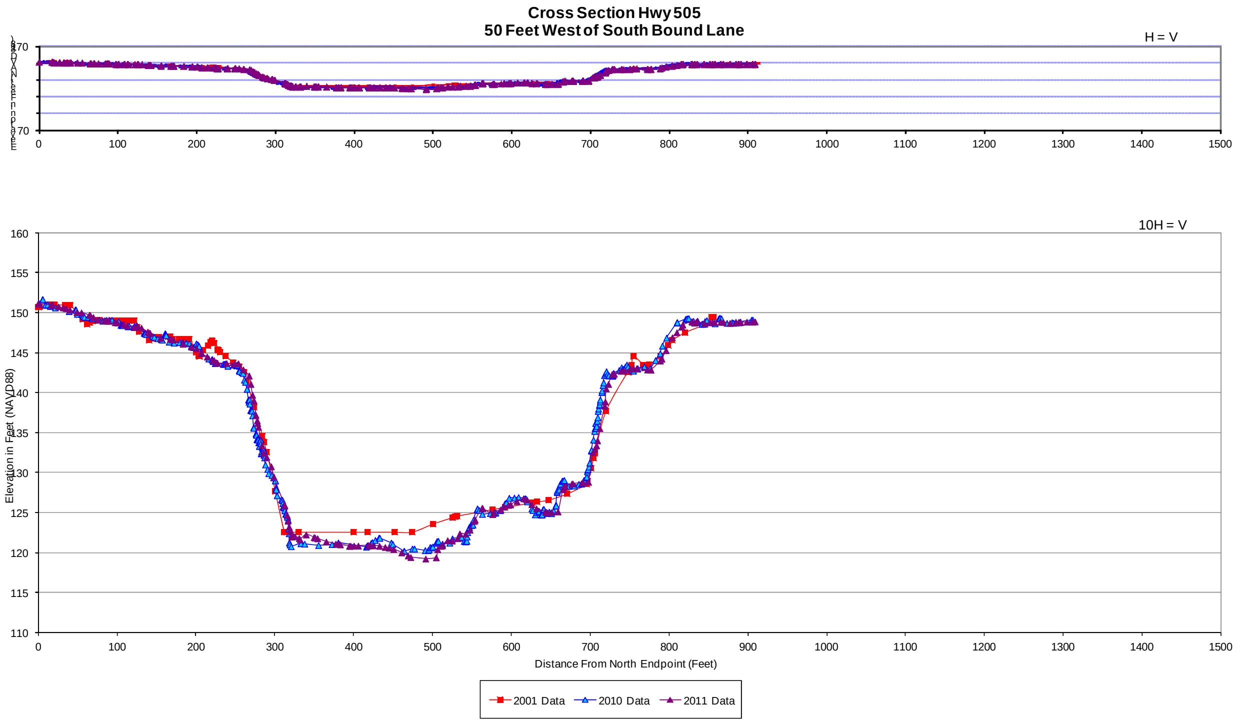


Figure 66 Interstate 505 Bridge (River Mile 21.0) 50 west

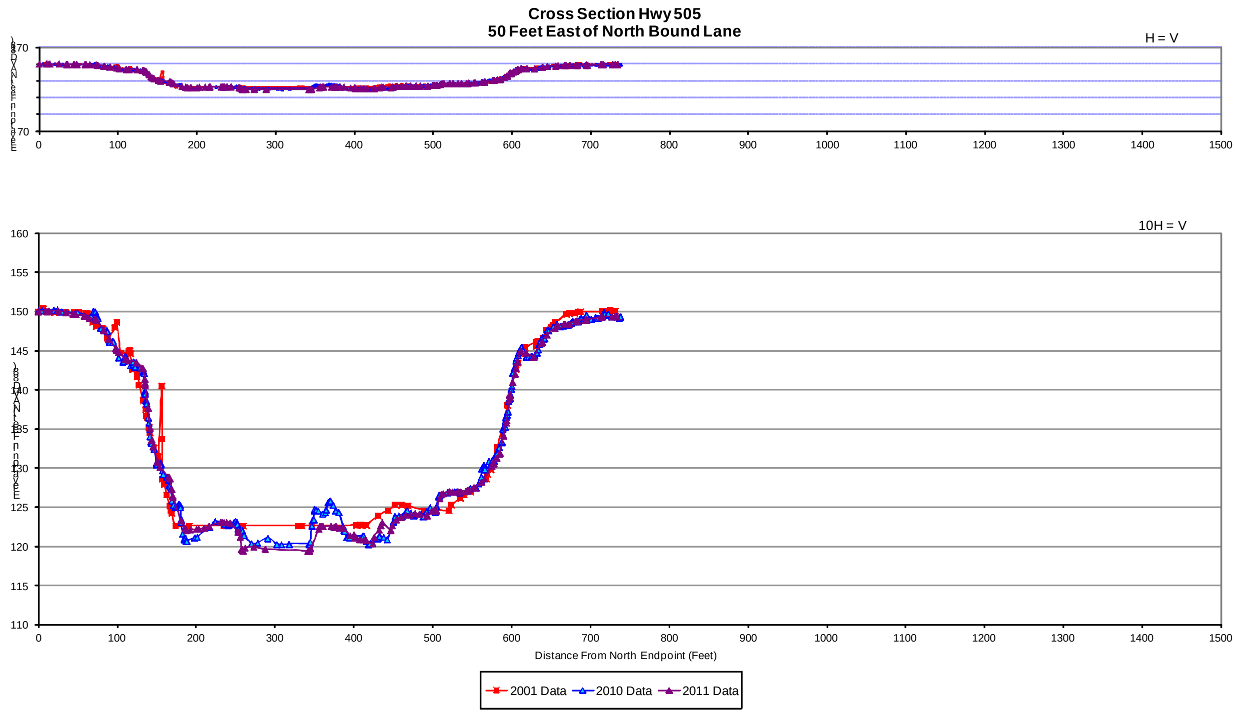


Figure 67 Interstate 505 Bridge (River Mile 21.0) 50 east

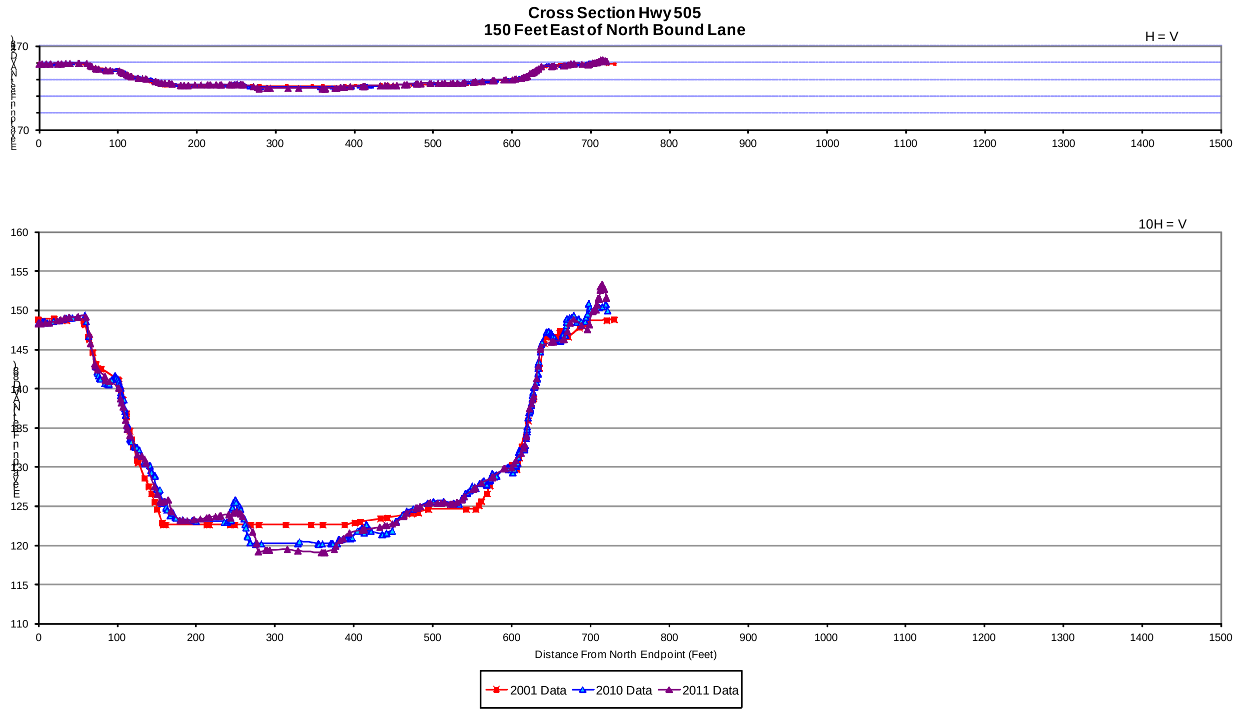


Figure 68 Interstate 505 Bridge (River Mile 21.0) 150 east

2.10.4 COUNTY ROAD 94B STEVENS BRIDGE (RM15.9)

At the County Road 94b Bridge near the Cache Creek Nature Preserve, the cross section profiles looking upstream show that there is no significant pattern of erosion or deposition between the surveys of 2001 and 2010. There is a slight indication that there is a minor shift in the direction of the right bank and some slight indication that there is aggradation. Looking downstream the conditions are similar. Overall the channel is extremely stable over the last 10 years, with the banks in the same location over that time period.

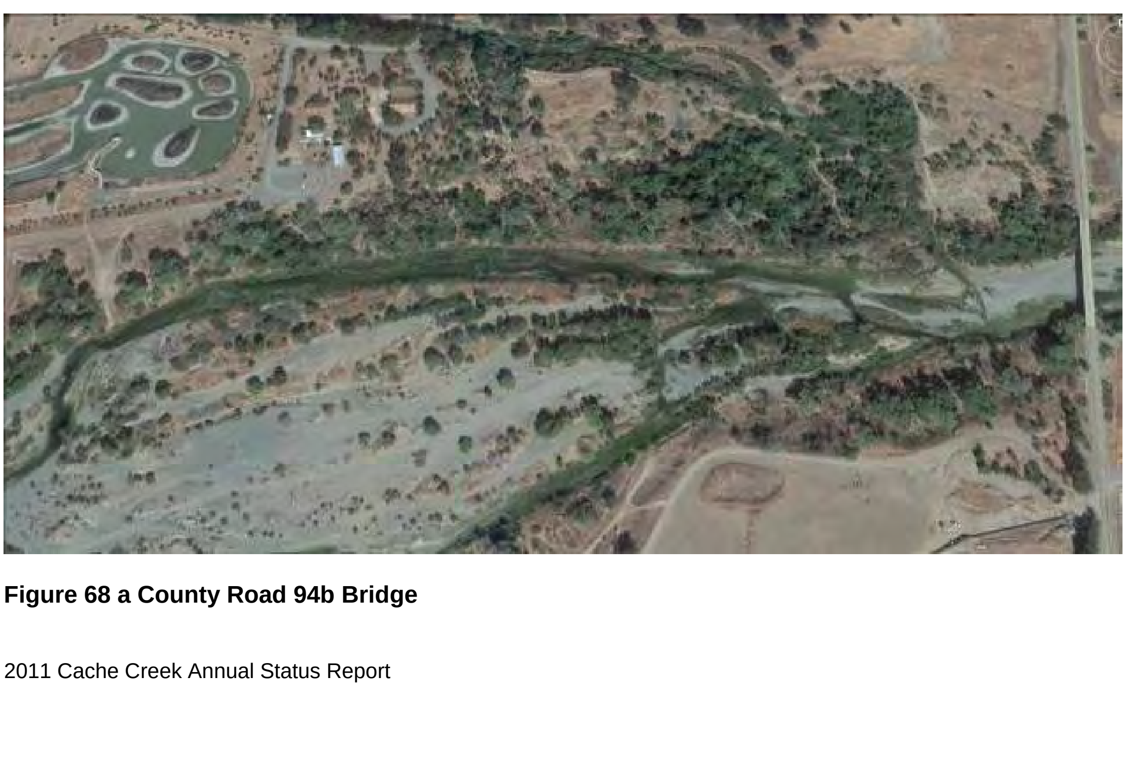


Figure 68 a County Road 94b Bridge

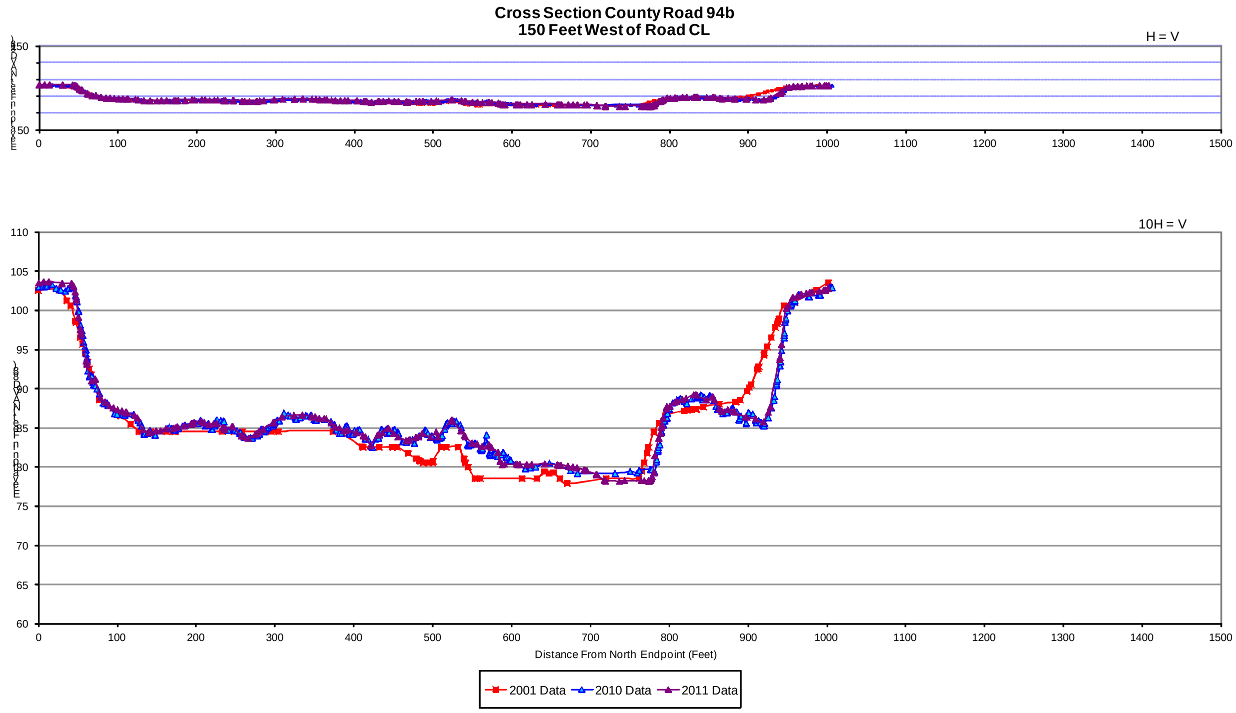


Figure 69 County Road 94b Bridge 150 west

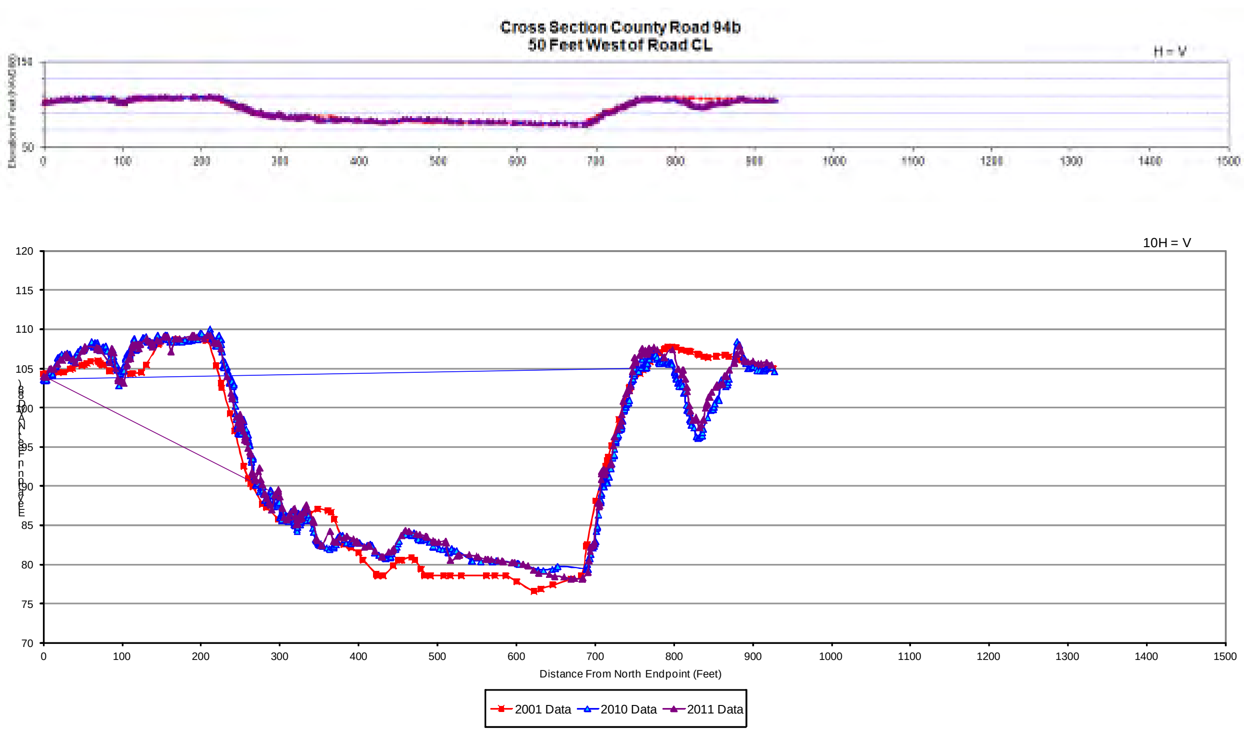


Figure 70 County Road 94b Bridge 50 west

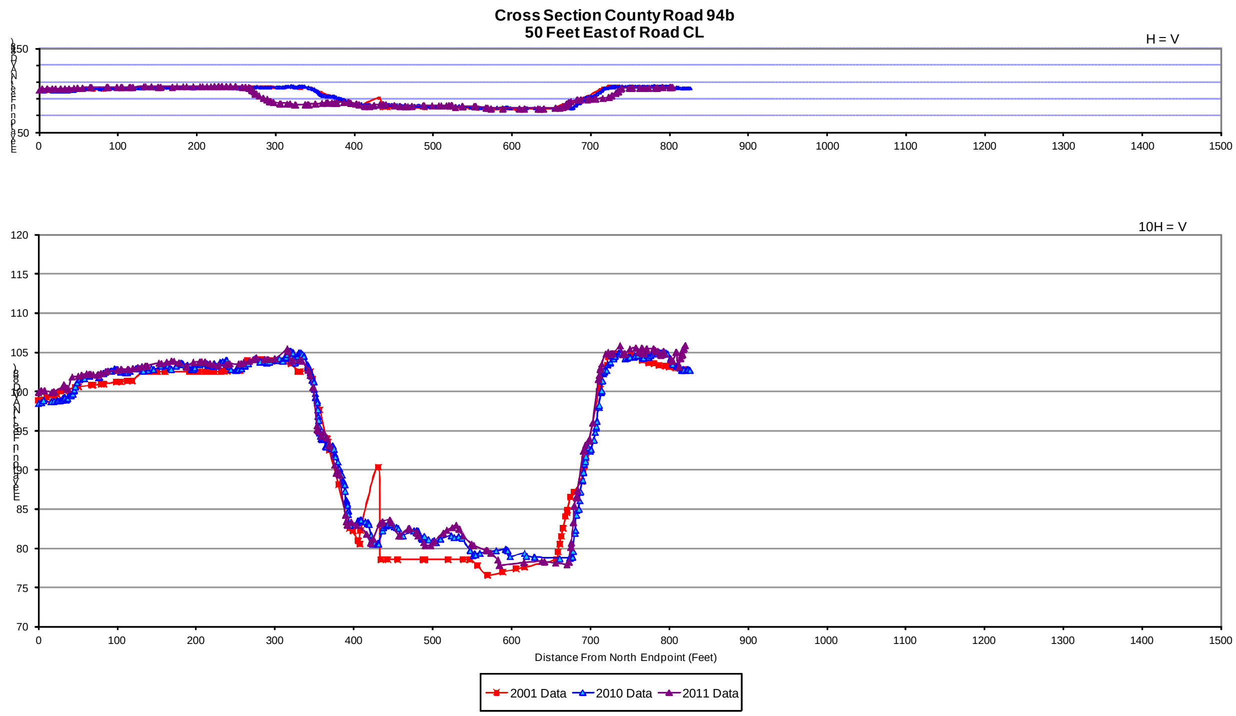


Figure 71 County Road 94b Bridge 50 east

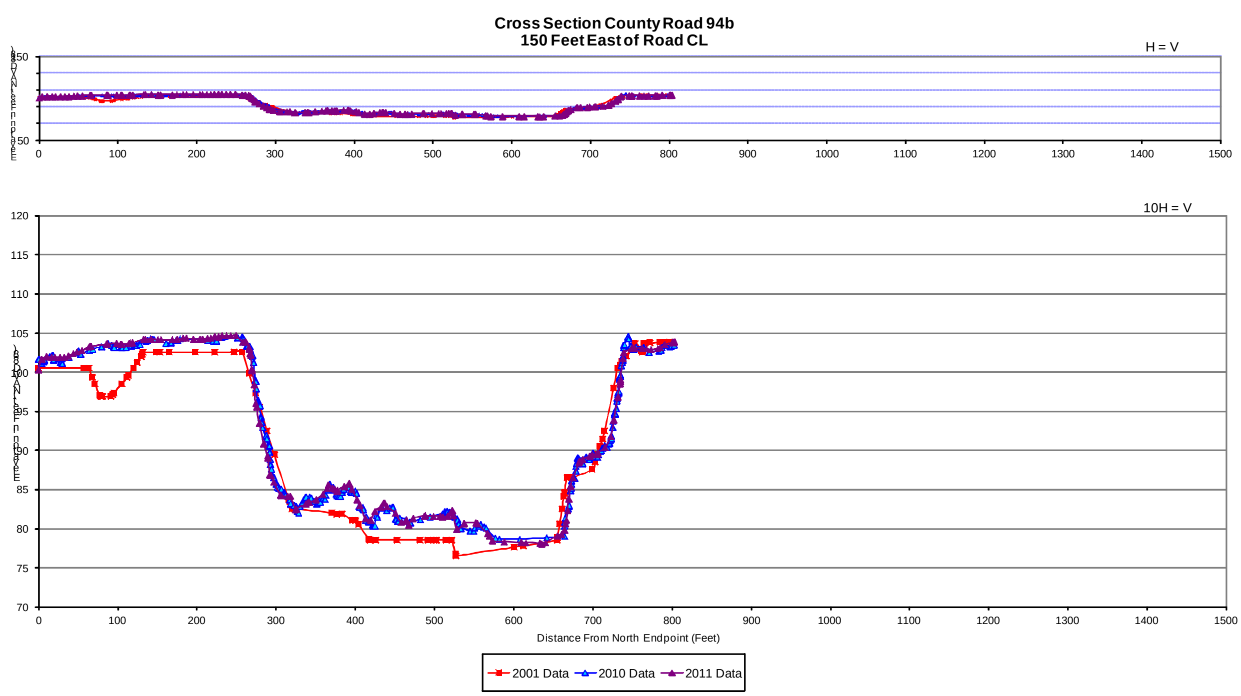


Figure 72 County Road 94b Bridge 150 east

Chapter 3 – HYDROLOGY AND WATER QUALITY

Cache Creek poses a wide variety of management challenges. The stream responds quickly to storm events, with flashy discharge and high flows that dissipate quickly. Sediment is mobilized by high flows, and each storm event causes changes to the stream bed and banks. Bank protection is a major issue on Cache Creek, with valuable farm land located near the active channel. Five gravel mines are also active near the CCRMP area, and each gravel mine has armored banks or diversion structures to control the flows and protect mining infrastructure. Flood capacity is limited in some locations by the narrow, incised channel, and there are areas of the stream where a flood could overtop the banks. Water quality poses additional problems, with boron contributed by the underlying bedrock, especially from the Bear Creek tributary, at potentially toxic levels to plants. Human influences add fertilizers, fuel and bacteria to the Creek, and our gold mining legacy has contributed mercury to the system. The Cache Creek watershed is probably the largest single contributor of mercury and methylmercury to the San Francisco Bay Delta region. Agricultural diversions and releases from Clear Lake and the 300,000 acre-foot Indian Valley Reservoir also affect flow and water quality in Cache Creek. These hydrology and water quality issues are collectively monitored and analyzed by the TAC hydrologist.

Water years are used to report data in the hydrology and geomorphology sections of this report. A water year is different than a calendar year, and is more in synch with the Mediterranean climate experienced in Yolo County. Summer is hot and dry, and winter is cool and humid with moderate rainfall. A water year starts on October 1, as the rainy season begins, and continues through the dry season, ending on September 30 of the next calendar year. A water year is named for the year it ends in, so this report covers the 2011 water year. This is a standard method that hydrologists use to report annual or seasonal data. Also by convention, in this report the terms stream, river, and creek are used interchangeably.

3.1 River Flow and Stream Hydrographs

The Cache Creek Improvement Program (CCIP) requires annual analysis of river stage and flow at the upstream and downstream ends of the CCRMP area. The nearest upstream gauge is at Rumsey, approximately 18 miles upstream from the Capay Dam. This is farther away than a gauge would ideally be positioned, but there are no major tributaries between the gauge and the CCRMP area. The downstream gauge is at the I-5 bridge, and is positioned perfectly to monitor flow out of the CCRMP area.

River stage was measured at each gauging site using electronic instruments, then sent by telemetry to the Department of Water Resources (DWR) web site. Each gauging site has a stage/discharge curve established by a stream gauging crew that visits the site monthly. Gauging sites are maintained by the USGS. The upstream (Rumsey) gauge has had some problems with accuracy at low flows, but was reconfigured in 2011. The Yolo gauge is accurate and reliable. Measurements were downloaded from the California Data Exchange Center's website (http://cdec.water.ca.gov/) to plot flow at the upstream and downstream gauging sites, and compare flow between years.

Stream flow was compared for different years by constructing a recurrence interval curve for Cache Creek (Figure 3.1.a). The recurrence interval for the Yolo gauge plotted by Leathers (2010) shows that flows in the 1,000 - 20,000 cfs range are relatively common on Cache Creek (Figure 3.1.a), and the 2011 peak flows fall within this range. Stream flow was plotted to produce hydrographs from the upstream and downstream gauging stations (Figures 3.1.b, 3.1.c). Both stream gauges are maintained by the USGS, and their monthly maintenance and calibration schedule produces accurate stage-discharge relationships and flow data for the sites.

Cache Creek experienced a wet year in 2011. This was the year that the State of California finally declared that the drought that started in 2007 was over, and snowfall in many parts of the Sierra was more than 150% of normal. In 2011, the annual peak flow at the Rumsey gauge was 19,414 cfs. In 2011, the annual peak flow at the Yolo gauge was approximately 16,300 cfs (Figure 3.1.c). These flows equate to a two or three year event, and are not especially high when compared to other wet years in Figure 3.1.a. This means that in terms of average statistical frequency every two to three years Cache Creek will experience natural flows similar to those experienced in 2011.

Flows on Cache Creek are also strongly influenced by releases from upstream reservoirs, and may not follow the natural hydrograph. Water is impounded in Indian Valley and Clear Lake reservoirs each Fall and Winter, and releases to the lower reaches of Cache Creek are limited until the reservoirs are sufficiently full. This causes an annual lag in flows to the lower watershed. Reservoir carryover also affects this balance. In wet years there is more carryover storage in the upstream reservoirs, and this may result in earlier filling and earlier stream flow on Cache Creek the next year.

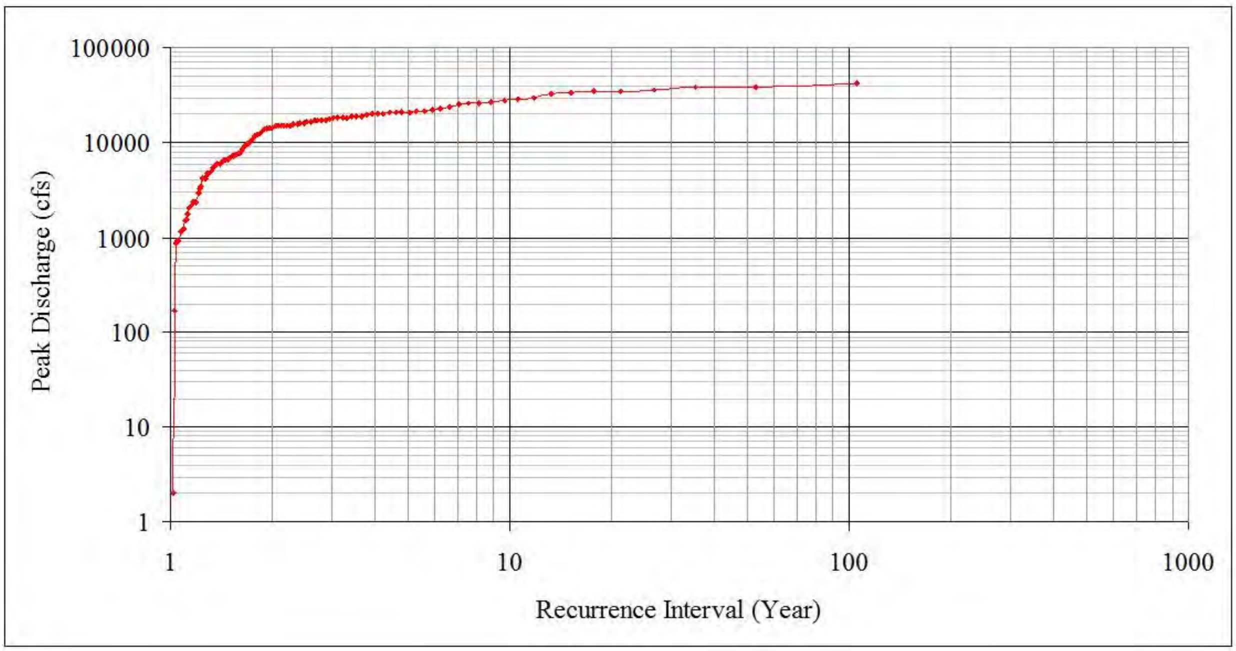


Figure 3.1.a: Recurrence interval for flows at the Yolo gauge, from Leathers (2010).

The gauges respond differently to flow events, and in general the peaks were higher at the Rumsey gauge in 2011. Gaps in the hydrograph (Figure 3.1.c) are a result of low flow summer conditions and water exports from Capay Dam. This diversion of water at the Capay Dam causes Cache Creek to dry up before it reaches the Yolo gauge, and the stream disconnects for several months each year. The downstream Yolo gauge is often dry during the hot summer months, when agricultural diversions are at their highest level and creek flows are at their lowest level. Cache Creek was an ephemeral stream before humans modified the system, so this summer dewatering may not be entirely un-natural.

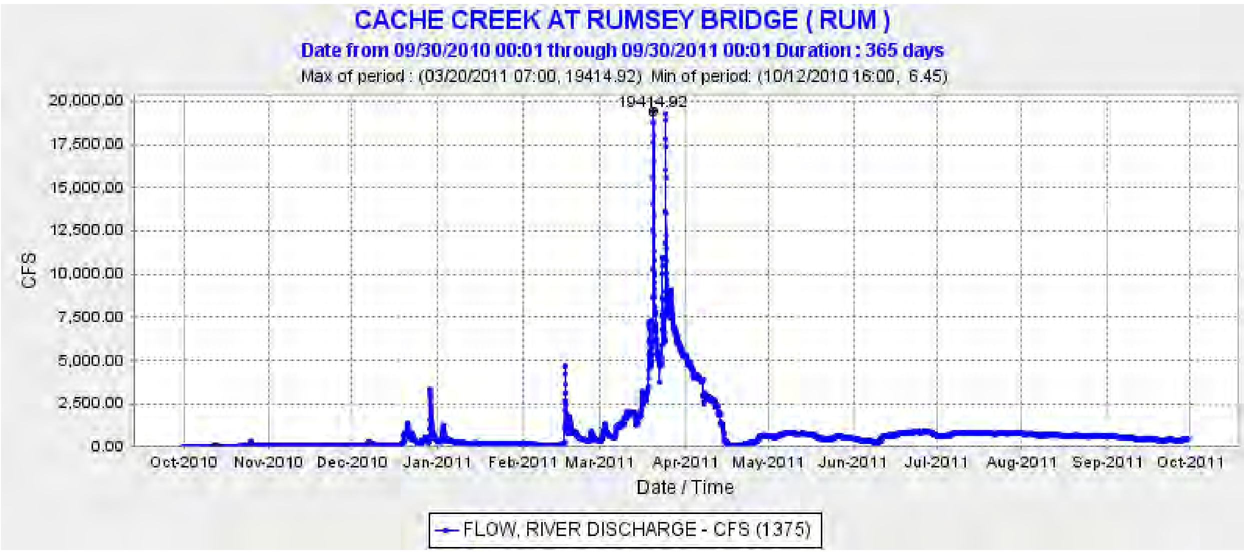


Figure 3.1.b: Hydrograph showing river flow for the water year 2011 at the Rumsey gauge, located approximately 18 miles upstream from the CCRMP study area. From the California Data Exchange web site, accessed October 2011.

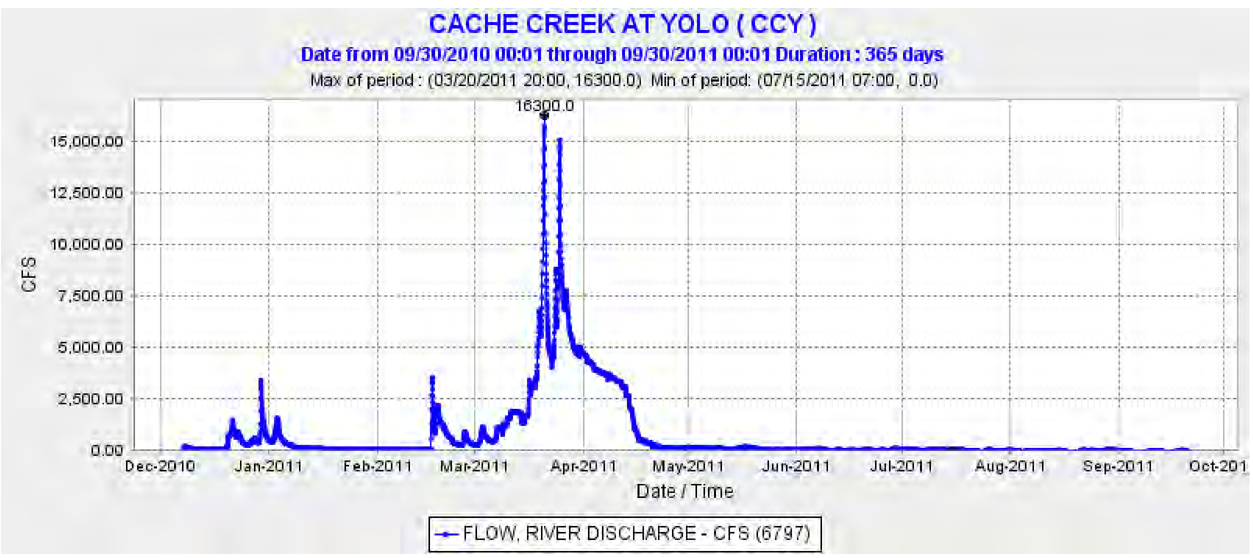


Figure 3.1.c: Hydrograph showing the 2011 water year at the Yolo gauge (I-5 Bridge), located at the downstream end of the CCRMP study area. From the California Data Exchange Center web site, accessed October 2011.

3.2 FLOOD MONITORING

The maximum flow for 2011 was slightly more than 19,000 cfs, and did not trigger any flood watch activities. Yolo County has worked to open lines of communication with the County's Emergency Services Manager, so that the expertise of the TAC can be available during a flood event.

Flood monitoring Recommendation: Continue to work with County disaster relief personnel, and make sure that the TAC is properly trained before the flood season starts.

3.3 SURFACE WATER QUALITY

Water samples were collected and analyzed as part of the CCRMP mandate to evaluate water quality annually. Samples were collected by County Staff, and analyzed for more than 50 compounds or elements by a certified environmental lab. The following water quality summary covers the 2011 water year, and builds on the water quality analysis performed by the TAC hydrologist in 2010. Water quality data from the 2011 water year was added to archived water quality information dating back to 1997 to give a better indication of long term trends and water quality in the CCRMP area.

Three water quality sample sets were collected during the 2011 water year. The first was a "first flush" sample, collected during the first heavy rain of the water year. This is a time when pollutants are swept into the stream after accumulating on the land surface for months. It is often a worst-case scenario, and shows water quality conditions when contaminants are at their highest levels. The first flush occurs on Cache Creek when sustained rainfall reconnects the Creek with continuous flows from Capay Dam to the I-5 bridge. This usually occurs in November or December, but depends on seasonal rains. The second water quality sample is called the "peak flow" sample, and characterizes water quality during the largest storm of the year. This is usually in January or February, although it can be difficult to determine which flow will be the largest of the year as the events are in progress. The last water quality samples were collected during "low flow" conditions at the end of the water year. This has historically occurred between August and October. Dates for each sampling event for the 2011 water year are summarized in Table 3.1.a.

	First flush sample	**Peak flow sample**	**Low flow sample**
2011 water year	December 12, 2010	March 16, 2011	August 10, 2011

Table 3.1.a: Dates for water quality sampling events, 2011 water year.

The 2002 Draft and Final Supplemental EIR for the CCRMP and CCIP (section 4.6.4 paragraph 5) lists minimum monitoring requirements for surface water: "Testing 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 (EPA Methods 8140 and 8150), suspended and floating matter, odor, and color." These guidelines form the basis for most of the water quality tests conducted on Cache Creek. A complete list of compounds analyzed is given in Table 3.3.b. Water quality data for water year 2011 is included in Appendix A. For the sake of brevity in this report, quality assurance/quality control (QA/QC) data are not included with the water quality results. Water quality and QA/QC were examined by the TAC hydrologist, and the 2011 data appear to be valid. Statistical methods and controls used by the chemistry lab were not verified; however, testing was completed by a certified lab with extensive experience. Blank and replicate samples were run to help isolate potential problems, and values reported by the labs were determined to be appropriate.

Many of the patterns described in 2009 and 2010 are still present. None of the water samples from the 2011 water year had pesticides or herbicides above the detection limits. These samples are listed as non-detect (ND) on data sheets, and results are not plotted in this report. The water quality sampling protocol currently involves analysis for whole suites of chemical pollutants that have not been detected since sampling began in 1999. When compounds are above detection limits but below maximum contaminant levels, no recommendation is made for the compound. Other compounds have a mix of non-detect readings and elevated contaminant levels. These compounds are plotted and discussed in the following section to show trends through time at different locations on the creek, and a recommendation is given for each compound. Non-detect values are plotted as zero values on these graphs.

Parameter	Units	Water Quality Objective (when available)	Parameter	Units	Water Quality Objective (when available)
Field tests			**Organophosphate Pesticides**		
Dissolved Oxygen	mg/l	>5.0 mg/l O (a)	Azinphos Methyl	ug/l	
pH (field measurement)	pHunits	6.5-8.5 (a,f)	Bolstar (sulprofos)	ug/l	
temperature	°F	<68° (a)	Coumaphos	ug/l	
			Demeton	ug/l	
Color/odor			Diazanon	ug/l	
Color	CU	<15 CU (a,b)	Dichlorvos	ug/l	
Odor	TON	<3 TON (c,e)	Dimethoate (Cygon)	ug/l	
			Disulfoton	ug/l	
Sediment			Dursban (Chlorpyrifos)	ug/l	
Total Dissolved Solids	mg/l	<500-1,500 mg/l (b)	EPN	ug/l	
Total Suspended Solids	mg/l	no adverse affect (a)	Ethoprop	ug/l	
Turbidity	NTU	5 NTU (c,e)	Fensulfothion	ug/l	
			Fenthion	ug/l	
Nutrients			Gardona (Stirofos)	ug/l	
Ammonia Nitrogen	mg/l	0.3-0.5 mg/l (c)	Malathion	ug/l	
Nitrate as N	mg/l	<45 mg/l as NO_3 (f)	Merphos	ug/l	
Nitrite as N	mg/l	<1 mg/l N (f)	Mevinphos	ug/l	
Orthophosphate Phosphorus (PO_4-P)	mg/l as P	0.1 mg/l elemental (g)	Monocrotophos	ug/l	
Total Kjeldahl Nitrogen	mg/l	0.1 mg/l (c)	Naled	ug/l	
			Parathion	ug/l	
Herbicides			Parathion-methyl	ug/l	
2,4,5-T	ug/l		Phorate	ug/l	
2,4,5-TP (Silvex)	ug/l	0.05 mg/l (e)	Ronnel	ug/l	
2,4-D	ug/l	0.07 mg/l (c)	Sulfotep	ug/l	
2,4-DB	ug/l		TEPP	ug/l	
3,5-Dichlorobenzoic acid	ug/l		Toluthion	ug/l	
4, Nitrophenol	ug/l		Trichloronate	ug/l	
Acifluorfen	ug/l				
Bentazon (Basagran)	ug/l	0.018 mg/l (e)	**Petroleum**		
Chloramben	ug/l		TPH as Diesel	ug/l	<100 µg/l (a)
Dalapon	ug/l	0.2 mg/l (c, e)	TPH as gasoline	ug/l	<5 µg/l (a)
DCPA	ug/l				
Dicamba (DNBP)	ug/l		**Metals**		
Glyphosate	ug/l	0.7 mg/l (e)	Boron, Total	ug/l	<0.1 mg/l (c)
MCPA	ug/l		Mercury, Dissolved	ug/l	<0.002 mg/l (c)
MCPP	ug/l		Mercury, Total	ug/l	<0.05 µg/l (c)
Pentachlorophenol(PCP)	ug/l	0.001 mg/l (c, e)			
Picloram	ug/l	0.5 mg/l (c, e)	**Bacteria**		
			Fecal Coliform	MPN/100ml	200/100ml (a)
			Total Coliform	MPN/100ml	

(a) = Central Valley RWQCB Basin Plan objective
(b) = California DHS drinking water limit
(c) = US EPA MCL, adopted by CVRWQCB (2008)
(d) = US EPA "Gold Book" limit for sensitive crops
(e) = California EPA drinking water MCL
(f) = Central Valley RWQCB drinking water standard
(g) = US EPA Aquatic life water quality standards (2006)

Table 3.3.b: List of constituents that must be monitored in surface water on an annual basis.

Dissolved Oxygen (D.O.)

The dissolved oxygen curve has seasonal spikes, with higher D.O. in the winter and lower D.O. in the summer (Figure 3.1.d). Dissolved oxygen varies seasonally because oxygen solubility is related to the temperature of the water. Dissolved oxygen levels range from 9-13 mg/l in the winter months, and are near saturated values. Dissolved oxygen levels drop in the summer months because warmer water holds less dissolved oxygen. Algal blooms may also contribute to low D.O. content in the summer months as decomposition of dead algae consume some of the available dissolved oxygen. All main channel samples have relatively high D.O. values given these limits.

Gordon Slough has lower D.O. values, and this is consistent with the muddy, slower moving water that passes through the slough. Warm, slow-moving water maximizes the production of algae, and decomposition of the algae consumes oxygen. This becomes a concern because low oxygen conditions are also a factor in the production of methylmercury.

Dissolved Oxygen recommendation: Future analyses should assess oxygen levels as percent saturation. No action is recommended for the low dissolved oxygen values, except to continue monitoring work near Gordon Slough.

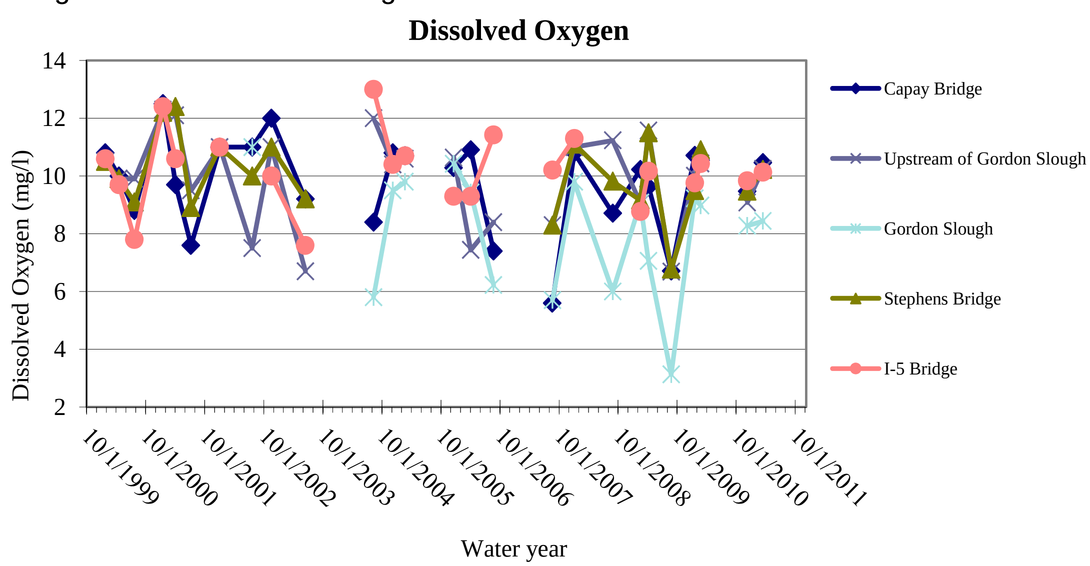


Figure 3.1.d: Dissolved oxygen levels at monitoring sites in the CCRMP area.

pH

The pH values from surface water in Cache Creek are slightly basic (Figure 3.1.e). This is typical of many rivers in California, and is a minor water quality issue. The underlying geology and dissolved constituents in surface water contribute to pH, and rivers can be either slightly basic or slightly acidic. A single acidic sample from the I-5 Bridge site on 8/17/05 looks like an anomaly, and may be a sampling or equipment error. Gordon Slough samples tend to have lower pH, and the pH has dropped slightly at Gordon Slough in the last two years. This trend toward more neutral conditions (lower pH) is probably a result of the decomposition of organic matter in the muddy, organic-rich runoff that flows through Gordon Slough.

pH recommendation: None

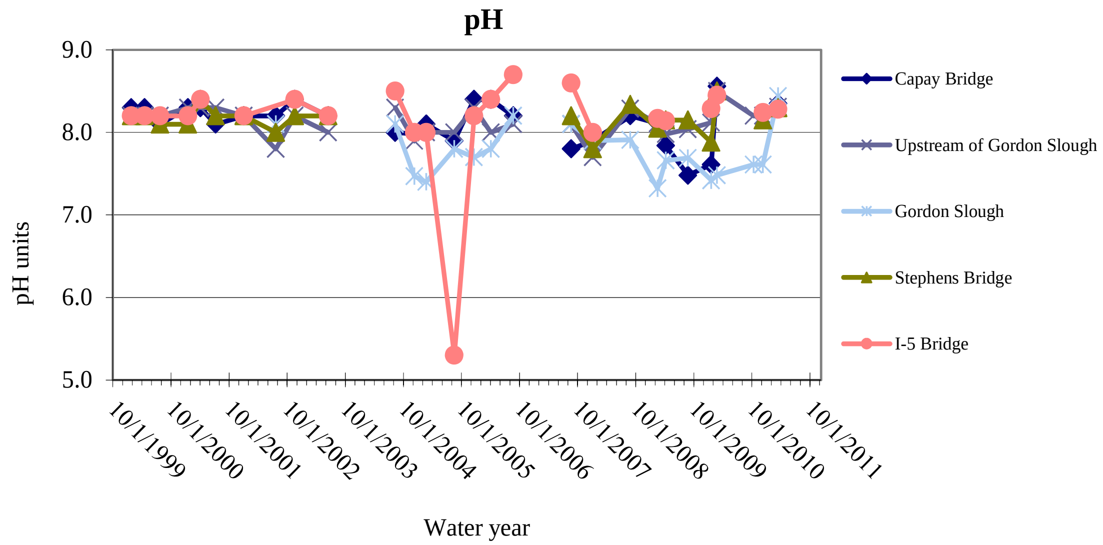


Figure 3.1.e: pH values at monitoring sites in the CCRMP area.

Temperature

Surface water samples show seasonal temperature variations in Cache Creek (Figure 3.1.f). Summer water temperatures are usually above 70° F, and often above 80° F. All summer temperature samples exceed the Regional Water Quality Control Board (RWQCB) surface water objective of 68° F. Winter temperatures range from 40° to 50°, and are within the recommended range for resident native and anadromous fish. High summer temperatures on Cache Creek are related to low flow. Cache Creek becomes disconnected during the summer months. Flow is limited or absent in the upper 10 miles of the creek within the CCRMP study area, and water collects in shallow pools. This leads to high temperatures that promote bacteria and algal growth, and support the expansion of non-native fish populations.

Elevated summer water temperature is one of the largest water quality issues on Cache Creek, and is partially responsible for the limited aquatic diversity.

Temperature recommendation: High summer water temperatures could be partly addressed by actively restoring native shrubs and trees on the banks for shade, and promoting the deposition of large woody debris in the channel. Large woody debris has several positive effects. Scour holes form near logs and root wads, and cooler groundwater may exchange with stream water in deep scour holes and pools. More riparian vegetation would lead to more dead logs in the channel. None of these steps will completely address the extreme temperature problem or lack of flow, but mature riparian vegetation and the resulting increase of in-stream woody debris would promote lower temperatures on Cache Creek. Cache Creek is a naturally ephemeral creek, which means that the creek goes dry in some reaches during the summer. The natural summer channel would have had a series of disconnected scour holes and pools for aquatic habitat, which could be mimicked on restoration projects. Water temperature control is an important part of channel restoration. Opportunities should be explored in areas that border the active channel to provide this type of dead woody material, and enhance the interaction between surface water and groundwater in the channel.

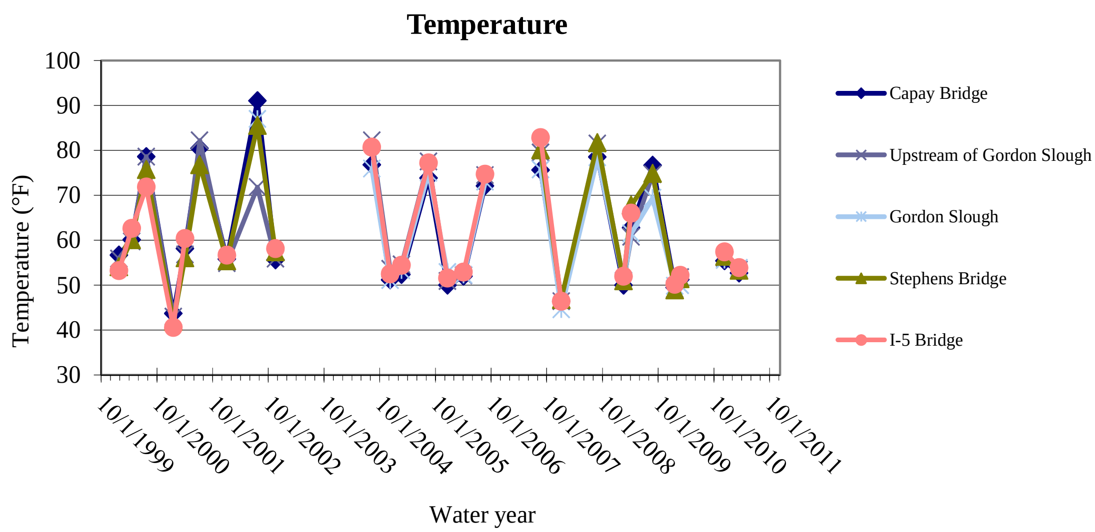


Figure 3.1.f: Temperature levels at monitoring sites in the CCRMP area.

Color

Color is regulated in drinking water, but guidelines for habitat and human contact are not specific unless a "nuisance or adverse effect" exists. The secondary drinking water standard of 15 color units is frequently exceeded in surface water samples from Cache Creek. High color readings are often related to high flows and muddy storm water in the first flush and peak flow sampling events. Gordon Slough has only been sampled since 2004, but samples collected from Gordon Slough have higher color values than any other sampling site in the CCRMP study area for any given sampling event (Figure 3.1.g). Gordon Slough has low TDS, TSS and turbidity values, so the source of the high color values from Gordon Slough is unclear. Small concentrations of dissolved organic matter may be contributed from Gordon Slough, or the suspended load may have different color in Gordon Slough. There is also an isolated color issue at the Capay Bridge site in August 2005. This is probably a localized issue, and may be from algal growth in a stagnant pool.

Color recommendation: No action, because Cache Creek is not used as a drinking water source.

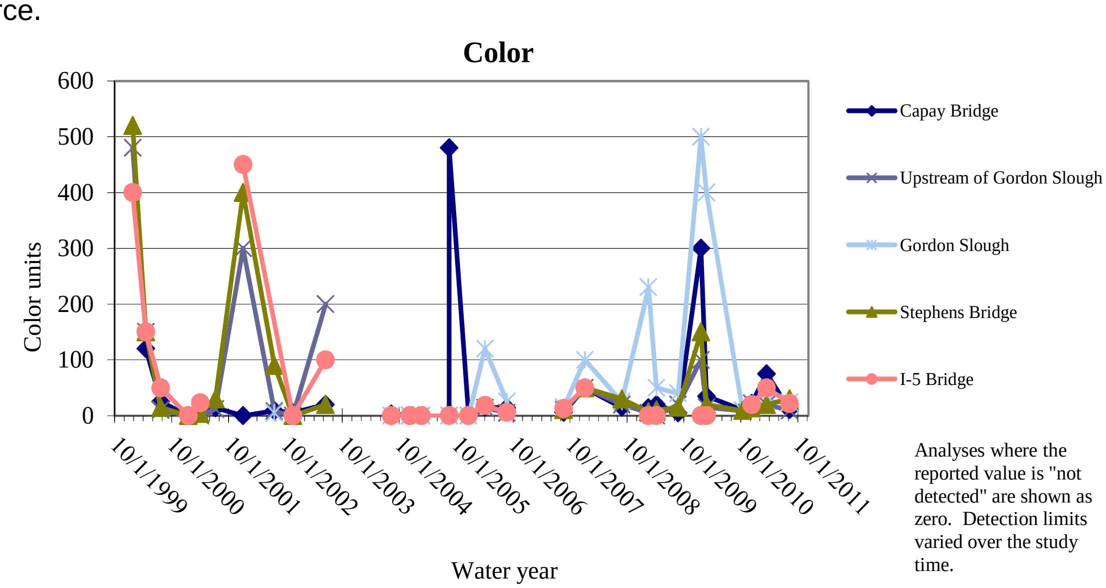


Figure 3.1.g: Color measurements at monitoring sites in the CCRMP area.

Ammonia Nitrogen

Ammonia is highly variable in the CCRMP area and many peaks in ammonia correlate with the first flush that occurs in winter (Figure 3.1.k). High levels of available nitrogen in the form of ammonia promote algal growth in Cache Creek during the hot summer months, so there are collateral effects to high ammonia concentrations in surface water. High surface water temperatures promote algal growth, and the ammonia provides necessary nutrients. Large mats of green algae are common in Cache Creek during the summer. Early ammonia measurements (1999 - 2004) often had maximum values at the downstream I-5 sample site. Based on detailed sampling that began at Gordon Slough in 2004, there was probably an ammonia source near or upstream from the Gordon Slough drainage. Ammonia is often related to agricultural sources, with ammonia applied to farm fields as a bioavailable source of nitrogen. Ammonia nitrogen is not regulated by the RWQCB, although the US EPA guidelines for aquatic life have a sliding scale for ammonia maxima that ranges from 0.3 - 0.5 mg/l. Ammonia levels discharged from Gordon Slough have at times exceeded this recommended maximum, although ammonia levels were generally low during the 2011 water year.

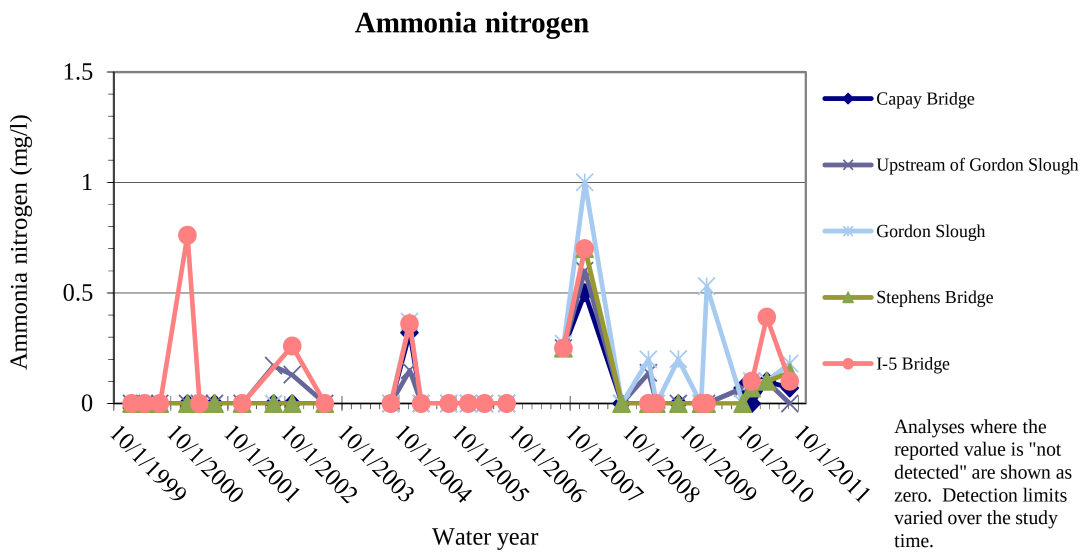


Figure 3.1.k: Ammonia concentrations at monitoring sites in the CCRMP area.

Ammonia Nitrogen recommendation: Continue to monitor ammonia levels, and if ammonia nitrogen levels increase again an appropriate course of action will be determined. This could include working with local partners to identify and reduce the source of ammonia.

Nitrate Nitrogen

Nitrate nitrogen is a component of the nitrogen cycle, and is derived from ammonia, sewage, animal waste, or naturally occurring nitrogen sources. Nitrate forms under oxidizing conditions in near-surface environments, and is regulated by the EPA and RWQCB. Nitrate can be reported as either NO_3 (nitrate) or NO_3-N (nitrate-nitrogen). This sometimes leads to confusion about the MCL (maximum contaminant level) for nitrate. The EPA lists MCL's of 10mg/l NO_3- N or 45 mg/l NO_3. The adverse health effects of nitrate on humans are well documented. All measured nitrate levels in the CCRMP area are above what we would expect for background levels, but are still below the 10 mg/l regulatory guideline (Figure 3.1.l). Nitrate is a nutrient source for algae, so the observed nitrate levels of 1-4 mg/l nitrate probably contribute to algal blooms during the warm, low flow summer months.

Nitrate nitrogen recommendation: Continue to monitor nitrate nitrogen, no additional action.

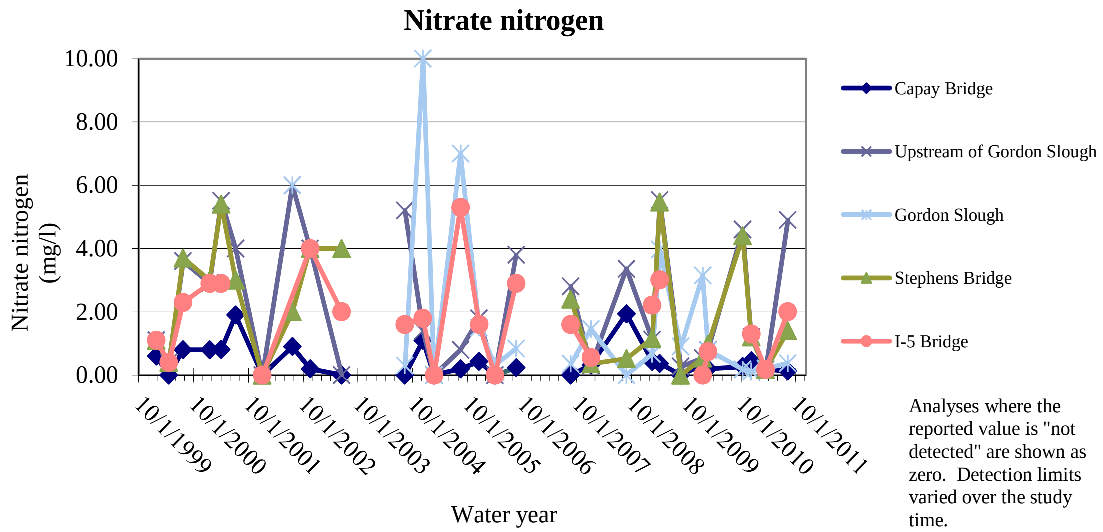


Figure 3.1.l: Nitrate nitrogen concentrations at monitoring sites in the CCRMP area.

Nitrite Nitrogen

Nitrite is a less common component of the nitrogen cycle that forms under reducing conditions. Nitrite levels are regulated to less than 1 mg/l by the EPA and RWQCB. Nitrite has not been a problem on Cache Creek, with the exception of the first flush event in 2005, when excess nitrite was detected at the downstream end of the CCRMP study area (Figure 3.1.m).

Nitrite nitrogen recommendation: Continue to monitor nitrite nitrogen; no additional action.

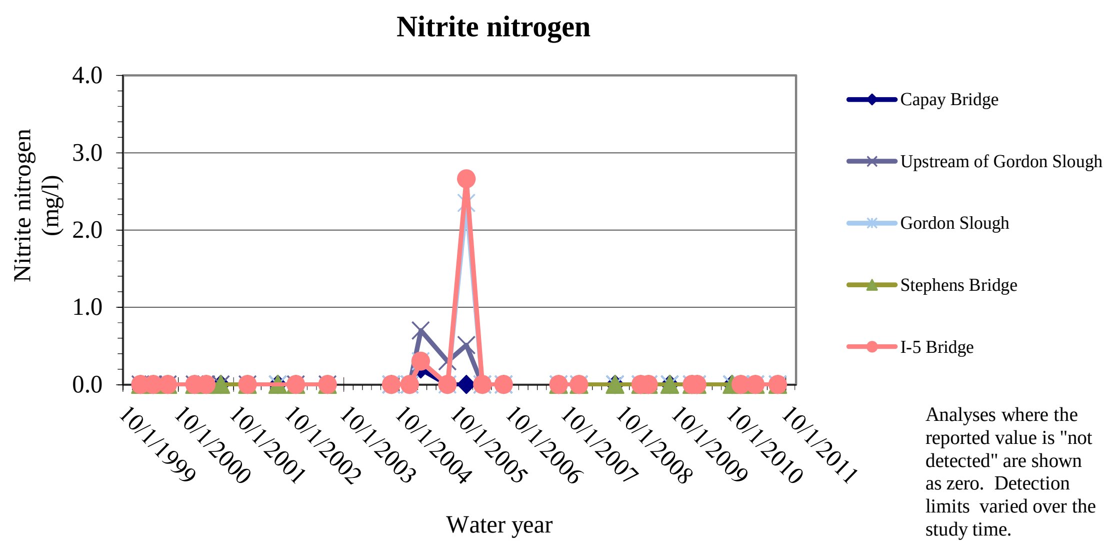


Figure 3.1.m: Nitrite Nitrogen concentrations at monitoring sites in the CCRMP area.

Total Kjeldahl Nitrogen (TKN)

Total Kjeldahl Nitrogen (TKN) refers to a lab technique that measures ammonia plus organic nitrogen concentrations. Organic nitrogen usually comes from plant or animal proteins and usually increases with the first flush or high winter flow measurements on Cache Creek (Figure 3.1.n). Gordon Slough has frequently experienced elevated TKN values. Regulatory agencies have not established a maximum contaminant level for TKN, although the US EPA is considering adding TKN to the federal drinking water standards. TKN levels on Cache Creek are relatively low, and show a correlation with ammonia levels. TKN is not a significant problem in most samples from Cache Creek.

Total Kjeldahl nitrogen recommendation: Continue to monitor total Kjeldahl nitrogen; no additional action.

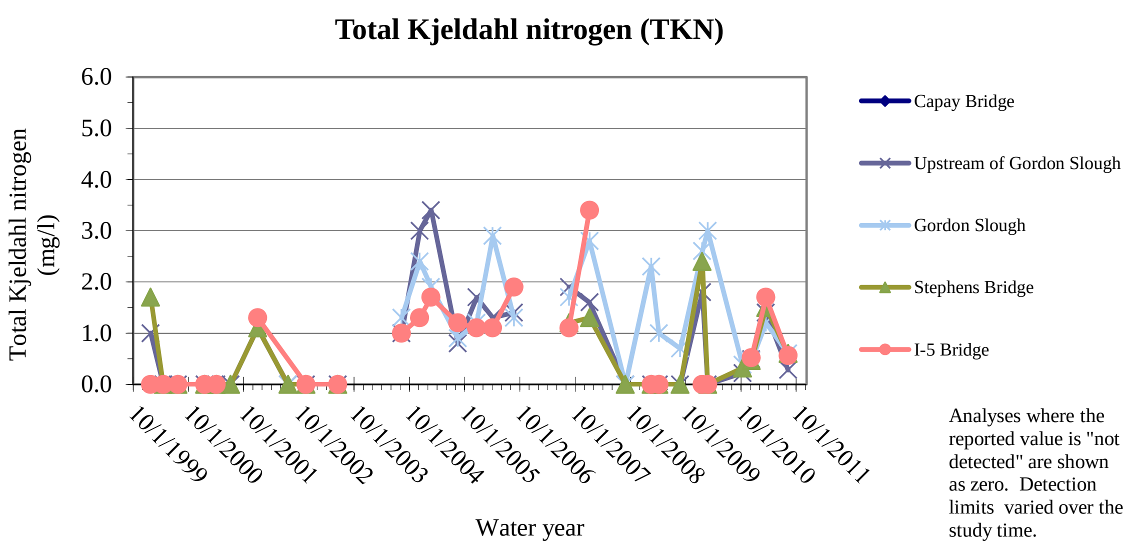


Figure 3.1.n: Total Kjeldahl Nitrogen concentrations at monitoring sites in the CCRMP area.

Calculated Organic Nitrogen (TKN - NH_3)

Calculated organic nitrogen equals measured TKN minus measured ammonia. This is an indirect method of determining organic nitrogen, and has some obvious flaws. Several of the early organic nitrogen values from Cache Creek are negative (Figure 3.1.o), which is not possible. This indicates that TKN and NH_3 values are so low they are within the error level of the instrument and method. Calculated organic nitrogen levels rise slightly after 2004, and are more meaningful. Organic nitrogen values are controlled by the larger TKN values, and closely parallel the TKN graph. Organic nitrogen levels have been low for the past three years, and were low again for 2011. There are no state or federal regulatory standards for organic nitrogen, and it does not appear to be a significant problem in the CCRMP study area.

Calculated organic nitrogen recommendation: None.

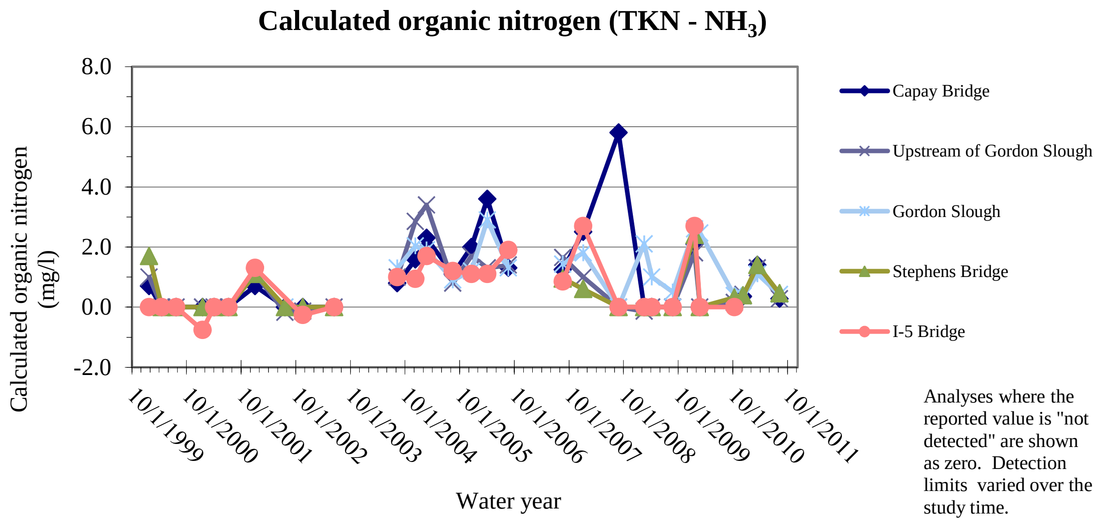


Figure 3.1.o: Calculated total organic nitrogen (TKN – NH3) concentrations at monitoring sites in the CCRMP area.

Mineral Nitrogen (Nitrate plus Nitrite)

Mineral nitrogen is the sum of nitrate plus nitrite, and is the inorganic nitrogen constituent. Mineral nitrogen is a naturally occurring component in river systems, but excess nitrate can also be added through the nitrogen cycle by converting ammonia or bioavailable nitrogen to nitrate. Mineral nitrogen levels on Cache Creek are higher than we would expect from a bedrock source, so extra nitrate or nitrite contribution is suspected. This could be from a variety of sources, including runoff, farm waste, septic systems, excess fertilizer, pipes or drains that contribute to nearby waterways, etc. Nitrate values control this calculated measurement, because nitrate values are significantly higher than nitrite values. Nitrate correlates strongly with river flow, so higher flow events result in higher mineral nitrogen values on Cache Creek (Figure 3.1.p). Gordon Slough and the Stevens Bridge sites have higher concentrations of mineral nitrogen than other sites on Cache Creek, and this is probably because of water quality issues (excess nitrate) from water sources upstream in Gordon Slough. The excess mineral nitrogen (nitrate) may feed algal blooms on Cache Creek during the summer months. There are no regulatory guidelines for mineral nitrogen.

Mineral nitrogen recommendation: Continue to monitor mineral nitrogen. No additional action.

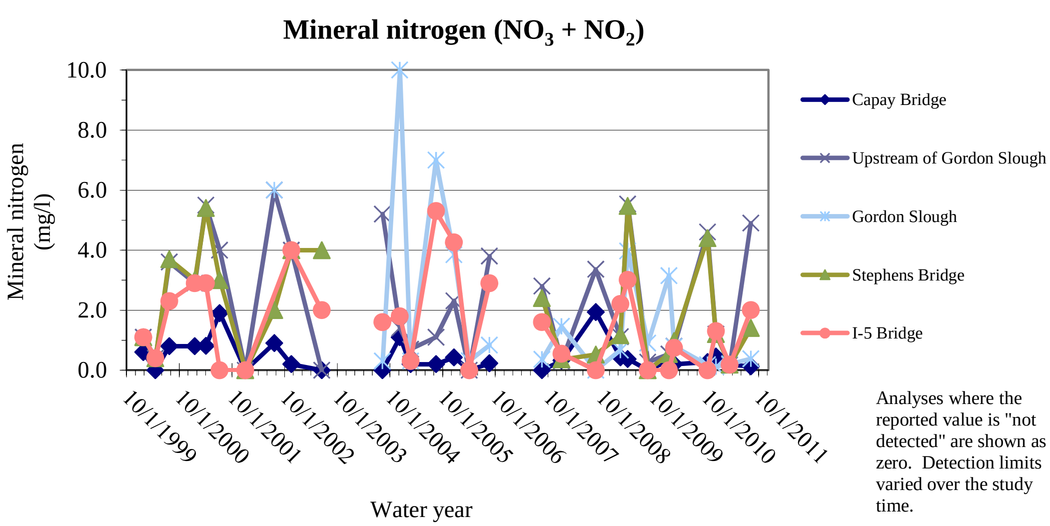


Figure 3.1.p: Mineral nitrogen (nitrate plus nitrite) concentrations at monitoring sites in the CCRMP area.

Orthophosphate Phosphorus (PO_4 phosphorus)

Orthophosphate phosphorus occurs naturally in streams, and is contributed by the underlying bedrock and recycled plant material. Orthophosphate is also a fertilizer, and excess orthophosphate in the CCRMP area is probably from agricultural sources. Orthophosphate may enhance algal blooms in streams, especially during the hot summer months. US EPA water quality standards for aquatic life have a maximum contaminant level of 0.1 mg/l for orthophosphate, although other regulatory agencies do not list this compound. This level was exceeded in the 2011 samples from Gordon Slough (Figure 3.1.q).

Orthophosphate phosphorus recommendation: This is a new water quality problem, and levels of orthophosphate are high enough that orthophosphate should be monitored closely. If orthophosphate levels remain high, Yolo County should work with local partners to identify the source of orthophosphate and reduce the problem.

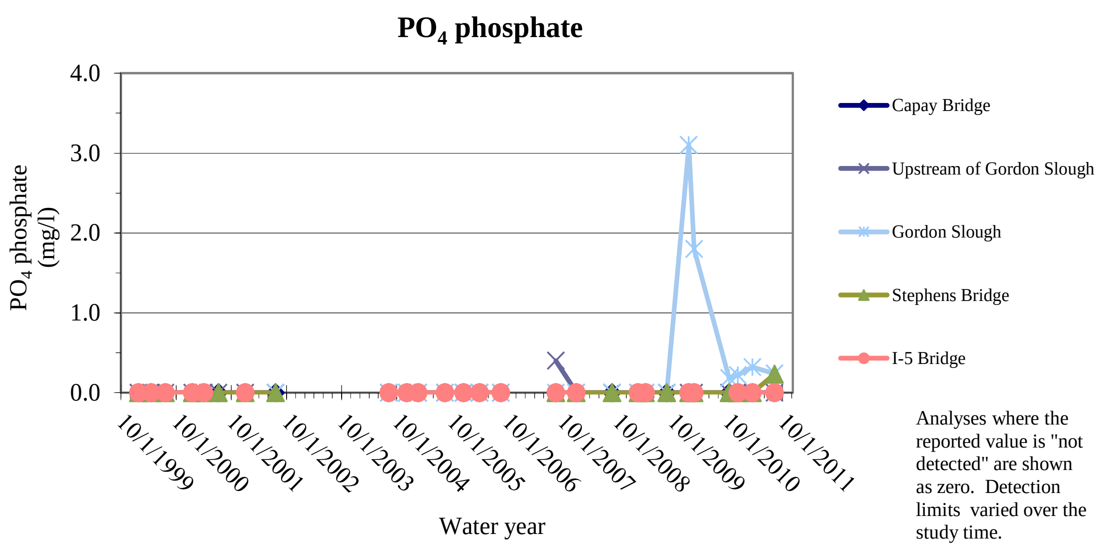


Figure 3.1.q: Orthophosphate (PO_4) concentrations at monitoring sites in the CCRMP area.

TPH as Diesel

TPH (Total Petroleum Hydrocarbon) as diesel is not regulated by most agencies, although the RWQCB Basin Plan has a taste and odor threshold for diesel oil of 100 µg/l, with oil and grease not to affect "beneficial use". This 100 µg/l level was exceeded every winter from 2004 to 2010. There were seasonal variations, but in general there was concern that diesel fuel was leaking into the creek. Gordon Slough and downstream sites seemed especially affected by the problem. This all seems to have stopped for the 2011 water year. Gordon Slough and the I-5 bridge sites had elevated diesel levels on the Dec. 10 sampling event, but the two following samples have been below detection limits for diesel fuel. This could mean that the source has been stopped. It could also be a temporary low, so we will continue to monitor diesel fuel levels very closely.

TPH as diesel recommendation: Examine TPH as diesel levels after every sampling event, and work with local partners to identify the source if the problem returns.

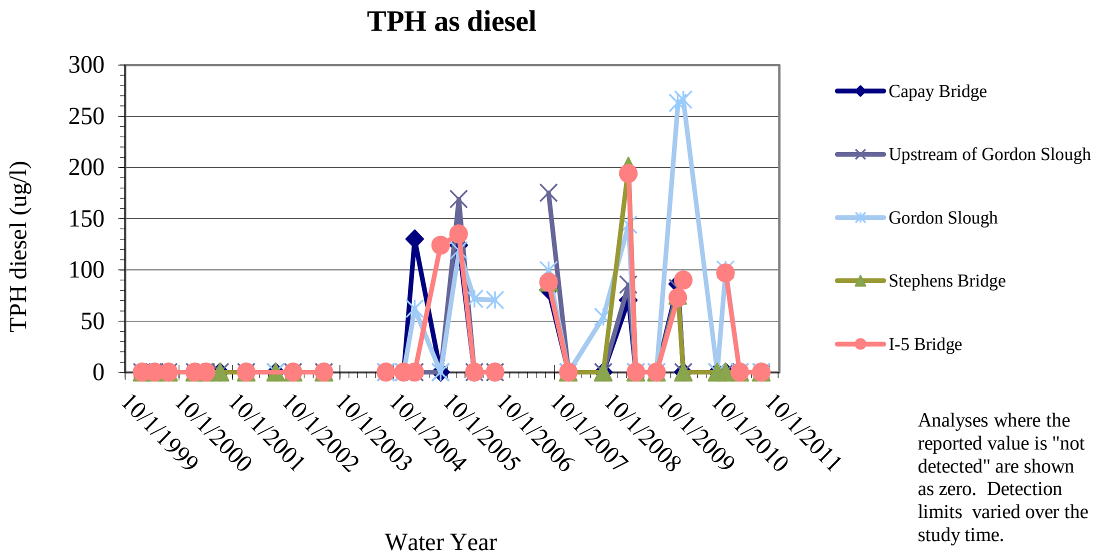


Figure 3.1.r: Total petroleum hydrocarbon (TPH) concentrations as diesel, measured at monitoring sites in the CCRMP area.

TPH as Gasoline

TPH (Total Petroleum Hydrocarbon) as gasoline has not been detected in any samples in the CCRMP area. The problem with diesel fuel in Cache Creek (see previous section) has drawn attention to petroleum spills and petroleum sources, so results from TPG as gasoline will be examined after each sampling event. This extra attention will help safeguard water quality and habitat on the creek.

TPH as gasoline recommendation: Examine TPH as gasoline results after each sampling event.

Total Boron

Boron is a naturally occurring pollutant in the Cache Creek watershed, and enters the system through dissolution of bedrock. Elevated boron levels are common in coastal watersheds that drain rocks of the Franciscan Complex, and little can be done to eliminate the problem. Boron is toxic to plants, and the best strategy may be to dilute boron-rich waters with water from a different source before applying to farm fields. In some parts of the country similar water quality problems have been addressed by mixing groundwater (well water) and surface water. In areas where boron is not managed properly toxic salts can form in soils, rendering the soil less useful for crop production. Boron may be toxic or stunt plant growth at levels ranging from 1-4 mg/l, with toxicity depending on the crop. Boron levels are plotted in µg/l, with 1000 µg = 1 mg. This means that levels of 1000 - 4000 µg/l are potentially harmful to plants. Surface water samples from Cache Creek are often in this range (Figure 3.1.s). The US EPA does not include Boron on its list of regulated contaminants, but has issued a health advisory paper on the effect of Boron (*Document Number: 822-S-08-003*). Health effects are variable depending on the age of the person and length of exposure. The health advisory for children is 2000 - 3000 µg/l boron in drinking water, while adults are allowed up to 5000 µg/l.

Boron concentrations from Cache Creek do not appear to correlate with season or flow, although spikes or trends are visible in Figure 3.1.s. Boron levels from Gordon Slough were often lower than other sites during the time period from 2005 to 2009. Boron levels from

Gordon Slough were higher in 2010 and 2011, and are not significantly different from other sample sites in the most recent sampling events.

Boron recommendation: Although boron is a pollutant and problem, there are no practical solutions to the problem. This is not a water quality issue that needs to be addressed at the present time.

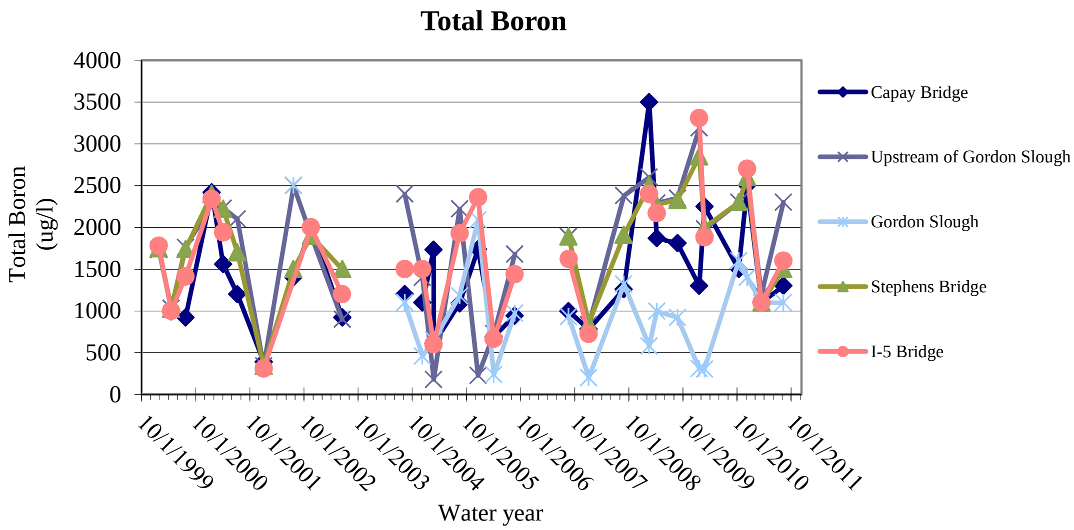


Figure 3.1.s: Total boron concentrations at monitoring sites in the CCRMP area.

Fecal Coliform Bacteria

When fecal coliform bacteria are present in natural waterways, the usual source is the intestinal tracts of higher mammals. This source can be humans, deer, cattle, sheep or other related users of the water and riparian habitat. Fecal coliform bacteria multiply rapidly after introduction into the waterway, especially during warm, low flow summer conditions. The Central Valley RWQCB Basin Plan has a sliding scale for fecal coliform bacteria based on several samples per 30 day period. A range of acceptable maxima from 100 - 400 counts/100 ml of sample water applies for swimming contact. Yolo County does not measure water quality at this frequency, so results may not be directly comparable to Basin Plan requirements. The drinking water standard for fecal coliform is 0 per sample.

Results from several years of sampling in the CCRMP area show high variability, although fecal coliform bacteria are almost always present in very high levels (Figure 3.1.v). The lowest values are generally on the upstream end of the CCRMP area, and fecal coliform counts tend to increase downstream. Gordon Slough has had the highest bacteria counts in most recent sampling events, with a peak in February 2010 that exceeded 160,000 counts/100 ml. This is a high value for winter conditions, and suggests direct upstream input from a septic system, cattle yard, or similar source.

Fecal coliform recommendation: Seek to identify the source of the problem. Cache Creek will be significantly cleaner if the source of fecal coliform bacteria is identified and eliminated. Standing water allows the bacteria to breed, so one possible solution is to increase flow.

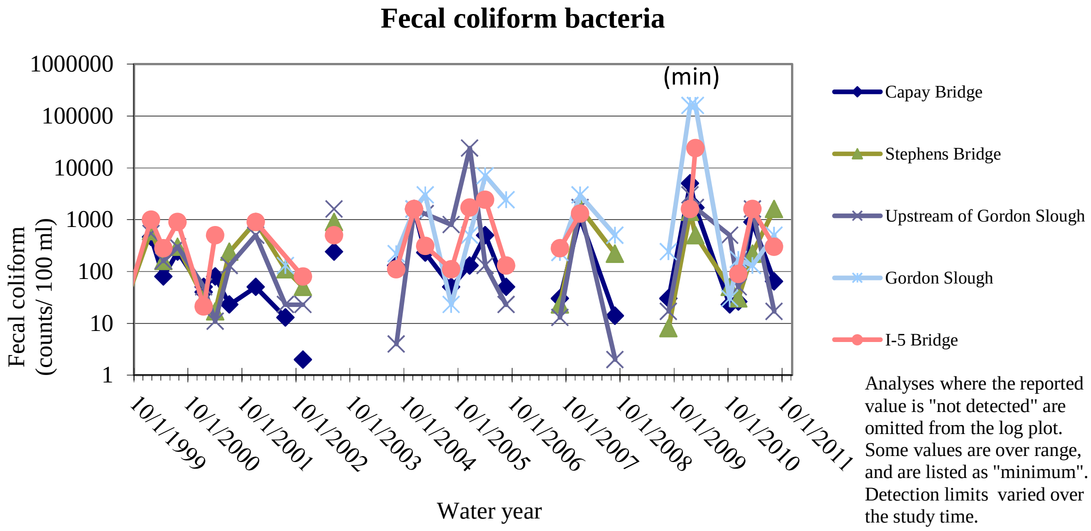


Figure 3.1.v: Fecal coliform bacteria counts at monitoring sites in the CCRMP area.

Total Coliform Bacteria

Total coliform bacteria are not regulated in natural waterways, but many of the health issues with fecal coliform are also present with total coliform bacteria. Total coliform counts include fecal coliform and other related bacteria, and have a variety of sources. They can cause infections in swimmers and recreational water users, and gastrointestinal problems when present in drinking water. Total coliform bacteria tend to increase during the warm summer months and in low flow areas. Total coliform bacteria are abundant in Cache Creek water samples (Figure 3.1.w), and closely follow trends observed in fecal coliform bacteria.

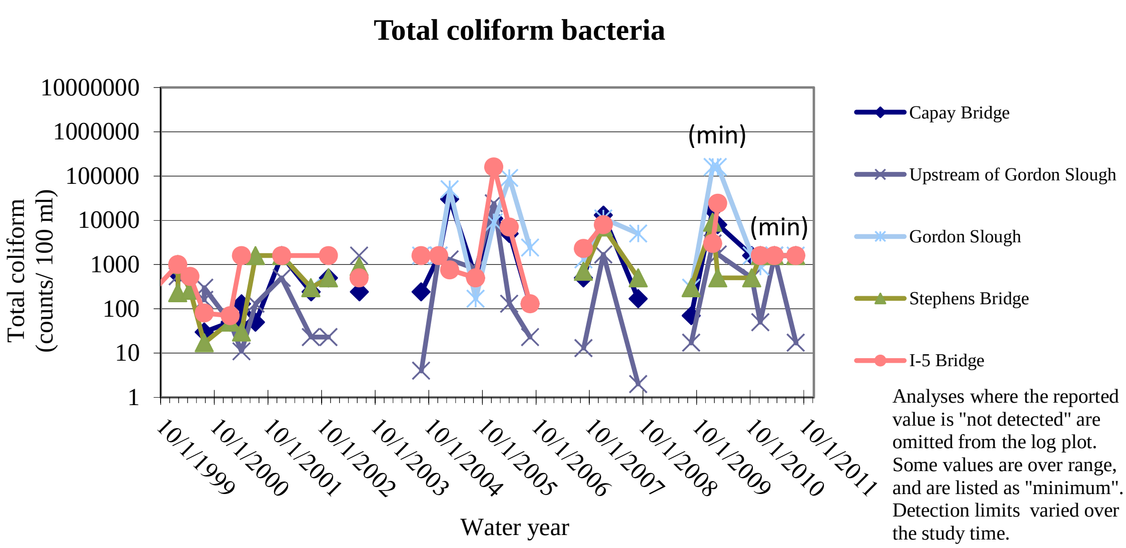


Figure 3.1.w: Total coliform bacteria counts at monitoring sites in the CCRMP area.

Total coliform bacteria recommendations: Reduce bacteria counts by increasing flow where possible. Consider other actions as appropriate to minimize human contact with bacteria, which tends to occur in the hot summer months.

Total Dissolved Solids (TDS)

Total dissolved solids are related to groundwater/surface water interaction and variations in flow. When groundwater seeps into the stream (also called a "gaining condition"), it contains extra dissolved material that results in high TDS values. The middle and lower reaches of the CCRMP area are close to sea level, have a high water table, and experience gaining conditions. This results in higher TDS values, The upper reaches of Cache Creek have less groundwater input, and TDS is lower (Max Stevenson, personal reference). These regional trends are complicated by variations in flow. High flows tend to dilute the system and reduce TDS concentrations, although this relationship is not always true. Residence time, solubility of the sediment, and composition of the bedrock are complicating factors. Guidelines for TDS have a complex sliding scale based on salinity, and the RWQCB states that TDS should not "… cause nuisance or adversely affect beneficial uses." Cache Creek usually has TDS values below the State Department of Health Services (DHS) recommended level of 500 mg/l, but this is not an enforceable guideline. Incursions as high as 1500 mg/l may be allowed depending on flow. Values of TDS observed in the CCRMP area during the past two years approach or exceed the 500 mg/l level (Figure 3.1.h), and may be undesirable from a habitat standpoint.

Total Dissolved Solids recommendation: Continue to monitor TDS, no additional action.

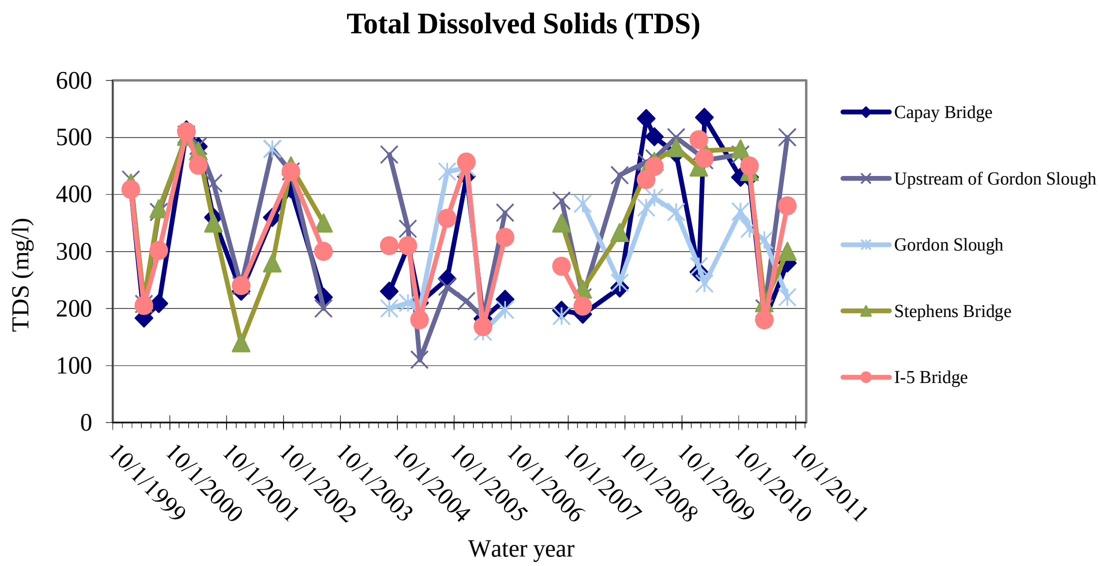


Figure 3.1.h: Total Dissolved Solids (TDS) values at monitoring sites in the CCRMP area.

Total Suspended Solids (TSS)

Total suspended solids have a strong correlation with flow, and high flows result in high concentrations of suspended sediment. This relationship is especially important as new mercury loads are imposed on watersheds because mercury is carried by fine suspended sediment. Most watersheds are monitoring suspended sediment as a proxy indicator of mercury load. New optical instruments can be calibrated to measure water turbidity (clarity), and this in turn is related back to flow. Potential partnerships with the YCFCWCD and the USGS will allow Yolo County to develop these relationships on Cache Creek. TSS measurements made during the surface water sampling program provide an indication of patterns in the CCRMP area (Figure 3.1.i); although continuous turbidity monitoring would be much more effective (see below). Regulatory agencies do not list specific limits or standards for TSS, other than the RWQCB guideline to not "… cause nuisance or adversely affect beneficial uses".

Total suspended solids recommendation: Continue monitoring, no new actions are recommended.

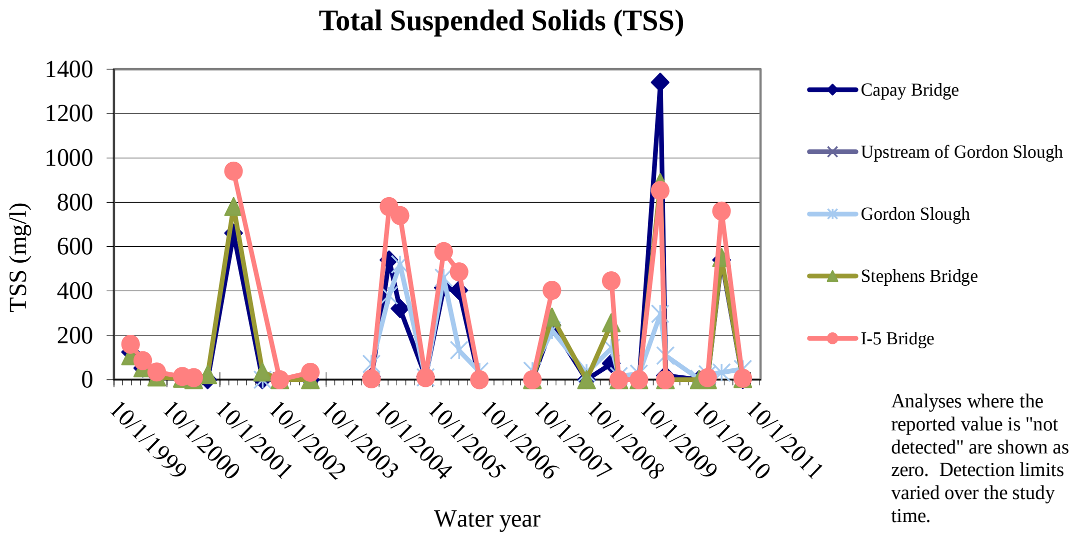


Figure 3.1.i: TSS (Total suspended solids) values at monitoring sites in the CCRMP area.

Turbidity

Turbidity is an indicator of the clarity of water. Increases in turbidity correlate strongly with increases in stream flow on Cache Creek, because high flows mobilize sediment. Turbidity values also correlate strongly with TSS (total suspended solids) measurements, but the techniques used for TSS and turbidity are different. TSS requires sample collection and sample processing to obtain results, so it is very difficult to obtain continuous TSS values through a storm event or on an annual basis. This limits the utility of TSS measurements for calculating sediment load in a stream.

Turbidity is an optical measurement with no sample handling, and is easily adapted to continuous measurements with data recorders. Turbidity meters that were developed in the past 20 years can collect continuous turbidity data, so sediment movement during storm events is characterized in much more detail. This does require calibration with a few TSS measurements, but the result is a continuous turbidity record that can be related to sediment load. Yolo County currently measures turbidity three times per year during the water quality sampling events, but does not currently have the capability to make continuous turbidity measurements or estimate sediment load based on turbidity.

Regulatory agencies are becoming more interested in turbidity measurements because sediment transport and mercury transport are closely related. California's gold mining legacy left us with a mercury problem, and mercury TMDL's (total maximum daily loads) are being established for impacted waterways. Cache Creek is one of the single largest sources of mercury to the San Francisco Bay Delta region, so sediment load and mercury load from Cache Creek are under regulatory scrutiny. It is anticipated that impacted watersheds will be required to estimate baseline mercury load and institute best management practices to reduce mercury transport. The first step in this process is an effective turbidity measurement program.

In the past year, Yolo County has started discussions with YCFCWCD, the USGS and DWR to upgrade turbidity monitoring within the CCRMP area and meet the expected requirements for calculating mercury load. Yolo County may be able to benefit from the technical expertise of the USGS and YCFCWCD by partnering to install continuous turbidity gauges at the upstream and downstream ends of the CCRMP area as part of a basin-wide project sponsored by DWR.

Turbidity is also monitored on construction projects to make sure that the project doesn't release a plume of muddy water into the creek. This site-specific turbidity monitoring may be mandated by the RWQCB as part of the permitting requirements for an in-stream project. The goal is to protect water quality, because high turbidity is harmful to aquatic life. Turbidity maxima are based on a sliding scale, with a baseline of 5 NTU (Nephelometric Turbidity Units) for drinking water. Site-specific goals are set for construction projects, and the turbidity is allowed to increase 10- 20% above background levels during construction. Turbidity levels on Cache Creek often exceed 5 NTU, especially during winter storms events (Figure 3.1.j). Turbidity maxima are two orders of magnitude higher than recommended levels during larger storm events.

Turbidity monitoring recommendation: Turbidity monitoring methods should be upgraded to include continuous turbidity monitoring. This newer technology will allow better tracking of sediment and contaminant loads. Yolo County should continue to work with partners to obtain a continuous turbidity record at the upstream and downstream ends of the CCRMP area. This will provide a baseline for future regulatory actions. This is part of the changing regulatory world, and wasn't envisioned in the original CCRMP or CCIP documents. Turbidity monitoring is more important now than it was in 1996 because of the link between mercury transport and sediment transport.

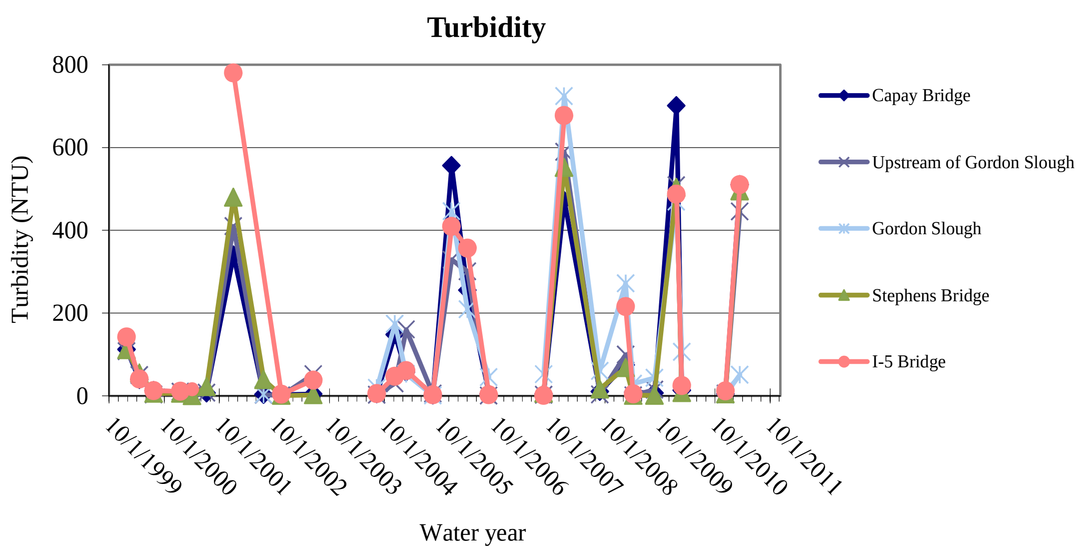


Figure 3.1.j: Turbidity measurements at monitoring sites in the CCRMP area.

Dissolved Mercury

The ultimate source of dissolved mercury in lower Cache Creek is the dozens of closed and abandoned mercury mines in the Upper Cache Creek Watershed. These mercury mines were located in Lake, Colusa, and Napa Counties, and provided liquid mercury to gold mining operations in the Sierra Nevada. Commercial gold mining is minimal now, but the mercury problem persists. Mercury continues to disperse from some mine tailings, and is carried by fine sediment into the lower reaches of the watershed. Mercury-laden sediment is remobilized during high flows, so the legacy of gold and mercury mining continues to cause environmental problems. Cache Creek is currently one of the largest contributors of mercury to the San Francisco Bay/Delta region, and new mercury total maximum daily load (TMDL) limits will continue to focus attention on the Cache Creek mercury problem. Liquid metallic mercury is relatively insoluble in water, and all recent water samples have had dissolved mercury levels below the practical detection limits (Figure 3.1.t). The spike in 2004 may be a sampling error or a single contribution to the creek. It has not recurred. It should be noted that standard methods for sampling and analyzing dissolved mercury in surface water are not adequate to detect methylmercury, which is discussed separately below.

Dissolved mercury recommendation: The single spike in dissolved mercury has not occurred again, so no additional action is recommended beyond the required monitoring.

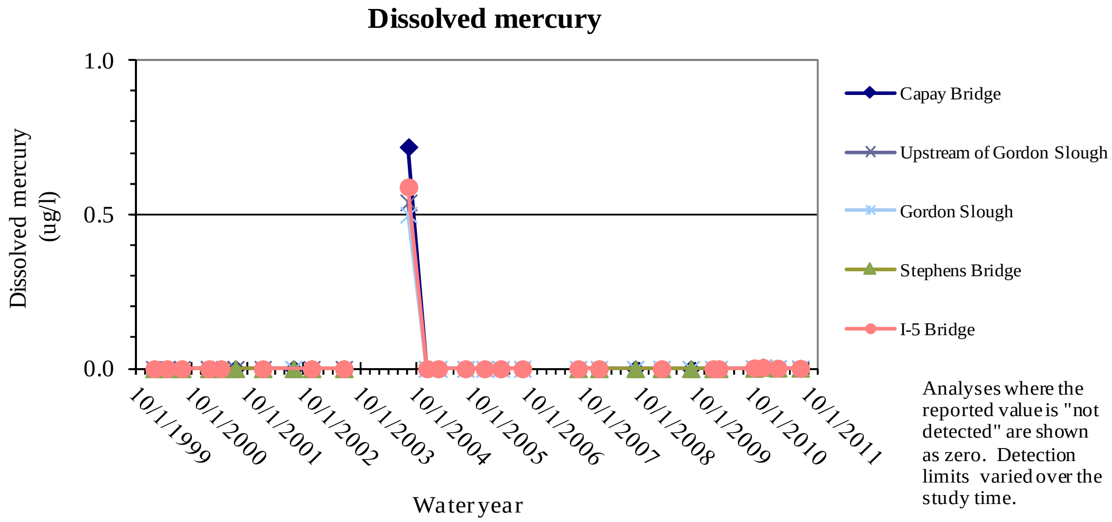


Figure 3.1.t: Dissolved mercury concentrations at monitoring sites in the CCRMP area.

Total Mercury

Total mercury is similar to dissolved mercury, but samples are not filtered before they are analyzed. This leaves clay particles and organic matter in suspension and mercury can bind to these compounds. Total mercury values are usually higher than dissolved mercury values. Total mercury tends to increase during high flow events that mobilize fine sediment and organic matter. A total mercury spike in 2011 is related to a high winter flow.

Total Mercury recommendation: Continue to monitor total mercury. At the present time regulatory agencies do not have a total mercury standard. There was a slight increase in total mercury levels from Cache Creek in 2011 (Figure 3.1.u), but no additional action is recommended.

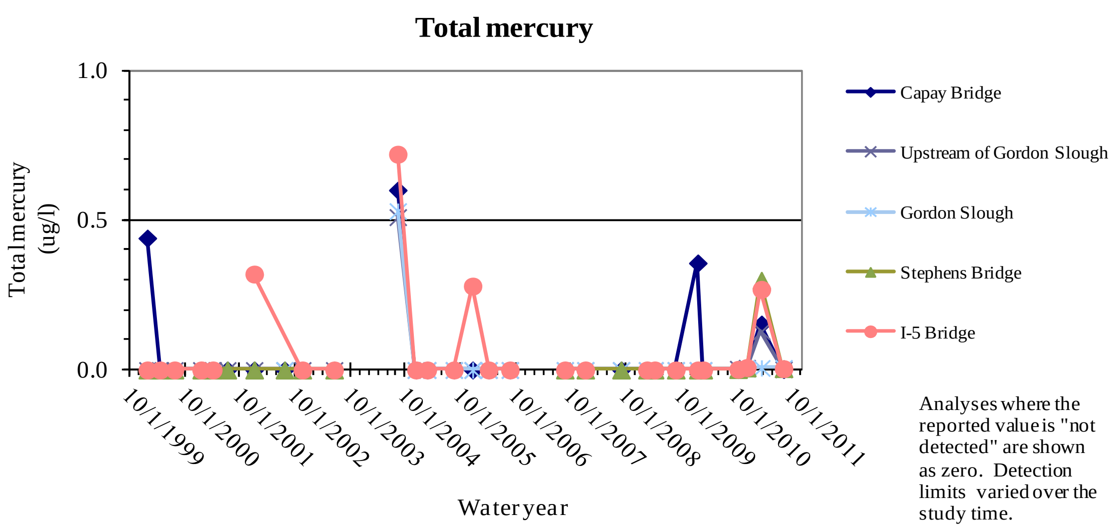


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Figure 3.1.u: Total mercury concentrations at monitoring sites in the CCRMP area.

Organophosphate Pesticides and Chlorinated herbicides

Yolo County spends a significant amount of the sampling budget analyzing for these compounds. They require complex extraction procedures in the lab, and are treated as suites of compounds by the lab. No detections were recorded in the past two years, or at any time since sampling began under the CCRMP program. Some of these compounds have been prohibited for more than 40 years, but the long residence time and known harmful effects on humans have led regulatory agencies to require continued sampling and analysis for these groups.

Organophosphate Pesticides and Chlorinated herbicides recommendation: Consider eliminating these constituents from the list of analyzed compounds.

3.4 METHYLMERCURY AND BIOACCUMULATION

Mercury-bearing ores are found throughout the upper Cache Creek watershed. These ore deposits are made available to the stream environment through several pathways. Some mercury is contributed by geothermal springs, some flows directly from mines into local rivers, and some is leached from ore bodies by natural and industrial processes. Liquid metallic mercury is relatively inert in the environment, and does not pose a large environmental risk. When liquid metallic mercury transforms to other forms it becomes a larger problem. Mineral forms of mercury can be transformed through chemical and/or biological processes into organic mercury compounds (including mono-methylmercury, also called methylmercury). These reactions occur in anoxic or low oxygen conditions, so low oxygen, organic-rich environments like Gordon Slough are potential hot spots for methylmercury production. This organic form can be readily taken up into the food chain by aquatic insects (macroinvertebrates). These organisms are eaten by small fish, which in turn are consumed by larger animals. The mercury is passed on to each predator through a process called biomagnification or bioaccumulation, resulting in larger and larger concentrations of methylmercury higher in the food chain.

Mercury conditions in Cache Creek have been studied extensively over the years. The County examined this issue when the CCAP was adopted. The CCAP regulations include requirements for continued monitoring of both off-channel and in-channel methylmercury conditions (see Section 10-5.517 of the County's Reclamation Ordinance). The County's regulations require that ambient mercury levels in the channel be determined every ten years and that the County determines whether any significant change in ambient concentrations of mercury in fish within the Cache Creek channel has occurred. Pursuant to this requirement, ambient levels were determined in 1997, as reported in the 1998 Annual Report. Ambient levels were to have been determined again in 2006. A new study to determine ambient mercury levels was begun in fall 2011 and will be completed in spring 2012.

Methylmercury recommendations: Complete determination of ambient methylmercury levels in the channel pursuant to the County regulations. Consider participation in a regionally supported monitoring program to analyze methylmercury in lower Cache Creek. This would be in addition to the required dissolved mercury sampling. This should be coordinated with the Regional Water Quality Control Board, USGS, YCFCWCD, DWR and other appropriate entities.

3.5 GROUNDWATER LEVELS AND ANALYSIS

Information for this report was taken from the Yolo County Water Resources Information Database, accessed at: http://wrid.facilitiesmap.com/index.cfm. This database has secure access, and can be filtered to show a variety of geographic and topographic features. Data were accessed in October 2011, and are used to meet two requirements of the CCIP:

- Install groundwater monitoring piezometers in streams, and monitor water levels.
- Coordinate with local landowners, and establish voluntary sharing of groundwater data.

Records from more than 200 groundwater wells are included in the Yolo County Water Resources Database, and other water level information is available if the search is widened to include shallow piezometers and monitoring sites. Groundwater level data are also available on-line through the USGS Water Resources Division (http://ca.water.usgs.gov/), and the Department of Water Resources' California Data Exchange Center (http://cdec.water.ca.gov/). Mining company reports are an additional source of groundwater data, because the mining companies are required to submit annual groundwater reports as part of the SMARA reporting process. All wells used in this report are from the Yolo County Water Resources Information Database. Wells were included in the groundwater analysis based on the following criteria:

- Well is less than 0.5 miles from Cache Creek
- Well is currently active
- A long-term data set exists for the well

Seventeen wells were selected from the County Water Resources Information database, and were plotted to show changes in the elevation of the water table with time (Table 3.5a).

Well I.D.	Well construction information (if known)	Note
10N02W17J001M	Well depth = 24 ft.	Bedrock reach above CCRMP area.
10N02W16R001M	No data	Bedrock reach above CCRMP area.
10NO2W16Q001M	Hole depth = 44 ft.	Bedrock reach above CCRMP area.
10NO2W21G001M	Well depth = 18 ft.	Bedrock reach above CCRMP area.
10N02W14A001M	Hole depth = 135 ft.	
10N01W18A001M	No data	
10N01W17A001M	No data	
10N01W07R002M	16" casing, Hole depth = 273 ft., Well depth = 300 ft.	
10N01W16G001M	No data	
10N01W21J001M	18" casing, Hole depth = 196 ft , Well depth = 152 ft	
10N01W23P001M	14" casing, Hole depth = 90ft, Well depth = 80ft	
10N01W24L004M	Well depth = 100 ft.	
10N01E29K001M	18" casing, Hole depth = 336 ft.	
10N01E22B001M	No data	
10N01E14M001M	No data	
10N1E14K001M	14" casing, Hole depth = 77 ft.	
10N01E13L001M	16" casing , Hole depth = 334 ft, Well depth = 290 ft.	

Table 3.5.a: Wells used to plot groundwater patterns near Cache Creek. Construction information is available for eleven of the seventeen wells.

Seventeen wells qualified for analysis because they are located within 0.5 miles of Cache Creek and are active wells with long-term monitoring records. Construction information was missing for six of the wells. The wells varied in depth from 24 ft to 336 ft, suggesting that some wells may penetrate different water-bearing intervals (Table 3.5.a).

Water levels were collected at different times of the year, from different water-bearing intervals, and with varied local influence from pumping. These variables limit the uses of the data set. This data set is not appropriate for detailed comparisons between wells, but it may be used to show larger seasonal or climatic patterns. There is also a strong upstream- to- downstream trend; the elevation of the water table decreases downstream (Figure 3.5.b).

These wells are distributed fairly evenly along Cache Creek from Capay Dam to I-5, and provide an upstream-to-downstream record of water levels near Cache Creek (Figure 3.5.a).

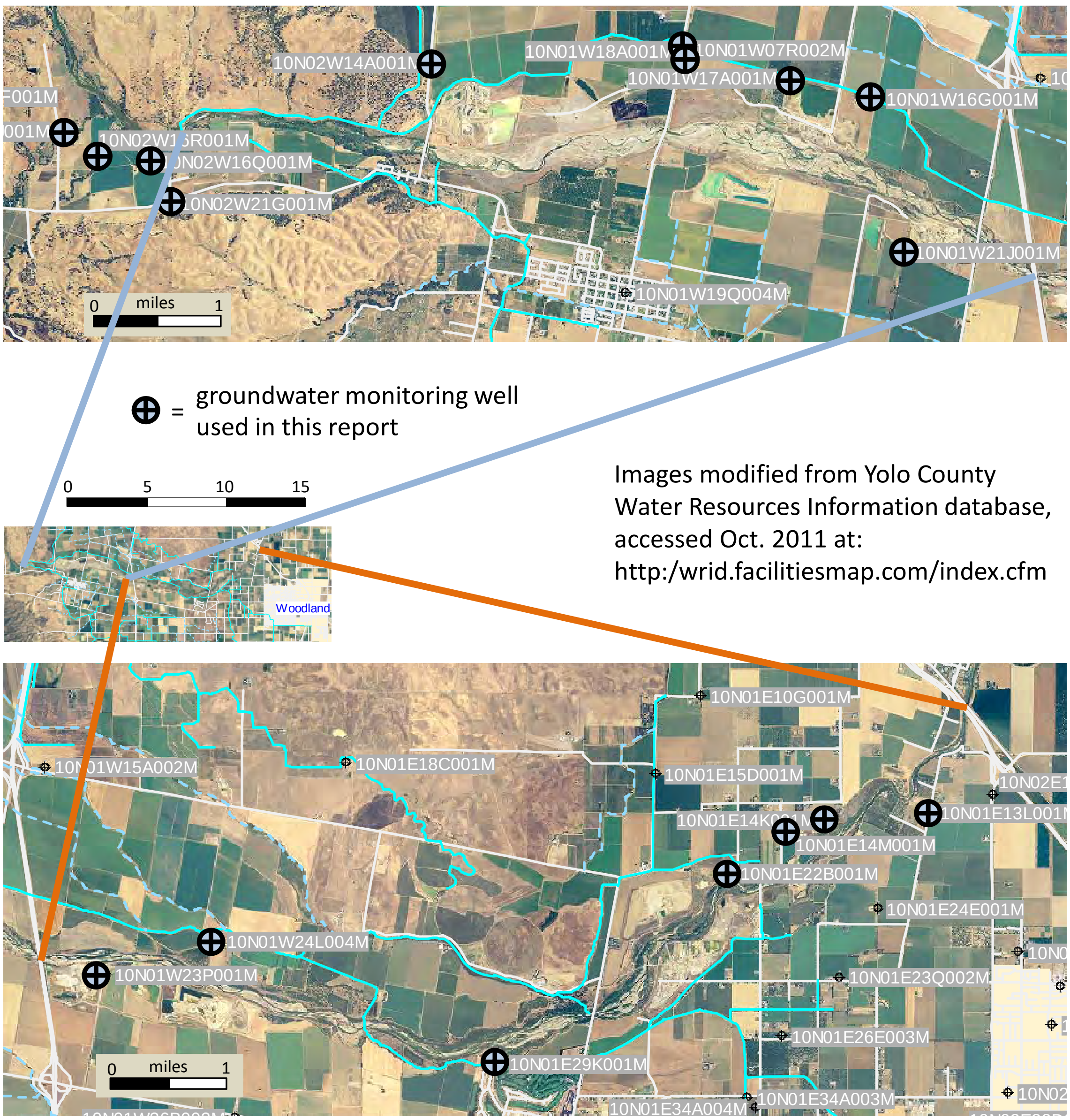


Figure 3.5.a.: Seventeen groundwater wells were used to show water table trends across the CCRMP study area.

Water levels were plotted as elevation above sea level, so there is a common datum for comparison of groundwater information (Figure 3.5.b). The groundwater table is almost 200 feet above sea level along the upstream or western edge of the CCRMP study area. The land surface elevation is also higher here, so depth to water in most western wells is tens of feet below the land surface and the wells are shallow. The land surface and the water table both decline gradually toward the east. Wells in the center of the CCRMP study area have groundwater elevations ranging from 150 to 120 ft above sea level. The elevation of the groundwater table continues to decline downstream, and at the eastern or downstream end of the CCRMP area, groundwater levels and the land surface elevation approach sea level. This puts the water table just above sea level at the eastern edge of the CCRMP area.

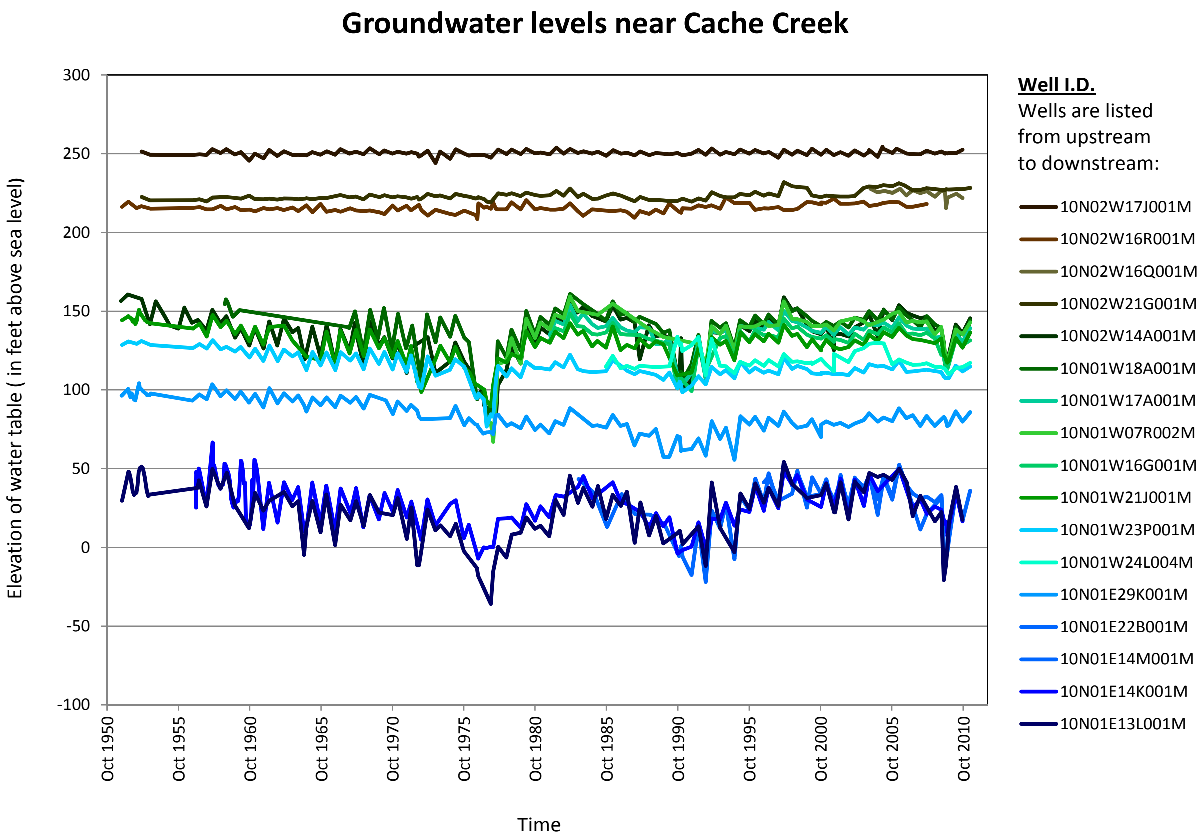


Figure 3.5.b: Groundwater levels (elevation of the water table) are shown for seventeen wells that lie within 0.5 miles of Cache Creek. Wells are listed from upstream to downstream in the key. The land surface elevation and the elevation of the groundwater table decrease downstream.

Large-scale groundwater patterns are related to topography. Land surface elevation decreases along a broad slope from the crest of the Coast Range to Woodland. Groundwater levels are a subtle representation of the land surface, and fall gradually as the gentle slope of the east side of the Coast Ranges meets the flat Central Valley. Cache Creek has incised into ancient floodplain material along this transect, and eventually the creek intersects the water table. This results in significant groundwater contributions to Cache Creek from the middle reaches of the CCRMP area to the Yolo settling basin. The lower section of Cache Creek is a gaining reach, and receives significant groundwater contributions.

Groundwater levels near Cache Creek are steady or have fallen very slightly in the past 55 years (Figure 3.5.b). Some wells show a slight increase in groundwater levels after 1995, when in-channel mining ceased. This stable trajectory indicates that groundwater is pumped at a sustainable rate near Cache Creek.

Factors that influence more than one well indicate regional influences, and may be related to climate. Wells in the center of the CCRMP study area have groundwater levels that correlate very closely. Broad dips and peaks in the signal show wet and dry periods. A decrease in water levels from 1988 to 1993 was a dry period, and wet years are shown as spikes.

The shortest term variability in groundwater levels appears as noise or chatter on the hydrograph (Figure 3.5.b). Short term variability is caused by seasonal changes. Water levels drop in the summer due to pumping and evapotranspiration. Water levels rise in winter as rains recharge the groundwater system. Seasonal variability ranges from 10 to 20 ft for most wells. This pattern is natural, although pumping increases the magnitude of change in many wells.

Overall groundwater trends are flat and there are no immediate concerns. Groundwater systems are often impacted by overpumping in other parts of the country, but this does not appear to be a problem in the CCRMP area. Groundwater information hasn't been assembled for several years, so the main recommendation for groundwater is to adhere to the CCIP guidelines, and include groundwater analysis in the annual reports. This activity is already required under the CCIP, so it will not be listed as a recommendation.

Groundwater recommendation: Continue to monitor groundwater levels near Cache Creek, and add data from mining company monitoring wells when it is available. Gravel producers have past data in hard copy form, and are willing to contribute future data digitally to the Yolo County Water Resources Information Database. This will add substantially to our ability to track groundwater levels and groundwater quality in the CCRMP area.

3.6 OVERVIEW OF GROUNDWATER AND SURFACE WATER PATTERNS BY REACH

Surface water flow and surface water quality vary across the CCRMP area as a result of upstream agricultural diversions and downstream input from the West Adams irrigation canal via Gordon Slough. A large portion of the water from Cache Creek is diverted at Capay Dam, and bypasses several reaches of the creek by flowing through the West Adams canal. The Capay, Hungry Hollow, Madison, Guesisosi, and Dunnigan Hills subreaches are effectively bypassed during much of the irrigation season. Summer flow is low in these reaches, and water quality is relatively consistent. Water from the West Adams canal reenters Cache Creek at Gordon Slough, and this input causes some noticeable changes in water quality. The Hoppins and Jesus Maria subreaches lie downstream from this point, and have mixed input from Cache Creek and Gordon Slough/ West Adams Canal. Water that emerges from Gordon Slough may be higher in bacteria, total mercury, phosphate, hydrocarbons, and nitrate. This suggests that Gordon Slough and possibly the West Adams Canal affect the water quality before it returns to the lower reaches of Cache Creek.

Groundwater patterns are strongly dependent on the underlying bedrock geology, and this varies by reach across the CCRMP area. Seventeen wells were used to evaluate groundwater levels in the CCRMP area, and these wells can be grouped by reach. The three upstream wells (10N02W17J001M, 10N02W16R001M, 10NO2W16Q001M, 10NO2W21G001M) are located upstream from the Capay subreach. They lie just outside the CCRMP area boundary, and are shallow wells with shallow depth to groundwater. Well depths range from 18 to 44 ft, and these wells are probably completed in the shallow gravels deposited by Cache Creek. Groundwater levels range from 210 to 250 feet above sea level. These wells are shown in shades of brown in Figure 3.5.b. They do not appear to penetrate the underlying Cretaceous sediments of the Great Valley sequence.

The middle reaches of the CCRMP area have deeper groundwater wells, and are probably completed in thicker alluvial sediments deposited by Cache Creek as the Creek spread out and deposited sediment in a large alluvial fan. Wells range from 80 to 330 ft. deep, and groundwater levels are 80 to 100 feet above sea level. These wells are shown in shades of green and blue in figure 3.5.b. Groundwater levels are remarkably consistent through this part of the CCRMP area. This includes the Hungry Hollow, Madison, Guesisosi, and Dunnigan Hills subreaches.

Wells in the lower reaches of Cache Creek have a variety of completion depths, but the water table is near the land surface regardless of well construction or location. The Hoppin and Jesus Maria subreaches are deeply channelized, and the creek probably intersects the groundwater table in some places. Yolo County Flood Control and Water Conservation District reports a noticeable increase in electrical conductivity in these lower reaches, which would be consistent with a groundwater input as the water table intersects the creek. These wells are shown in darker shades of blue in Figure 3.5.b. Well depths range from 77 to 334 ft, and the elevation of the water table is 0 to 50 ft above sea level. The water table and the land surface drop gradually from west to east, and groundwater contributions become more important downstream.

CHAPTER 4 – VEGETATION AND WILDLIFE

4.1 Overview

Lower Cache Creek's position in the broad Central Valley Plain, low channel gradient, annual lateral channel movement, and channel braiding provide for a limited number of riparian habitat types and associated native plant species. Vegetation along and within Cache Creek is presently restricted by a number of factors. There is limited area for riparian expansion, as most of the channel is deeply entrenched, bound by levees, or restricted by adjacent land uses. High flow velocities can literally tear out riparian vegetation along the flow lines. Reaches in the upstream part of the CCRMP lack sufficient shallow groundwater availability to support native plant regeneration. The small sizes of remaining intact habitat patches, comprised mainly of Fremont cottonwoods and mixed willows, have left Lower Cache Creek susceptible to colonization by exotic invasive species and reduced its ability to support endemic bird species, such as the yellow-billed cuckoo (*Coccycus americanus*). The wildlife that relies on this vegetation to provide their habitat is thus constrained to the small areas of intact habitat. As a result, the majority of the CCRMP area is dominated by drought tolerant invasive annual weedy vegetation.

Based on a review of the creek using aerial photos, LiDAR, and field surveys, significant changes to native riparian vegetation extent or density have occurred between May, 2010 and May, 2011. In general, channel migration and associated erosion led to significant losses of both understory and overstory vegetation in 2011 in the surveyed transects, illustrating the fluctuating and temporary nature of riparian habitat throughout the CCRMP. Despite the general loss of vegetation due to channel migration in most transects, some increases in riparian extent are visible in the Hoppin and Jesus Maria Reaches, at the downstream end of the CCRMP.

A detailed comparative analysis of vegetation in the 12 permanent vegetation transects (Andregg) indicates that significant changes in riparian density and location occurred between 2010 and 2011. Losses of riparian vegetation from the 2011 high flows were evident with a *total* loss of 14% of the understory and 17% of the overstory vegetation in the 85.93 acres contained in the survey transects. Only three areas (Transect 9, 10 and 12) increased or didn't change in understory acreage and only one area (Transect 9) increased in overstory acreage. The survey transects, however, are only representative of general conditions. These data suggest a trend of declining riparian vegetation coverage after a nominal two to three year flood event. This event was not very severe, yet led to significant losses in riparian canopy coverage and overall extent. The TAC biologist will continue to monitor the areas of vegetative loss in order to monitor natural recovery.

4.2. Riparian Wildlife

Riparian wildlife was readily observed during the 2011 Creek Walk and a field survey. The most obvious wildlife observations (Table 1) are of birds and small mammals due to the nature of how the creek is monitored. Birds are often noisy and obvious, and small mammals leave tracks and droppings that are also obvious. The current observations are not a systematic means of assessing species. A five year biological trend analysis, which is tentatively planned for development in 2012, will provide a more comprehensive assessment of habitat in the CCRMP area. The riparian plant communities described below form the basis for many of these wildlife communities.

Table 1 2011 Animal and Plant Species Observed Source: Erik Ringelberg	
Common Name	**Scientific Name**
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Spinus tristis*
American Kestrel	*Falco sparverius*
American Pipit	*Anthus rubescens*
American Robin	*Turdus migratorius*
Anna's Hummingbird	*Calypte anna (Presumption)*
Bank Swallow	*Riparia riparia*
Beaver	*Castor canadensis*
Belted Kingfisher	*Megaceryle alcyon*
Black-Tailed Deer	*Odocoileus hemionus columbianus*
Black-tailed Jackrabbit	*Lepus californicus*
Barn Swallow	*Hirundo rustica*
Bobcat	*Lynx rufus*
Brewer's Blackbird	*Euphagus cyanocephalus*
California Jay	*Aphelocoma californica*
California Quail	*Callipepla californica*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Grackle	*Quiscalus quiscula*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Great Egret	*Ardea alba*
European Starling	*Sturnus vulgaris*
Great Blue Heron	*Ardea herodias*
Great Horned Owl	*Bubo virginianus*
Green Heron	*Butorides virescens*
House Finch	*Carpodacus mexicanus*
House Sparrow	*Passer domesticus*
Killdeer	*Charadrius vociferus*
Lesser Nighthawk	*Chordeiles acutipennis*
Mallard	*Anas platyrhyncos*
Marsh Wren	*Cistothorus palustris*
Morning Dove	*Zenaida macroura*
Northern Flicker	*Colaptes auratus*
Northern Harrier	*Circus cyaneus*
Northern Mockingbird	*Mimus polyglottos*
Osprey	*Pandion haliaetus*
Rock Pigeon	*Columba livia*
Raccoon	*Procyon lotor*
Rattlesnake	*Crotalus oreganus oreganus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rock Dove	*Columba livia*
Song Sparrow	*Melospiza melodia*
Striped Skunk	*Mephitis mephitis*
Swainson's Hawk	*Buteo swainsoni*
Western Meadowlark	*Sturnella neglecta*
Western Sandpiper	*Calidris mauri*
White Crowned Sparrow	*Zonotrichia leucophrys*
Yellow-billed magpie	*Pica nuttalli*

Table 2 Common Plant Species Observed Source: Erik Ringelberg	
Common Name	**Scientific Name**
Alder	*Alnus rubra*
Arroyo Willow	*Salix laseiolepis*
Arundo	*Arundo donax*
Bearded Rye	*Lolium muliifldrum*
Bearded Sprangletop	*Leptochloa fascicularis*
Blackberry	*Rubus discolor*
Blazing Star	*Mentzelia laevicaulis*
Buckeye	*Aesculus californica*
Canadian horseweed	*Conyza canadensis*
Cattail	*Typha latifolia*
Cocklebur	*Xanthium strumarium*
Cottonwood	*Populus fremontii*
Coyote Willow	*Salix exigua*
Cuman ragweed	*Ambrosia psilostachya*
Beggars deviltick	*Bidens frondosa*
Blue Elderberry	*Sambucus mexicana*
English Ivy	*Hedera helix*
Fig	*Ficus sp.*
Heliotrope	*Heliotropium europeam*
Horehound	*Marrubium vulgare*
Horsetail	*Equisetum fluviatile*
Italian ryegrass	*Lolium multiflorum*
Italian thistle	*Carduus pycnocephalus*
Loosestrife	*Lythrum californicum*
Lupine	*Lupinus sp.*
Milk thistle	*Sillybum marinarum*
Mugwort	*Artemesia douglasiana*
Mulefat	*Baccharis salicifolia*
Mustard	*Brassica spp.*
Narrow-leafed cattail	*Typha angustifolia*
Pacific Willow	*Salix lucida ssp. lasiandra*
Pepperweed	*Lepidium latifolium*
Poison Oak	*Toxicodendron diversilobum*
Prickly lettuce	*Lactuca serriola*
Prostate pigweed	*Amaranthus blitoides*
Purple cudweed	*Gnaphalium purpureum*
Pussyfoot	*Dalea obovata*
Rabbitsfoot grass	*Polypogon monspeliensis*
Red Willow	*Salix laevigata*
Ripgut brome	*Bromus diandrus*
Sandbar Willow	*Salix exigua*
Slender Oats	*Avena fatua*
Smilo Grass	*Pipatherum milaceum*
Soft brome	*Bromus hordeaceous*
Southern California Black Walnut	*Jugans californica var. californica*
Swamp picklegrass	*Crypsis schoenoides*
Sweet white clover	*Melilotus alba*
Tall flat sedge	*Cyperus eragrostis*
Tamarisk	*Tamarix sp.*
Tobacco plant	*Nicotania sp.*
Tule	*Schoenoplectus acutus var. occidentalis*
Wild Grape	*Vitis Californica*
Wild Oats	*Avena barbata*
White Alder	*Alnus rhombifolia*
Whorehound	*Marrubium vulgare*
Yellow Star Thistle	*Centaurea solstitialis*
Yerba Sante	*Eriodictyon californicum*

4.3 Riparian Vegetation

Riparian vegetation refers to plant communities associated with rivers and creeks. The most common native plant community in the lower Cache Creek riparian corridor is mixed riparian forest. The width and complexity of mixed riparian forest varies and is typically characterized by one or more well-developed canopy layers. Common riparian vegetation includes shrubs and vines, small trees, and emergent cottonwoods (*Populus fremontii)* at the tallest level. In some areas of the creek, an open or sub-canopy layer consists of dense riparian shrubs dominated by willow species including arroyo willow (*Salix lasiolepis*) and sandbar willow (*S. exigua*). A discontinuous understory layer is generally present within the mixed riparian forest including species such as blue elderberry (*Sambucus mexicana*), Himalayan blackberry (*Rubus discolor*), poison oak (*Toxicodendron diversilobum*), and wild grape (*Vitis californica*). A ground layer, when present, ranges from sparse to densely vegetated and consists of grasses such as creeping wild rye (*Leymus triticoides*) and forbs such as mugwort (*Artemisia douglasiana*). Seedlings of some of the more shade-tolerant of the tree species mentioned above can occasionally also be found in the understory. While valley oaks (*Quercus lobata*) typically occupy the driest edge of Cache Creek's riparian zones, they are considered upland species in current riparian habitat classifications. The CCRMP's goal of establishing a continuous corridor of riparian vegetation is informed by the annual monitoring program. The following vegetation analysis provides the understanding of how natural regeneration is progressing. Once the entire creek is analyzed, this type of analysis can be used to assess the performance of previous re-vegetation efforts.

4.4 2011 Vegetation Analysis

4.4.1 Summary

The 2011 high-resolution color aerial photographs provided an opportunity to complete a spatial analysis and comparison to the 2010 aerial photos, and comparison of both of those datasets to the 2006 Yolo Natural Heritage Program (NHP) vegetation dataset. In addition, in 2011, LiDAR (Light Detection And Ranging) data were available to compare with 2010 LiDAR data for the same transects. LiDAR, essentially aerial laser mapping of topography (including vegetation), is a tremendously powerful tool for assessing change in channel shape, identifying and calculating fill and cut resulting from channel processes, and assessing change in riparian area and vegetation height. These analyses are intended to lay the analytical foundation for standard methods for assessing vegetation and habitat change within the full 14.5 mile length of Cache Creek within the CCRMP area.

Vegetation in the 12 Andregg (2002) transect locations were assessed using both aerial photographs and LiDAR data. The area of the 12 transects totaled 85.93 acres, or 3.7% of the 2,324 acres in the CCRMP area. The systematic siting of these transects by Andregg, and the variable area of each transect, do not allow for these transects to have ideal statistical power. However they do provide a strong foundation for scaling-up methods and analyses to the full reach scale. Within the 85.93 acres contained in the transects, the LiDAR data identified a total of 4.3 acres covered with understory vegetation and 11.9 acres of overstory vegetation in 2010, and 3.7 acres covered with understory vegetation and 9.9 acres of overstory vegetation in 2011. Detailed results are provided in Appendix B.

Significant losses of riparian vegetation from the 2011 high flows were evident with a total loss of 14% of the understory and 17% of the overstory vegetation in the 12 transects. Total understory acreage increased or remained the same in only three transects (9, 10, and 12). Overstory acreage increased in only one transect (9). The Andregg transects, however, are only representative of general conditions and the data quality varies, as noted in the analysis. The important idea to take away from these data is the declining trend of riparian vegetation coverage after a nominal two to three year event.

The use of LiDAR data for vegetation analysis provides an effective tool for monitoring changes in riparian vegetation within the CCRMP area. The methods used are reliable and relatively inexpensive to apply. Some systematic data management and collection challenges remain, but these are expected and minor. An unsupervised (automated) classification of the color aerial photos done by the aerial survey contractor would be of significant benefit for future analysis, if the model is created with the ground truthing component fully developed.

The CCRMP boundary should be updated and the permanent transects (Andregg) should be reviewed for minor modifications based on the updated boundary. Specifically, the HEC-RAS model and aerial photos can be used to update the CCRMP boundary to capture those areas where the channel has migrated outside the original CCRMP boundary lines.

4.4.2 Goals

The Cache Creek vegetation analysis can take several forms and still be consistent with CCIP direction. The analysis should be clear and repeatable to allow for future comparisons, as well as reliable enough to be useful as the state of the science evolves over time. It is critical to establish the approach so that the methods are not revisited endlessly and the reporting outcomes can lead to a common understanding of vegetation patterns and inform management decisions. The analysis requires assessing riparian and upper terrace vegetation conditions in 2011 and visually comparing them to 2010. The analysis also requires assessing riparian vegetation and other landscape conditions along the 12 Andregg-established transects following manual classification using the Yolo Natural Heritage Program (NHP) polygon classes. To meet those broad needs, three specific objectives were developed:

Objective 1: Compare the 2010 (orthorectified, georeferenced) aerial photos of the CCRMP to the most recent aerial photos (2011). These dimensionally accurate and spatially precisely located photos can be compared for each reference location.

Objective 2: Compare the 2010 and the 2011 suitable aerial photos of the CCRMP to the Yolo NHP dataset. These precisely located aerial photos can be compared to each vegetation or land use classification (polygon) compiled by NHP for each reference location. The comparison includes coarse-level (landscape and reach level) assessment of relative channel position, vegetation or land use class, area and extent. Compare these remote sensing data with preliminary field observations on two transects.

Objective 3: This objective takes the coarse scale aerial photo analysis from Objectives 1 and 2, and refines it to the sub-reach scale (100m belt transect) for the purposes of “ground truthing” in the field, using the Andregg Vegetation Transects for these more detailed comparisons. In addition to the aerial photos, which provide a gross visual estimate, LiDAR data were used at the transect scale to provide even more analytical analysis of change. These assessments can provide validation of the 2010 aerial photo and the NHP datasets for that transect, as well as provide a statistically sound, technical basis for monitoring vegetation dynamics over time.

4.4.3 Methods and Sources

Aerial Photos- The 2010 aerial photos were compared to the 2011 aerial photos. These photos were loaded into a Geographic Information System (GIS) workstation running ARC GIS 10.0. The GIS allowed “clipping”, or masking-out, of the datasets outside the CCRMP boundary.

Natural Heritage Program (NHP) Dataset- Similarly, the 2006 Yolo Natural Heritage Program (NHP) vegetation dataset was imported into the GIS and clipped to meet the CCRMP boundary. The NHP dataset came from a variety of sources, including Chico State University and the Department of Water Resources Tributaries Study, and included 21 different land classes ranging from water to upland oak. For the purposes of analysis these classes were aggregated to a subset of 9 classes by combining similar vegetation and use classes. For example, the class ‘barren anthropogenic’ was added to the class ‘urban/built up’, and all agricultural classes were combined. A more detailed description was provided in the 2010 Cache Creek Annual Status Report.

LiDAR- The 2010 LiDAR data was compared to the 2011 LiDAR data. These files were loaded into a Geographic Information System (GIS) workstation running ARC GIS 10.0. The GIS allowed us to mask-out non-pertinent areas as was done with the aerial photos, isolating the Andregg transects. The GIS allowed for highly accurate analysis of specific acreages and height classes of vegetation within the transect areas. Two classes of vegetation height were provided by Towill, Class 3 ASPRS Low Vegetation (0.25’ to 4.99’ above bare ground) and Class 5 High Vegetation (all features 5’ and above bare ground). For the purposes of discussion, these heights roughly coincide with understory tall grasses and shrubs, and taller overstory saplings and trees. It is important to note that Arundo and tamarisk can fit in either class, depending on its age. Significant data noise precluded a complete watershed analysis comparison from year to year.

Visualization- The aerial photo data were compared on a reach by reach basis by switching between years, and switching between datasets. While the detection of change and comparison was completed through visual examination for this initial investigation, which is not as accurate as a statistical analysis, it was valuable at the watershed scale. In 2011, the vegetation polygons were hand digitized in GIS for two Transects (5 and 6) to see what additional data could be developed through this standard method.

CCRMP Boundary- For the purposes of this analysis the adopted CCRMP boundary was used, as depicted in the County GIS, which is defined in part by a combination of the top of the channel banks and the 100 year floodplain. As described in the 2010 report, there is some variation in the locations of this boundary relative to the channel banks and 100-year floodplain throughout the CCRMP, due in part to channel migration, and some of which may be a mapping offset error.

Transect Locations- The 2002 Andregg Vegetation Transects were used for the permanent transects, consistent with the 2010 analysis.

4.4.4 Discussion

It is important to note that geomorphology and the associated hydraulic dynamics are important drivers of ecological conditions in the CCRMP area. The plants and animals that occupy the creek respond to these patterns in predictable ways. For example, low velocity areas close to the ordinary high water mark tend to accumulate fine sediment, which provides suitable substrate for emergent riparian vegetation such as tules, cattails, and some sedges. High velocity areas that aggrade above the ordinary high water mark may provide suitable habitat only for invasive annuals, if any vegetation cover emerges at all. Reaches that have low terraces easily accessed by annual floods can develop shrub complexes, if protected from the main flow. In order to understand the current vegetation patterns on the landscape and the need for (and the design of) restoration, it is necessary to understand the physical features and flood processes of the creek. There will be some redundancy between each TAC member’s analysis because of this common element. However, the following details describe how and why those elements are important from a riparian biology perspective.

The aerial photos provided a consistent dataset for assessing the creek at the CCRMP (14.5 miles long) and the reach (2 mile long) scale. The aerial photos are useful for a plan view assessment of areas which is otherwise not possible. It also provides an invaluable temporal record of annual changes. However, the manual use of the photos for detecting change in vegetation dynamics is very difficult and time consuming. A more automated process using LiDAR was used in 2011 to great success. While the current data are not sufficient for a watershed scale analysis, the method holds promise as a tool for rapid assessment of vegetation changes throughout the CCRMP area.

The vegetation transects are intended to provide small-scale locations for repeatable surveys of plants and habitats that provide greater detail and accuracy than can be achieved solely through the use of aerial photos and LiDAR. Surveying the small area of the transects is much less time-consuming and costly than surveying the full 2,324 acres in the CCRMP. These data can then be used as an indicator of the type of vegetation changes that occurred throughout the CCRMP over the previous year. The accuracy with which the individual transect data reflects vegetation changes over a full reach, and the cumulative transect data can accurately represent vegetation change throughout the CCRMP, is an open question. The representational accuracy of the transects will be better understood once the LiDAR and the aerial photo analysis can be systematized over the entire CCRMP. Equally important, the transects provide a manageable dataset for annual evaluation that illustrate the modes of vegetation changes, including the impacts of creek flows, channel meander, aggradation and erosion, and the relative effectiveness of invasives management practices.

4.4.5 Analysis of the Andregg Vegetation Transects

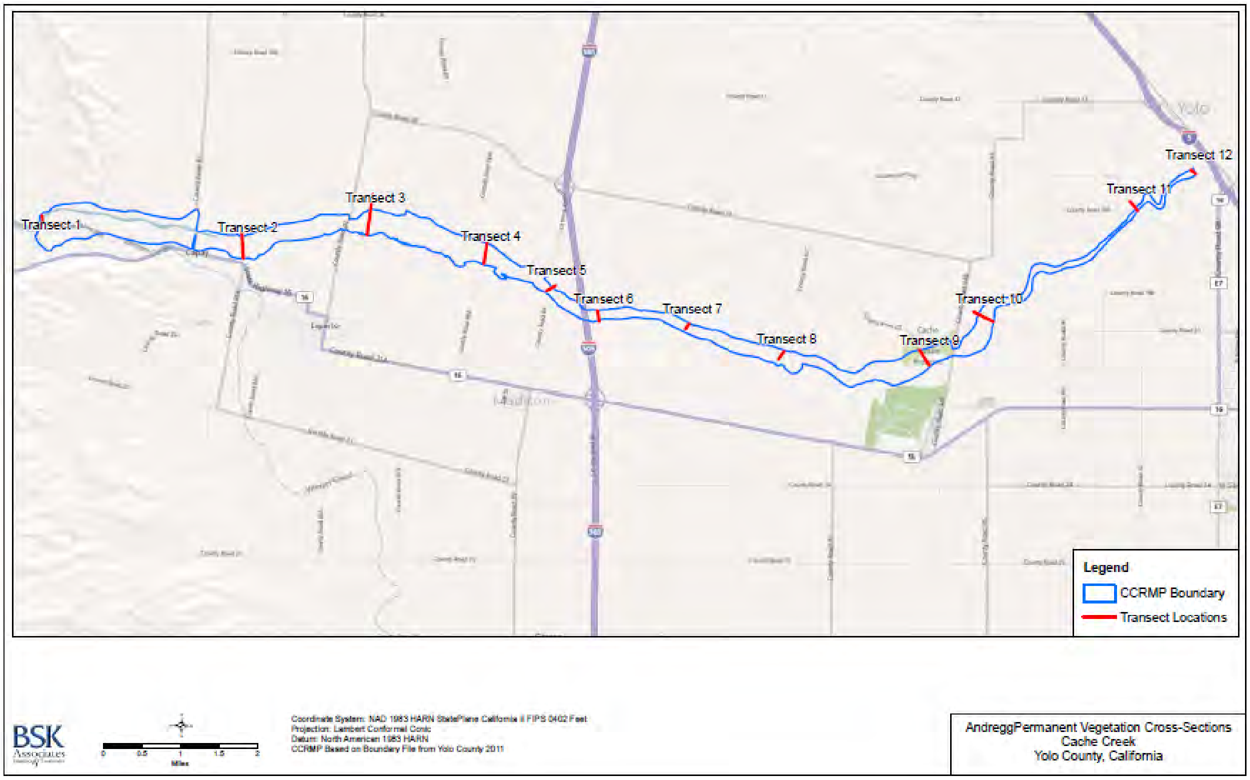
Based on a review of the transects, significant changes to native riparian vegetation extent or density have occurred between May, 2010 and May, 2011. In general, channel migration and erosion led to significant losses of both understory and overstory vegetation in 2011 in the surveyed transects, illustrating the fluctuating and temporary nature of in-channel habitat throughout the CCRMP. Despite the general loss of vegetation due to channel migration in most transects, some increases in understory extent are visible in Transects 10 and 12. Maps of the LiDAR data assessed in each of the transects are included in Appendix B.

Cache Creek Vegetation Analysis Based on 2010 and 2011 LiDAR Data

Transect Number	Total Area of Transect (Acres)	ASPRS Class 3 Vegetation					ASPRS Class 5 Vegetation				
		2010 Area (Acres)	2010 Area (% of Total)	2011 Area (Acres)	2011 Area (% of Total)	Difference 2010 to 2011 (Percent)	2010 Area (Acres)	2010 Area (% of Total)	2011 Area (Acres)	2011 Area (% of Total)	Difference 2010 to 2011 (Percent)
1	5.52	0.21	3.8	0.18	3.3	-14%	0.71	12.9	0.53	9.6	-25%
2	11.60	0.24	2.1	0.17	1.5	-29%	0.58	5.0	0.54	4.7	-7%
3*	13.36	0.35	2.6	0.22	1.6	-37%	0.62	4.6	0.16	1.2	-74%
4	11.14	0.64	5.7	0.55	4.9	-14%	1.27	11.4	1.06	9.5	-17%
5	4.30	0.26	6.0	0.15	3.5	-42%	1.05	24.4	0.82	19.1	-22%
6	5.28	0.41	7.8	0.33	6.3	-20%	0.63	11.9	0.29	5.5	-54%
7	4.59	0.31	6.8	0.2	4.4	-35%	0.6	13.1	0.44	9.6	-27%
8	6.99	0.4	5.7	0.33	4.7	-18%	1.55	22.2	1.32	18.9	-15%
9	10.09	0.43	4.3	0.46	4.6	7%	1.4	13.9	1.79	17.7	28%
10	8.74	0.78	8.9	0.78	8.9	0%	2.29	26.2	1.89	21.6	-17%
11	1.53	0.11	7.2	0.07	4.6	-36%	0.65	42.5	0.55	35.9	-15%
12	2.79	0.18	6.5	0.27	9.7	50%	0.55	19.7	0.49	17.6	-11%

ASPRS = American Society of Photogrammetry and Remote Sensing
ASPRS Class 3 Vegetation Defined by Towill as All Feature 0.25 ft. to 4.99 ft. Above Bare Ground
ASPRS Class 5 Vegetation Defined by Towill as All Feature 5 ft. or Greater Above Bare Ground
Data from Towill 2010 and 2011 LiDAR Data, Analyzed Using ArcGIS 10.0

*Transect 3 appears to have significant false positive overstory in 2010



Capay Reach

The biological conditions in the Capay Reach are very similar to those documented in 2010, with the exception of the small area of vegetation clearance for the Capay Dam apron project. There are significant populations of ravenna grass and Arundo in the Capay Reach, which the Cache Creek Conservancy is working to control. There are also large monocultures of ravenna grass and arundo just upstream of the dam. The arundo successfully treated by CCC is very apparent around RM 27. The area around RM27.5 was scoured by this year's flows, with the remnants of arundo clumps visible. This area may be temporarily disturbed for the next couple of years as the old plants break apart with the flows.

Transect 1 (Capay Reach, Andregg YC_01-TC_02) This transect is the most upstream, encompassing the Capay Diversion Dam at the western end of the CCRMP. Overall, the vegetation type and extent is largely determined by the dam, an irrigation canal that runs adjacent to the creek, and adjacent farming. The very shallow bedrock in this transect acts as a confining layer that limits the types of vegetation that can survive here.

A majority of the vegetated area of the spillway immediately downstream of the Capay dam has been stripped to the bedrock. This may have been related to construction activities carried out in 2010 to repair the dam's apron, though the site has shown erosion to bedrock in past seasons as well. The dominant vegetation in the area was comprised of shrubs and trees. The LiDAR data show a similar loss of both classes of vegetation.

Hungry Hollow Reach

The Hungry Hollow Reach is dominated by a large fan of sediment. This is a normal feature created by the change in valley form, as the confined channel widens to approximately 6 times its width at the narrowest point upstream. This is one of the widest and visibly driest reaches of the creek, with large expanses of annual grasslands dominated by invasives and no riparian forest. This is a difficult area for traditional restoration because of its high natural dynamism, and low groundwater levels. This reach also shows some nominal vegetation scour due to channel movement, though none of the scour appears to be significant. There are numerous and extensive ATV tracks through the channel and riparian zone from RM 25.1-24.5. These tracks then coalesce to define a series of major ATV trails on the south bank by RM 24. Cache Creek Conservancy treated tamarisk and arundo in this reach in 2011, and the arundo treatment is apparent around RM 23.

Transect 2 (Hungry Hollow Reach, Andregg YC_05-TC_06) This transect is located in the western end of the Hungry Hollow Reach, which is dominated by a large fan of sediment. Minor shrub cover has decreased in the southern third of the transect and along the channel. The LiDAR data show some limited riparian vegetation losses in both classes.

Transect 3 (Hungry Hollow Reach, Andregg YC_07-TC_08) This transect is located within the same reach as Transect 2, but it is outside of the fan area created by the change in gradient and the confining bedrock layer is no longer visible near the surface. The southern portion of the transect includes the Syar South Bank Spur Dikes, which protects existing vegetation from the historic creek meander that prevents the establishment of mature riparian vegetation throughout most of this transect. There is no noticeable change in vegetation since 2010. The channel braiding is largely the same except that the center channel appears to have become dominant. The LiDAR data show essentially no changes in either vegetation class.

Madison Reach
ATV use picks up significantly around RM 23 and continues downstream to the Guesisosi Reach. Unintentional ATV damage to re-plantings could delay or preclude successful restoration efforts. This may require a tactical approach, situating re-vegetation away from main access points and historic impact areas. The spur dikes are clear of vegetation and appear to have been re-rip-rapped.

Transect 4 (Madison Reach, Andregg YC_09-TC_10) This transect is in the transitional zone between the highly braided Hungry Hollow and Madison reaches and the more confined downstream reaches. It contains only a few remnant patches of riparian forest. This area appears to be suitable for revegetation efforts that could extend the vegetated corridor found in the downstream reaches. Tree and shrub cover has decreased in the lower terrace, where sediment has been reworked. Some bank cutting is visible in the south. The LIDAR data indicate that channel movement has lead to moderate loss of both classes of riparian vegetation in this reach.

Transect 5 (Madison Reach, Andregg YC_11-TC_12) This transect is very similar to Transect 4, with similar opportunities for restoration and challenges due to the highly modified terrain associated with the old bridge, the flow deflectors, and the historic in-channel mining roads. This aerial photo shows significant lateral channel migration to the north with upper terrace erosion and bank cutting, just upstream of the transect. This channel migration has occurred over the past several years, and continued in 2010. The creek is now well outside of the CCRMP boundary in this area upstream of transect 5. Even as the bifurcated stream migrated to the north, the southern portion of the channel was eroded and carried larger flow volumes in 2011. Vegetation coverage in this transect decreased, particularly in the wedge where the larger flows in the southern part of the channel eroded significant amounts of sediment. The LiDAR data show that the vegetation loss was mainly in the upper canopy.

Guesisosi Reach
The Guesisosi Reach is central to providing contiguous riparian cover from the lower Dunnigan Hills and Hoppin Reaches to the upstream reaches. There is severe ATV damage to the riparian vegetation on the north bank around RM 21. There is more evidence of vegetation damage at RM 20.2, and interestingly what appear to be “game trails” coming down onto the lower flood plain from the north. Game trails are simply areas that wildlife use to go from the creek to riparian cover. These must be well-used in order to be visible from the air. The more

common trails on Cache Creek are created by river otters, but these are rarely visible at these resolutions. There are some large trees, apparently cottonwoods, in the water and the lower floodplain (large woody debris recruitment) at RM 19.5. Large woody debris provides structure for fish and wildlife and is important for the ecology of streams.

Transect 6 (Guesisosi Reach, Andregg YC_13-TC_14) This transect is very similar to Transects 4 and 5, which also have remnant riparian forest that could support restoration efforts. Some vegetation loss occurred within the channel as the main channel flow migrated south, with scour and sediment deposition on the north. The vegetation loss was significant according to the LiDAR, mainly in the overstory class.

Transect 7 (Guesisosi Reach, Andregg YC_15-TC_16) The vegetation in this transect is in better condition than the upstream transects in the Madison and Hungry Hollow Reaches. This figure shows the slight lateral channel migration to the south, loss of vegetation and bank cutting along the south bank, and small scale braiding as the channel migrates south. The LIDAR data support conclusions drawn from the aerials, and this loss of vegetation was from the clearing of the lower terrace for a channel stabilization project. Vegetation for restoration was planted following the bank repairs. Even as the channel was shifting south, the north bank was also eroded and lost vegetation.

Dunnigan Hills Reach

The Dunnigan Hills Reach has some of the best expanses of mixed riparian forest and, as a result, best canopy cover on the creek. This reach also shows some vegetation scour due to channel movement. There are extensive ATV tracks through the channel and riparian zone at RM 18.5. There is some visual evidence that the ATV tracks are promoting side channel establishment on the south bank. There also appears to be extensive untreated arundo in the upper terrace, although it may have been treated and just had not collapsed yet. At RM 17 there is the worst ATV damage in the whole CCRMP, mainly on the south bank. Side channel creation by ATVs is apparent on the north bank. Extensive patches of arundo on the north bank have been treated, and there appear to be more game trails within that area.

Transect 8 (Dunnigan Hills Reach, Andregg YC_17-TC_18) This transect has patches of riparian habitat, and is adjacent to healthy patches of forest and wetland in the Milsap property. Deposition is occurring on the north side of the channel, with erosion occurring in the middle of the channel. The channel appears to be straightening and migrating south. Loss of a few trees along the southern portion of the channel and of shrubs and trees where the mid-channel bar scoured is clearly visible in the aerial photo. Significant new areas of ATV impact are visible as well. The LiDAR demonstrates its effectiveness in this transect by identifying the moderate losses of both classes of riparian vegetation due to channel movement.

Transect 9 (Dunnigan Hills Reach, Andregg YC_19-TC_20) The north edge of the transect is the Cache Creek Nature Preserve, the anchor for restoration throughout the CCRMP area. The south end of the transect is just downstream from Wild Wings Park. Portions of this riparian zone could be used for reference assessments to compare restoration or reclamation projects to current conditions. There was little change in vegetation, with some erosion in the north and south channels. The relative difference in vegetation loss appears to be due to LiDAR misclassification, not channel movement in the southern border. Vegetation on the south bank showed a solid increase in class size.

Hoppin Reach

The Hoppin Reach has several well defined ATV tracks along both banks and throughout the riparian zone, including the largest ATV water crossing on the Creek (RM 15.5). There does seem to be less riparian vegetation removed by channel erosion than upstream, partly due to the entrenched nature of the channel at this point. However, at RM 14.5 there is significant ATV use visible throughout the channel and adjacent wetlands. It seems that where the channel itself is not accessible for this use the impact on the surrounding riparian zone is magnified.

Transect 10 (Hoppin Reach, Andregg YC_21-TC_22) This transect is in the transition zone between the well-vegetated middle reaches and the more deeply incised lower reaches. This location still has a broad enough floodplain to accomplish traditional restoration. Erosion of the north and south banks, with loss of trees and shrubs, is visible in the aerial photos. Deposition within the channel has increased braiding. The LiDAR shows significant losses of overstory vegetation on the south bank and some increases in understory vegetation on the north bank. The apparent filling-in of the overstory canopy gaps on the north bank is particularly interesting, as it shows that natural regeneration is occurring here at a more visible rate than the other observed locations.

Jesus Maria Reach

This reach also shows some nominal vegetation scour due to channel movement, particularly at Huffs Corner. None of the scour appears to be significant. There are what appear to be small patches of arundo on the north bank, but these seem minor.

Transect 11 (Rio Jesus Maria Reach, Andregg YC_23-TC_24) This transect is deeply entrenched and has limited potential for restoration under current conditions. The transition to high banks associated with channel entrenchment and loss of floodplain width essentially strands the historic riparian forest and provides no new growing space for regeneration. Significant modeling and coordination would be required for successful large-scale riparian restoration. There was further erosion of the low-flow channel. Only minor differences in either vegetation class were apparent in the LiDAR data.

Transect 12 (Rio Jesus Maria Reach, Andregg YC_25-TC_26) This transect is similar to the upstream reach at Transect 11. There is potential to expand the floodplain width on the north bank through grading the area between the levee and the water, and re-contouring the “island” feature. This figure shows a significant erosion repair along the levee. There was a decrease in grasses and shrubs on the north bank. The area also clearly shows ATV tracks. There has been some erosion on the south bank. LiDAR shows some understory increase on the north bank and some data problems in the middle “island” portion. It appears that the flow velocities in this transect were sufficient to remove the re-establishing vegetation.

4.5 Annual Invasive Weed Management

Significant improvements have occurred in recent years because of Cache Creek Conservancy’s (CCC) efforts to chemically treat tamarisk (*Tamarix* sp.), giant reed (*Arundo donax*), and ravenna grass (*Saccharum ravennae*), resulting in a visible reduction of total area covered by mature plants of these species. CCC’s Invasive Weed Control Program has had a significant positive ecological effect by reducing some of the negative impacts caused by tamarisk and giant reed, including fine sediment accumulation, vegetation restrictions, and flow redirection. The removal of these invasive weeds also opens up growing space for native plants that generally provide better habitat for wildlife in the Cache Creek corridor. The establishment or re-establishment of invasive weeds is difficult to discern from aerial photos or LiDAR, but is readily assessed in the transect assessments. Many of the invasive weeds are late blooming plants, so they are best assessed by surveys conducted in late summer. However, the rare native species tend to bloom early in the growing season.

The benefits of the CCC Invasive Weed Control Program need to be continued through coordinated weed management with upstream partners. Yolo Resource Conservation District is leading the development of a Cache Creek Watershed Weed Management Plan in conjunction with Cache Creek Watershed Forum partners. This plan will help refine strategic weed management efforts in the CCRMP area. Newer and potentially more broadly spread riparian species, such as white top-perennial pepper weed and drier riparian site invasives, such as milk thistle (*Silybum marianum*), Italian thistle (*Carduus pycnocephalus*), and yellow star thistle (*Centaurea solstitialis)* have spread dramatically over the past three years and became dominant dry season plants in the CCRMP area. The longer-term challenges from Himalayan blackberry (*Rubus* sp.), ravenna grass (*Saccharum ravennae*), and fig (*Ficus* sp.) are found throughout the planning area, but are typically untreated and not mapped. Himalayan blackberry can overwhelm a riparian site in two years. Figs can overwhelm a region in a decade through initial slow colonization, followed by exponential expansion. All invasives have to be treated systematically, or treated invasive species will simply be replaced by untreated invasive species. The weed management program should be coordinated with a re-vegetation program to avoid or reduce weed re-colonization.

Giant reed and tamarisk, and to a lesser degree Himalayan blackberry, can create depositional levees which confine the lower flow channels. Their removal would improve flood capacity. Removal of the invasive species will also allow for the establishment of more diverse native flora. However, removal alone is not a solution. As identified in the CCRMP, revegetation with native species is critical in reducing the re-establishment of these and other invasive species. A specific treatment, mapping, and re-planting plan should be developed as a component of a Comprehensive, Integrated Revegetation Plan (CCRMP 4.4-10). The Cache Creek Watershed Weed Management Plan, which will be completed in 2012, will provide an important tool to guide strategic weed management efforts in the CCRMP area. CCC's 2010 'Native Vegetation Management Plan for the Jesus Maria Reach of Cache Creek' provides an important start for the development of a CCRMP-wide Revegetation plan.

Strategically, it is critical to identify existing and new threats and respond to them in a concerted top to bottom fashion in the watershed. The most expeditious means of accomplishing this is to collect the data during the existing weed spraying program. Each invasive species, its approximate extent, and any treatment, should be identified on a handheld GPS unit and mapped in GIS. CCC reports annually on invasive weed management activities, and will begin GPS mapping of treatment areas in 2012. This will make it easier to determine the success of the weed management program and strategically target revegetation efforts. As articulated in the CCRMP and CCIP, tactical revegetation in the areas that have been treated should be implemented. Fast growing replacements, such as local willow species and native grasses can be established readily on barren or sparsely weeded sites, with supporting irrigation as needed. It is also important that the CCC continue to engage private landowners with significant weed problems in order to ensure that comprehensive management can be completed.

4.6 Major Channel Stabilization Recommendations

The CCIP (Chapter 3) lists several priorities to be used in allocating resources for various improvement projects. The priorities include a variety of actions such as implementation of the "Test 3" profile, which includes bank shaping near state and county bridges, implementation of restoration where needed, and a variety of other projects.

There are four areas of concern:

1. Huff's Corner (RM 11.6) remains a flood risk consideration
2. the PG&E Pipeline/Pallisades (RM 26.9) exposure and erosion is an ongoing problem
3. Dead arundo and tamarisk in the Capay Reach should be replaced with native plantings in selected areas in this reach, in order to avoid destabilization of the floodplain.
4. The bank retreat patterns at three sites (near RM 25.4 -25.5, RM 22.0, and RM 20.6) have newly created floodplain areas that could be prime locations for reestablishing

riparian vegetation. This dynamic process can be utilized for regeneration of riparian habitat. In coordination with local land owners, site-specific small scale revegetation plantings should be considered to supplement natural regeneration.

4.6.1 Channel Maintenance activities

The CCIP provides guidance on channel maintenance activities that are to be undertaken in order to address local conditions that need to be corrected to prevent larger stream stability problems. Two categories of projects identified in the CCIP are directly related to vegetation management. First, the CCIP calls for vegetation removal to maintain hydraulic capacity, reduce the probability of bank erosion, or to remove undesirable species. This could be achieved through selective mechanical or chemical control of dense stands and/or undesirable species. The CCIP also calls for minor bank protection works, which can be accomplished through revegetation and biotechnical controls.

There are three identified needs for vegetation removal for hydraulic capacity. The first is the continuation of the ongoing weed management along the north banks in the Jesus Maria Reach (between Transects 11 and 12). Also, as described earlier, the channel has shifted at RM21.6, and a local landowner has expressed concerns regarding the potential negative influence of vegetation on this area.

There is significant erosion on the northern bridge piers at the Road 87 crossing, and at the I-505 crossing. The situation should be assessed to determine if riparian vegetation is impairing and/or deflecting flow at the bridges. If so, the vegetation should be removed in order to protect the bridge piers.

Upper Capay Reach, Dunnigan Hills Reach, and Rio Jesus Maria Reach do still contain expanses of tamarisk, Himalayan blackberry, and arundo. But these populations do not appear to have discernable hydraulic influence, with the exception noted in the previous section. These reaches were assessed through review of aerial photos to look for nearby upstream and downstream “signatures”, or features on the landscape which would indicate that the vegetation is deflecting flow or causing a scour feature. Review of channel conditions in the field and from the aerial photos in 2011 did not identify any specific vegetation removal needs for short-term channel maintenance.

CHAPTER 5 – ADMINISTRATION

The Cache Creek Area Plan (CCAP) administration continued to undergo significant change in 2011 following related County Departmental and Division restructuring in 2010. The Natural Resources Coordinator position was reclassified as a Natural Resources Program Coordinator. A Manager of Natural Resources position was created, with responsibility for a variety of programs including the CCAP. The Off-Channel Mining Plan (OCMP) continues to be administered by the County Planning and Public Works (PPW) Department. In addition, all new mining permit applications and Flood Hazard Development Permits will be processed through PPW. Finally, an outside consultant continued to assist with the process of rebuilding the program, providing oversight, management, and audit services. Significant progress was made in 2011 to re-align staff and consultant work with program goals and objectives. Relationships with core partners have been re-established or strengthened through improved communications. The production of this Annual Report demonstrates the renewed commitment of all the CCAP partners in meeting the intended purpose and goals of the CCAP.

5.1 FUNDING

The CCAP, and specifically the Cache Creek Resources Management Plan (CCRMP) and Cache Creek Improvement Program (CCIP), are funded through aggregate mining fees paid by aggregate producers within the CCAP boundary. The Gravel Fee Mining Ordinance, adopted by the Board of Supervisors in 1996 and amended in April, 2007, requires a series of fees to be placed on each ton of gravel sold (not mined) within the CCAP, for monitoring and restoration of the creek, as well as administration of the program.

5.1.1 GRAVEL MINING FEE BREAKDOWN BY FUND

Pursuant to the Gravel Mining Fee Ordinance, Section 8-11.01(a) and (c), the calculated fee split over ten years is as follows:

Effective Dates	Total $ per ton	CCRMP	M/R	OCMP	CCC	Surcharge[1]
1/1/97 to 3/31/07	*0.20*	*0.10*	*0.02*	*0.03*	*0.05*	*0.10 (original)*
4/1/07 to 12/31/07	0.45	0.25	0.02	0.08	0.10	0.20
1/1/08 to 12/31/08	0.468	0.26	0.021	0.083	0.104	0.20
1/1/09 to 12/31/09	0.487	0.271	0.021	0.087	0.108	0.20
1/1/10 to 12/31/10	0.506	0.2813	0.0223	0.0901	0.1123	0.20
1/1/11 to 12/31/11	0.526	0.292	0.023	0.094	0.117	0.20
1/1/12 to 12/31/12	0.547	0.3041	0.0241	0.0974	0.1214	0.20
1/1/13 to 12/31/13	0.569	0.3163	0.025	0.1013	0.1263	0.20
1/1/14 to 12/31/14	0.592	0.3292	0.026	0.1054	0.1314	0.20
1/1/15 to 12/31/15	0.616	0.3425	0.0271	0.1096	0.1368	0.20
1/1/16 to 12/31/16	0.64	0.355	0.028	0.113	0.142	0.20

Note: Cents-per-ton fee split shown to four decimal places only where necessary to allow for exact split of collected fees.
1) No proportional annual increase on the Production Exception Surcharge
Source: TSCHUDIN CONSULTING GROUP, June 2, 2010

The Fee Ordinance establishes the amount of the gravel mining fees and how they are to be spent, pursuant to the following guidance:

The **CCRMP Implementation** Fee is to be used to implement the CCRMP and CCIP. Specifically, it can be used for the design and construction of projects for channel stabilization and bridge protection; the design and construction of channel maintenance projects; monitoring, modeling, and flood watch activities per the CCIP; and compensation of the TAC.

The **Cache Creek Conservancy Contribution** is to be used for habitat restoration and enhancement along Cache Creek, and revegetation projects consistent with CCRMP creek stabilization objectives.

The **Off Channel Mining Plan (OCMP) Administration** fee is to be used for the implementation of the OCMP, administration of the long-term mining permits and Development Agreements, and inspection of mining and reclamation operations.

The **Maintenance and Remediation Fee** is to fund a long-tem, interest-bearing account for the following future activities: the correction of mercury bioaccumulation problems after reclamation has been completed, if necessary; clean-up hazardous materials contamination after reclamation is completed, if necessary; extended environmental monitoring of the off-channel mines, including data gathering and groundwater modeling, beyond that required in the mining permits; and maintenance of publicly held lakes within the plan area. No expenditures may be drawn from the Maintenance and Remediation fund until January 2027, at which time the fund shall be made available for the activities identified in this section. Starting in January 2047, the funds may be made available for implementation of the CCAP, including; habitat restoration; creation of open space and passive recreation opportunities; and creek restoration and stabilization.

The Twenty Percent **Production Exception Surcharge** is collected for any amount of aggregate sold in excess of annual permitted production. These funds are to be divided evenly between the CCRMP Implementation fund and the Maintenance and Remediation fund.

In 2010, the aggregate sales within the CCAP totaled 1,730,834 tons, resulting in fees due in 2011 of $910,418. Tons sold in 2010 were the lowest in CCAP history representing less than one third (32 percent) of the programs highest year in 2003 of 5,334,183 tons sold. However, this is consistent with the economic downturn that is affecting all industry sectors. With the creation of a base annual CCAP program budget in 2010, the cycles of the economy will be smoothed over the life of the program and thus, disruption to program delivery will be minimized in the future. Finally, it should be noted that, at the discretion of the County, up to 35 percent of the CCRMP fee paid by aggregate producers may be offset by costs incurred from participating in channel improvement projects. However, such offsets cannot be utilized for bank protection mitigation measures required under the off-channel mining permits. There were no fee offsets in 2011.

5.1.2 CCRMP Budget

The Cache Creek Area Plan (CCAP) budget, per the Gravel Mining Fee Ordinance, consists of three distinct funds: The CCRMP, the OCMP and the Maintenance and Remediation funds. The Cache Creek Conservancy portion is paid directly to the Conservancy. For a complete breakdown of the CCAP budget, please see the Final County Budget available on line at http://www.yolocounty.org/Index.aspx?page=933.

The FY 2011-2012 budget contains funding for several long-term CCAP required elements, including the ten-year CCAP update ($300,000), the five-year riparian survey and map

($100,000), and the HEC RAS model ($15,000). In 2011, staff established a contingency fund that will be utilized to fund such long term requirements that are not annual program activities.

Fiscal Year 2011-12 Budget Fund 032 BU2972 CAO-CACHE CREEK RESOURCE MGMT		
Major Object		**FY2011-12 Adopted Budget**
SALARIES AND EMPLOYEE BENEFITS	$	206,167.00
SERVICES AND SUPPLIES	$	950,653.00
OTHER CHARGES	$	2,250.00
FIXED ASSETS-STRUCTURES/IMPS	$	55,000.00
Total Appropriation	**$**	**1,214,070.00**
FEES AND PERMITS-SAND & GRAVEL	$	486,537.00
INVESTMENT EARNINGS	$	11,250.00
Total Revenue	**$**	**497,787.00**

Finally, those expenditures above and beyond the anticipated revenue are covered by the residual program fund balance. For FY 2011-12, the beginning balance for the CCRMP fund was $1,153,090.91.

5.1.3 GRANTS

Two grants were received for Off Highway Vehicle (OHV) related activities in the CCRMP area. The Yolo County Sheriff was awarded a grant of approximately $40,000 for OHV patrols and enforcement actions within Cache Creek. The Cache Creek Conservancy received a California State Parks OHV Mitigation grant of $31,662. This grant will fund restoration and mitigation work on up to three sites: Cache Creek Nature Preserve, Correll-Rogers Water Recharge and Habitat site, and Wild Wings Park.

The National Park Service's River, Trails, and Conservation Assistance (RTCA) program selected Yolo County for technical assistance in the development of a Cache Creek Parkway Plan. The Parkway Plan will build on the CCAP by developing a coherent use plan for the lands and lakes that will be dedicated to the County in the coming years, enhancing opportunities for land and water-based recreation, riparian habitat conservation and restoration, increased groundwater infiltration, enhanced water quality, and flood and stormwater management. RTCA technical assistance will enable County staff and partner organizations to draw on RTCA's extensive experience working on conservation and trail planning projects throughout the country.

The Water Resources Association (WRA) of Yolo County agreed to provide $35,000 in funding to the Cache Creek Watershed Forum, with the Yolo RCD as the implementers, for a grant to prepare a Cache Creek Watershed Wide Invasive Species Management Plan. This plan will coordinate and guide invasive removal in the Cache Creek watershed including the CCRMP area.

5.2 APPLICATIONS FOR IN-CHANNEL ACTIVITIES

As required under Section 8-3.404 of the Yolo County Flood Damage Prevention Ordinance, the TAC is responsible for making recommendations on all proposed projects located within the CCRMP area. The recommendations are then forwarded to the Floodplain Administrator for a final decision. There were no applications for in-channel activities within the CCRMP area in 2011.

5.3 STATUS OF PROGRAMMATIC PERMITS

The CCRMP relies on several programmatic federal and state permits that allow for annual implementation of in-channel activities and for successful adaptive management. The County is in the process of seeking reauthorization of several of these permits, which streamline the process for channel improvement and habitat restoration projects in the CCRMP area. The status of each of these permits is summarized below:

5.3.1 U.S. Army Corps of Engineers (USACE)

Construction activities within wetland areas, as defined under the Federal Clean Water Act, require prior approval of a Section 404 permit from the USACE. USACE issued Regional General Permit No. 58 for in-stream activities conducted within the CCRMP area in July, 1997. This permit was renewed in May, 2004. The County applied for reauthorization of this permit in 2010, and has been working through the reauthorization process in 2011. As long as a proposed project shows that it is consistent with the requirements of the CCRMP by obtaining a Flood Hazard Development Permit from Yolo County, and meets the conditions required by the USACE for the General Permit, it is anticipated that a separate Section 404 Individual permit will not be required once the Regional General Permit has been reauthorized. The RGP #58 is a valuable streamlined process for supporting habitat restoration and channel stabilization on Lower Cache Creek, and is integral to achieving the goals and objectives of the CCAP and of multiple partner agencies.

5.3.2 U.S. Fish and Wildlife Service (USFWS)

As a part of the approval process for the Section 404 permit, the USACE is required to consult with the USFWS regarding a project's potential effects on federally listed threatened and endangered species. In September 1996, the USFWS issued a biological opinion for Valley Elderberry Longhorn Beetle (VELB). The County will be coordinating with the Service to renew this opinion in conjunction with the reauthorization of the USACE regional 404 permit described above.

5.3.3 California Department of Fish and Game (CDFG)

Construction activities within the defined bed and banks of stream channels require prior approval of a Streambed Alteration Agreement (1600 Permit) from the CDFG. CDFG originally issued a general 1600 permit for in-stream projects within the CCRMP area in July 1997. This permit was reauthorized in August 2002. In August, 2008, the 1600 authorization was replaced by a Section 1602 Memorandum of Understanding, which establishes an individual project permit template. Reauthorization of the original general 1600 permit will be sought in 2012. As long as a proposed project shows that it is consistent with the requirements of the CCRMP by obtaining a Flood Hazard Development Permit from Yolo County, and meets the conditions required by the CDFG for the 1600 Permit, a separate Stream Alteration Agreement from the CDFG will not be required once the 1600 Permit has been reauthorized.

5.3.4 Regional Water Quality Control Board (RWQCB)

A 401 Water Quality Certification, permitted by the RWQCB, is required in order to implement the Army Corps 404 Permit. A general 401 Certification was originally approved in July, 1999, and reauthorized in August, 2002. The process of seeking reauthorization of the 401 Water Quality Certification was begun in 2011 and will continue into 2012. As long as a proposed project shows that it is consistent with the requirements of the CCRMP and meets the conditions required by the State Water Resources Control Board, project-specific 401 Certification from the SWRCB will not be required once the programmatic 401 Certification has been reauthorized.

5.3.5 Central Valley Flood Protection Board

In 1980, the State Reclamation Board (now the Central Valley Flood Protection Board) staff determined that Cache Creek is a "designated floodway." However, at the request of Yolo County, the Reclamation Board declined to adopt floodplain regulations concerning proposed construction projects within the creek channel. Under Section 8414 of the State Water Code, if the Reclamation Board declines to adopt floodplain regulations for the designated floodway, then the local agency having jurisdiction over the project area may adopt regulations. These regulations have the same force and effect as those adopted by the State Reclamation Board.

The requirement for floodplain regulations is fulfilled by the Cache Creek Resource Management Plan (CCRMP) and Cache Creek Improvement Plan (CCIP), as implemented under the Flood Hazard Development Ordinance (Chapter 3 of Title 8 of the County Code), which continue to fulfill the State Water Code requirements.

5.3.6 California Department of Conservation

The CCRMP is recognized in Section 2715.5 (PRC) of the state Surface Mining and Reclamation Act (SMARA) as the functional equivalent of a general reclamation plan for implementation of the CCRMP/CCIP. Specific and detailed plans for improving channel shape, erosion protection, and riparian habitat are implemented by the County, individual mining companies, and other private parties under a "blanket" mining and reclamation permit held by the County. This was first authorized under Assembly Bill 297, sponsored by Assembly Member Helen Thomson in 1999. The second authorization, Assembly Bill 1984 (sponsored by Assembly Member Lois Wolk) passed in 2004. The third authorization, Assembly Bill 646 (sponsored by Assembly Member Wolk) passed in 2007. Senate Bill 133 (sponsored by Senator Lois Wolk), passed in 2011, authorizes the CCRMP through December 31, 2017.

5.4 PARTNER ORGANIZATIONS AND OTHER CREEK-RELATED PROGRAMS

The following entities are important partners with the County in implementing the CCRMP and CCIP:

5.4.1 Cache Creek Conservancy (CCC)

The Cache Creek Conservancy (CCC) is a 501(c)3 non-profit corporation whose mission is to promote the restoration, enhancement and prudent management of the stream environment along Cache Creek from Capay Dam to the Yolo Settling Basin. CCC, created in 1996, manages land for wildlife habitat, controls invasive plants, and provides environmental education within the lower Cache Creek. It receives fees generated by the Cache Creek Area Plan, as well as funding from state, federal, and foundation grants. CCC is staffed by an Executive Director, an Administrative Assistant, a Tamarix and Arundo Project Coordinator, and a Habitat Restoration Manager, working under the direction of an independently elected Board of Directors. CCC and the County have collaborated on a number of joint ventures related to the creek, including management of County-owned lands such as the Correll-Rodgers property, the Milsap property, and the Cache Creek Nature Preserve.

5.4.2 Yolo Chapter of the California Construction and Industrial Materials Association (CalCIMA)

CalCIMA is the industry representative for the sand and gravel producers mining lands in the CCAP program area. CalCIMA and the member Producers are active partners in the implementation of the CCAP. The members of the Yolo Chapter of CalCIMA that participate in the CCAP include Granite, Syar, Teichert, and CEMEX. The County and CalCIMA meet regularly in order to enable feedback and participation in program implementation. Producer representatives regularly attend CCAP TAC meetings, the annual Creek Walk and other program related activities. The Producer’s program history and participation has contributed greatly to the recent realignment of the program to the original mission and purpose. In addition, the Producers are partnering outside of the mandated program requirements, thus enhancing the program. For example, in 2011 the Producers agreed to participate in a countywide ground water monitoring program and the sharing of electronic groundwater data with the County. This data will help to inform CCRMP water analysis, as well as the overall countywide groundwater system.

5.4.3 Yolo County Flood Control and Water Conservation District (YCFCWCD)

YCFCWCD's mission is "To plan, develop, and manage the conjunctive use of the District's surface and groundwater resources to provide a safe and reliable water supply at a reasonable cost, and to sustain the socioeconomic and environmental well-being of Yolo County." YCFCWCD's boundaries cover 195,000 acres of Yolo County, including the entire CCRMP area. The District operates Clear Lake, Indian Valley Reservoir, and owns the majority of water rights for Cache Creek. As such, YCFCWCD plays a central role in determining the flow of surface water within the Cache Creek watershed. The Capay Diversion Dam, at the upstream end of the CCRMP area, provides some of the water that the District distributes through more than 150 miles of canals and laterals. YCFCWCD is an important partner in stream restoration projects, including the wetlands at the Cache Creek Nature Preserve. In 2011, YCFCWCD and the County began partnering on water quality monitoring within the CCRMP area, and engaged in discussions on possible partnerships to expand turbidity and flow monitoring within the CCRMP area. YCFCWCD manages the Water Resources Association's groundwater monitoring program that provides valuable data that helps inform the CCRMP's impacts on groundwater.

5.4.4 Yolo County Resource Conservation District (RCD)

The mission of the Yolo County Resource Conservation District (RCD) is to protect, improve, and sustain the natural resources of Yolo County. Resource Conservation Districts were first created as a result of the "Dust Bowl" crisis. Originally focusing on soil and water issues, the mission has broadened to include fish and wildlife habitat restoration, farmland preservation, and control of invasive plant and animal species. The Yolo RCD provides technical guidance, education, and on-site expertise for private landowners and growers, cities, schools, agencies, businesses, and research institutions. The County partners with RCD in managing Capay Open Space Park. RCD is a lead agency in managing invasive plants throughout the Cache Creek watershed. In 2011, RCD was awarded a grant by the Water Resources Association of Yolo County for the development of a Cache Creek Watershed-wide Weed Management Plan. Staff from the CCAP program will continue to actively participate in the development of this plan, which will priorities for invasive plant management throughout the watershed.