Feather River Coordinated Resource Management Watershed Monitoring Program

Funded by Plumas Watershed Forum

2006 Report

Recording flow using a bridge crane from Deadfall Bridge on Lights Creek, Indian Valley

Prepared by Plumas Corporation
Quincy, CA
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Introduction

The Feather River Coordinated Resource Management (FR-CRM) group, a proactive consortium of 21 public agencies, private sector groups, and local landowners, was formed in 1985 in response to widespread erosion and channel degradation in the Feather River watershed. 140 years of intense human use, including mining, grazing, timber harvesting, wildlife, railroad and road construction, have all contributed to a watershed-wide stream channel entrenchment process. FR-CRM has been monitoring the Feather River watershed since 1999 in an effort to establish baseline data for assessing long-term trends in watershed condition, and the potentially significant effects of restoration projects on watershed function. Most of the monitoring effort is concentrated in the Indian Creek watershed because of its highly degraded upper watershed condition, and high potential for benefit from restoration with many square miles of alluvial valleys. Site location follows a nested approach.

Program Background

Background information such as an overview of the watershed, monitoring program objectives, and protocols can be found in the three previous FR-CRM Watershed Monitoring Reports from 2001, 2004, and 2005. The last two reports (2004 and 2005) can be found on the FR-CRM website at www.feather-river-crm.org. The monitoring stations were installed in 1999 and data has been collected from 2000-2006.

Initial funding for FR-CRM's monitoring program was provided by a federal Clean Water Act grant (Aug 1998 to Dec 2000). Subsequent funding sources were: the California Surface Water Ambient Monitoring Program (SWAMP) from Oct 2000 to Dec 2003 and the Plumas Watershed Forum (2004 to 2006). The primary goal of the monitoring program funded by the Forum was to continue operation of the ten continuous recording stations, with the addition of some project sites that have watershed-level significance. Physical and biological surveys of the 20 Monitoring Reaches were not included in this effort. Those sites will likely be re-surveyed as more funding becomes available, due to geomorphic changes caused by the extended high stream flows of 2005-06.

Monitoring Program Description

As the fourth FR-CRM Watershed Monitoring Report, this report documents on-going monitoring data from the 2006 water year (October 1, 2005-September 30, 2006). The 2006 water year saw the highest flows since the start of FR-CRM's watershed monitoring program. FR-CRM completed a significant amount of sampling in 2006 before the monitoring program ran out of funding. Since this report is minimally funded, data was collected and analyzed for priority sites with respect to monitoring program continuity. Some of the continuous recording stations require maintenance following the extended high stream flows of 2005-06 and others are reaching their life expectancy. Funding from UC Davis Indian Creek modeling project will help pay for their maintenance/replacement in 2007.

Four main subwatersheds of the Feather River are covered under this monitoring program:

- Indian Creek
- Spanish Creek (Indian + Spanish = East Branch North Fork Feather River)
- Middle Fork Feather River
- North Fork Feather River

Most important findings in this monitoring report:

- Big Flat peak flow attenuation and longer duration of baseflow
- Last Chance Watershed: decreasing number of days with temperature readings exceeding 75°F (lethal to coldwater fish habitat) below project areas

Figure 1. Feather River CRM Watershed Monitoring Locations – all "types"

Table 1. Feather River Watershed Monitoring Sites and Parameters Recorded

Map #	Monitoring Site by Subwatershed	Monitoring Type
	North Fork Feather River (NFFR) watershed	
3	NFFR @ Domingo Springs (abv Lake Almanor)	MR[∞]
25	NFFR @ acw[†] East Branch NFFR	MR
	Butt Cr (abv 307 Br)	MR
	Goodrich Cr	MR (discontinued)
	East Branch mouth (acw NFFR)	MR
19	Spanish mouth (acw Indian)	MR
17	Spanish Cr acw Greenhorn	MR
18	Greenhorn Cr mouth	MR
16	Spanish @ Gansner Park (Hwy 70)	CRS[‡]
15	Rock Cr mouth	MR
14	Indian Cr blw Indian Falls (acw Spanish Cr)	DWR
13	Wolf Cr @ Town Park	MR
26	Wolf Cr @ Main St Bridge	CRS
12	Lights Cr @ Deadfall Br	MR & CRS
11	Indian Cr @ Taylorsville	MR & CRS & DWR weather
10	Indian Cr @ Flournoy (bcw[§] Red Clover)	MR & CRS
9	Indian Cr @ DWR weir (acw Red Clover)	MR & CRS
6	Red Clover @ Chase Bridge	MR
	Thompson Valley (TVL)	DWR weather
8	Red Clover Cr @ Drum Bridge	MR
7	Red Clover @ Notson Bridge	CRS
5	Last Chance (LC) Cr @ Murdock	MR
4	Last Chance (LC) Cr @ Doyle Crossing	CRS & DWR weather
	McClellan Cr	DWR
	Cottonwood Cr	CRS
	Little Stoney Cr	DWR
	Willow Cr	DWR
	LC @ Alkali Flat low water crossing	DWR
	Ferris Cr	DWR
	LC @ Bird-Jordan Neck	staff gage & DWR
	Jordan Peak (JDP)	DWR weather
	Middle Fork Feather River (MFFR) watershed	
24	MFFR abv Nelson Cr	MR
	MFFR @ Sloat	staff gage
23	Jamison Cr @ 23N37 Br	MR
22	Sulphur Cr @ Clio	MR & CRS & volunteer weather station
	Boulder Cr	staff gage
	Barry Cr	staff gage
	Sulphur @ Lower Loop Bridge	staff gage
	Sulphur @ Upper Loop Bridge	staff gage
21	MFFR blw A23 Br (Beckwourth)	MR
	MFFR near Portola (MFP)	DWR flow

[∞] Monitoring Reaches (MR) are included in the above schema to give the reader an idea of the breadth of the overall watershed monitoring program. Monitoring Reaches have been surveyed three times for geomorphic, habitat, chemical, and biological characteristics. Long term monitoring of these sites is expected to give watershed managers a better understanding of processes and long term trends in these subwatersheds. The types of data collected at Monitoring Reach sites can be found in the SWAMP final report, with details on protocols in Appendix A.

[†] "acw" means "above confluence with"

[‡] Only operation and maintenance of the Continuous Recording Stations (CRS) sites are funded by the Plumas Watershed Forum.

[§] "bcw" means "below confluence with"

Data Collected at the Continuous Recording Stations (CRS):

- Stage (calibrated to flow)
- Water Temperature
- Air Temperature
- Turbidity (NTU's) (Spanish Creek at Gansner and Indian Creek at Taylorsville only)

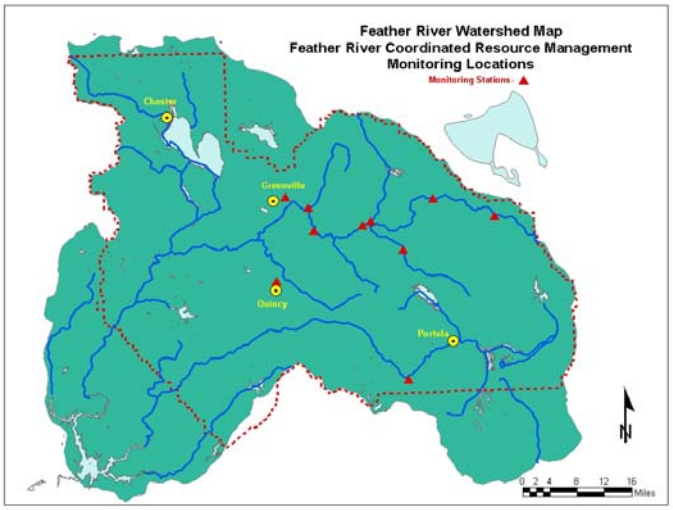

Figure 2. Location of Continuous Recording Stations (CRS)

Much of CRM's restoration efforts are concentrated on restoring the function of the watershed to store winter and spring precipitation, and release it later in the year. Continuously recorded flow data (via stage height) can help track this function of the floodplains within the Feather River watershed. Water temperature is another parameter monitored at the Continuous Recording Stations, which is biologically important due to its effect on native aquatic species. Stream flow stage, air and water temperature are read every 15 minutes by Campbell CR10X data loggers at the following monitoring sites: Red Clover Creek on Notson Bridge; Last Chance Creek at Doyle Crossing, and Million Dollar Bridge; Cottonwood Creek above and below Big Flat (not on map); Indian Creek at the DWR weir (abv Red Clover), at the Flournoy Bridge (blw Red Clover), and at the Taylorsville Bridge; Lights Creek at Deadfall Bridge; Wolf Creek at the Main Street Bridge in Greenville; Spanish Creek near Highway 70 at the Gansner Park Bridge in Quincy; and on Sulphur Creek at the Highway 89 Bridge.

The stage, air and water temperature readings are stored as hourly averages and then summarized into daily files at the end of each water year. To continuously record turbidity, Analite 195 laser sensors (a nephelometric (NTU) probe) were installed on Indian Creek (at Taylorsville Br) and Spanish Creek (at Gansner Park) in 2001. The data loggers are capable of storing up to six months of data. FRCRM staff and contract technicians download data bi-monthly to ensure reliable station operation. Because of periodic channel shifts at most of the stations monthly calibration measurements are required. Rating tables are reviewed and/or updated annually.

DWR Weather Stations

The California Department of Water Resources recently installed weather stations and one flow station in the Feather River watershed to assist in managing the water resources. In 2006, a new flow station was installed on Middle Fork Feather River near Portola (MFP) along with a DWR weather station in Thompson Valley (TVL) in the Red Clover watershed. These stations, and the two DWR weather stations installed in the Last Chance watershed in 2000 (Doyle Crossing) and 2004 (Jordan Peak), are accessible on the California Data Exchange Center (CDEC) website at www.cdec.water.ca.gov. The Taylorsville DWR weather station should soon become web (CDEC) accessible. Stream discharge and stage height are recorded at the DWR flow stations, while the DWR weather stations record rainfall, temperature, relative humidity, wind speed, wind direction, and atmospheric pressure.

Overall Findings

FR-CRM is currently collecting data. The 2006 Water Year experienced the highest annual precipitation in the last decade with 154% of historic average annual precipitation for the Feather River Basin (see Table 1). Four moderate flood events induced during the 2006 Water Year - New Years, February 27, March 25 and April 16 – are examined closely in this monitoring report.

Table 2. Precipitation averages

Water Year (10/1-9/30)	Percent of Historic Average annual precip for all Feather River Basin from CDEC*	Water Year (7/1-6/30)	Total annual precip (inches) at Indian Cr in Genesee (Wilcox data)
		1996	54.55
		1997	58.9
1998	144%	1998	60.70
1999	99%	1999	47.8
2000	101%	2000	43.65
2001	56%	2001	23.6
2002	77%	2002	33.6
2003	111%	2003	49.6
2004	83%	2004	42.8
2005	109%	2005	45.6
2006	154%	2006	68.2
			48.1 = Avg

* calculated by averaging the percent average of all reporting stations in the watershed. For 2004 there were 6/10 stations with averages (Sierraville, Vinton, Portola, Chester, Strawberry Valley, Brush Cr). For 2005, 9/10 stations were reporting (all of the above, plus Greenville, Quincy, and DeSabla). For 2006 data, 10 out of 10 stations were reporting.

I. Last Chance Creek watershed

The Last Chance watershed was designated as one of the two demonstration watersheds in the Feather River basin by FR-CRM 10 years ago. Spanish Creek was chosen as the other demonstration watershed due to its proximity to educational institutions and landowner interest. Direct management and land use change in Last Chance watershed is minimal and there is not as much urban interference in watershed function as in the Spanish Creek watershed.

Last Chance Creek

Completed in 2005, the Last Chance Creek project restored nine miles of stream in eastern Plumas County (see Table 3 for list of projects). Two weather stations in the Last Chance watershed are at Doyle Crossing and Jordan Peak and real-time data is available on the CDEC website. The Doyle Crossing continuous recording stream flow station is 4 miles downstream of the Big Flat project site on Cottonwood Creek and captures the discharge from most of the upper Last Chance watershed.

Table 3. Completion of Project work at Last Chance Creek

Year	Reach Name	Miles of Channel	Affected Acreage
1995	Big Flat on Cottonwood Cr	0.78	47
2001	Stone Dairy	0.43	20
2002	Meadowview & Artray	1.6	300
2003-4	Ferris Field I, Alkali Flat, Bird, Bird-Jordan, Ferris Cr, Jordan Flat I	4.1	800
2004	Above Charles	0.38	80
	Big Flat Modification	0.57	34
2005	Jordan Flat Supplemental	0.34	50
	Dooley Cr	1	80

Peak Flow Attenuation at Big Flat – Cottonwood Creek

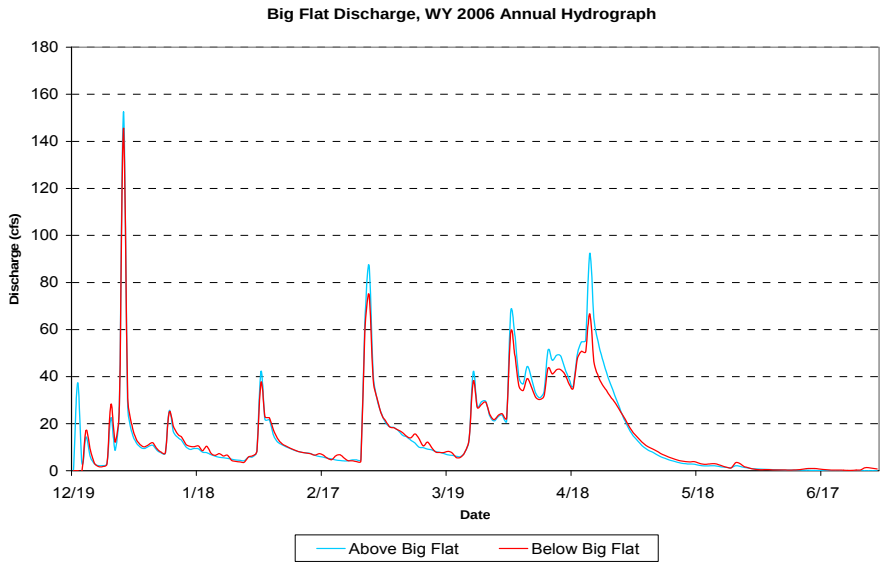

Figure 3. Annual Hydrograph recorded above and below Big Flat project area

Big Flat on Cottonwood Creek was the first pond-and-plug project implemented by FR-CRM in 1995. In the summer of 2004, a modification of 0.57 miles of channel was completed. Two winters after the completion of the channel modification, the above normal precipitation year of 2006 produced some significant results from the two continuous flow recorders installed above and below the project area. The gage readings above and below the project area show a marked flood attenuation because one would expect to see high flows at the downstream station, but the graph shows higher peaks at the upstream station (see Figure 3). The annual hydrograph shows a 15-20% reduction in flood peaks. The gage readings also show a sustained baseflow on the recession limb of the spring runoff during the 2006 water year (see Figure 3). Figure 4 more clearly illustrates the spring recession limb of daily average discharge recorded above and below the Big Flat project area. The 2006 water year shows the meadow absorbing peak flows and releasing the flows later in the year.

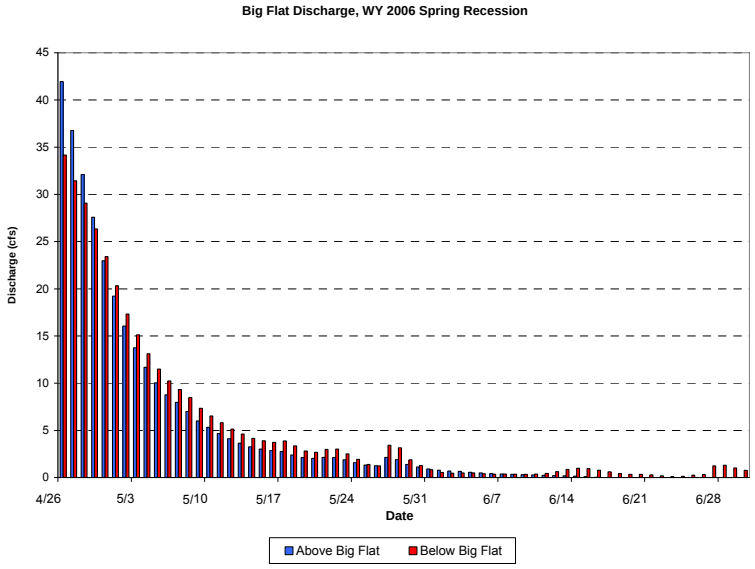

Figure 4. Discharge readings above and below Big Flat project during the Spring recession limb

The hydrograph of a late winter storm (2/28-3/22/06) during the 2006 water year takes a closer look at peak flow attenuation with a 15-20% reduction in peak discharge (see Figure 5). Figure 5 also illustrates an extended duration of surface water in Cottonwood Creek that has been recorded following the Big Flat modification of 2004.

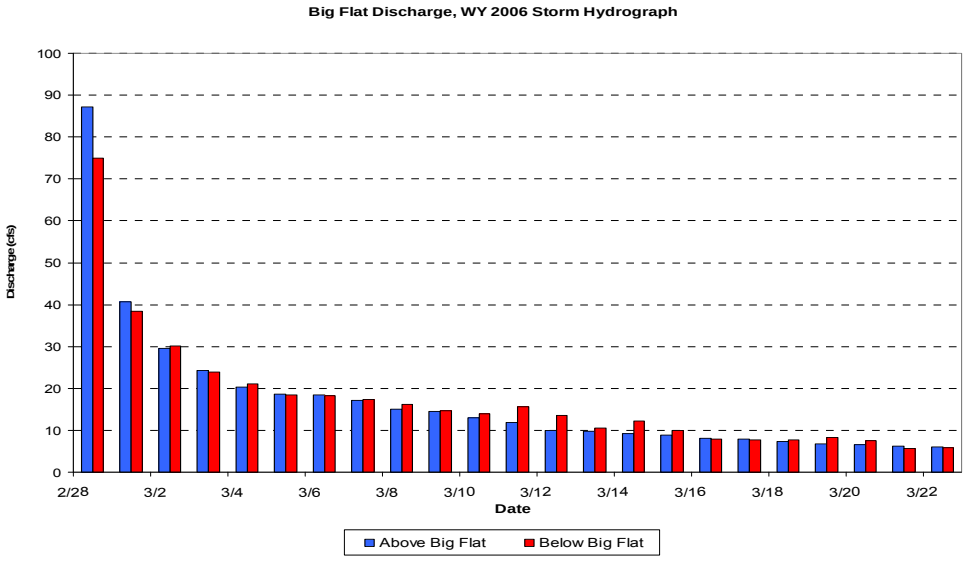

Figure 5. Storm hydrograph (2/28-3/22/06) showing discharge above and below Big Flat

Figure 6 takes a closer look at the hydrologic response of Big Flat on Cottonwood Creek to the peak flow event for WY2006 - the New Year's Flood (12/20/06-12/31/06). The graph shows a 2 day delay from when the discharge peaked above vs. below the project area. The peak flow/increased discharge appears to be attenuated and absorbed by the Big Flat meadow and gradually released back into Cottonwood Creek, sustaining a higher base flow for an extra 3 days.

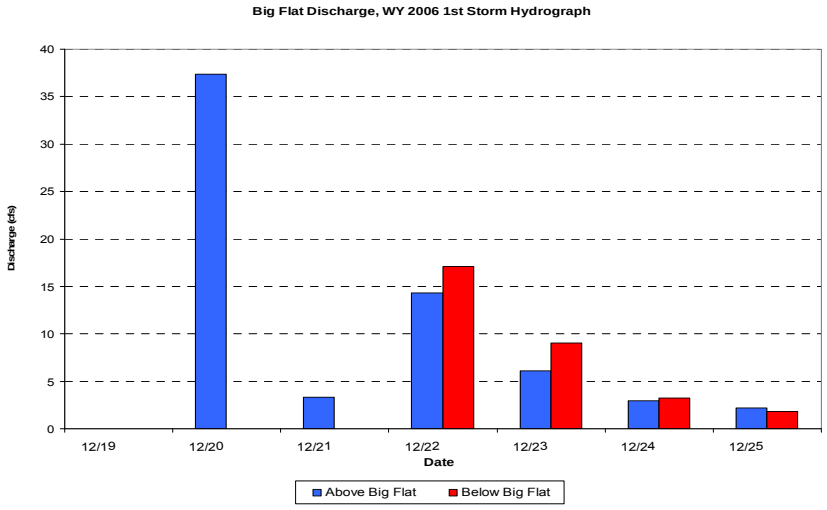

Figure 6. Close-up look at hydrologic response of Big Flat to New Year's Storm 12/20-12/25/05

Last Chance vs. Red Clover:

The annual hydrographs of these watersheds are compared to see if there is a discernable difference between the hydrologic response of Last Chance with more restored meadows and stream channel versus Red Clover with little restored floodplain area during the 2006 Water Year. Dr. Levant Kavvas (UC Davis) completed a flow model of the Last Chance watershed in 2005. The Doyle Crossing gage on Last Chance Creek measures flow from 64,000 acres of the Last Chance watershed, while Red Clover at Notson Bridge measures 69,190 acres of watershed flow. A comparison of the 2006 annual hydrographs of the Last Chance and Red Clover watersheds showed that the two watersheds have a similar response to precipitation events during the big water year. During the 2006 water year, 28.88 inches of precipitation was recorded at Doyle Crossing on the Last Chance watershed.

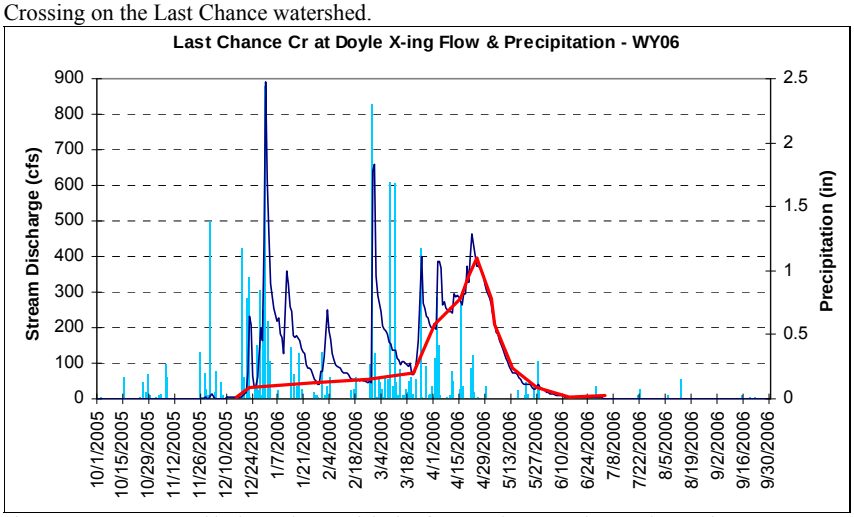

Figure 7. WY 2006 annual hydrograph & precipitation for Last Chance Creek at Doyle Crossing

The red lines in Figures 7 and 8 follow the rising limb and falling limb of base flow in Last Chance and Red Clover creeks over the 2006 Water Year. Both watersheds took a similar amount of time (130 days for Last Chance and 128 days for Red Clover) to reach the height of wetness for the 2006 water year (see Figure 7 & 8). The receding limb of the yearly hydrographs show a similar drainage response following the bulk of precipitation for WY2006 with drainage durations of 74 days for Red Clover Creek and 60 days for Last Chance Creek.

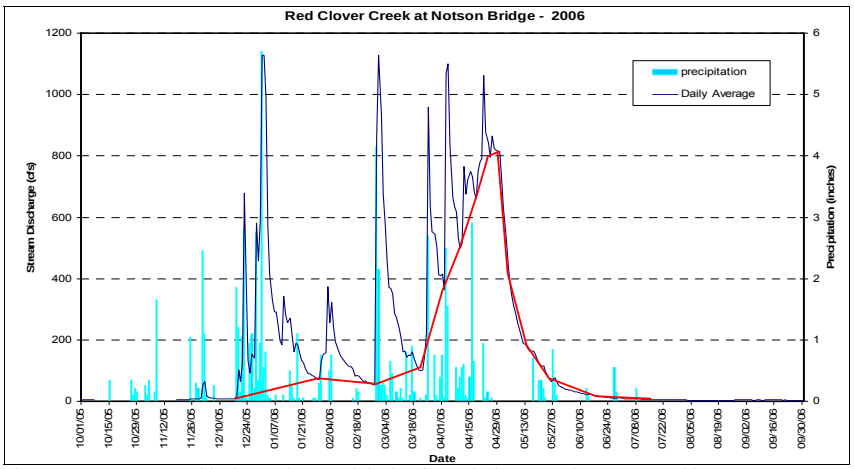

Figure 8. WY2006 annual hydrograph & precipitation for Red Clover Creek at Notson Bridge

Figures 7 and 8 also show that in dry and wet antecedent moisture conditions, the discharge of Red Clover watershed at Notson Bridge is a little less than 2 times that of Last Chance watershed at Doyle Crossing, though they exhibit similar hydrologic responses to storm events and their watershed size is almost the same. This is expected due to the greater amount of precipitation falling in the Red Clover watershed in comparison to the drier Last Chance watershed. Because of the larger volume of water, however, one would also expect that the response time of Red Clover watershed would be slower, but this is only slightly noticeable. Maybe with more of Red Clover creek restored in 2006, the next water year may show a greater difference in response time.

Unfortunately, during the New Year's Storm (12/30/05), the discharge of Red Clover at Notson Bridge exceeded the rating curve (stage height to discharge). The maximum rated discharge of Red Clover at Notson Bridge is 1129 cfs. Therefore, a comparison of the hourly hydrograph (12/30/05-1/9/06) for the New Year's Storm from the monitoring stations on Red Clover at Notson Bridge and Last Chance at Doyle Crossing does not yield definitive data. The following hourly storm hydrograph from the two monitoring stations on Last Chance and Red Clover does suggest a steeper recession limb of the peak flow on Red Clover, though the data is not conclusive.

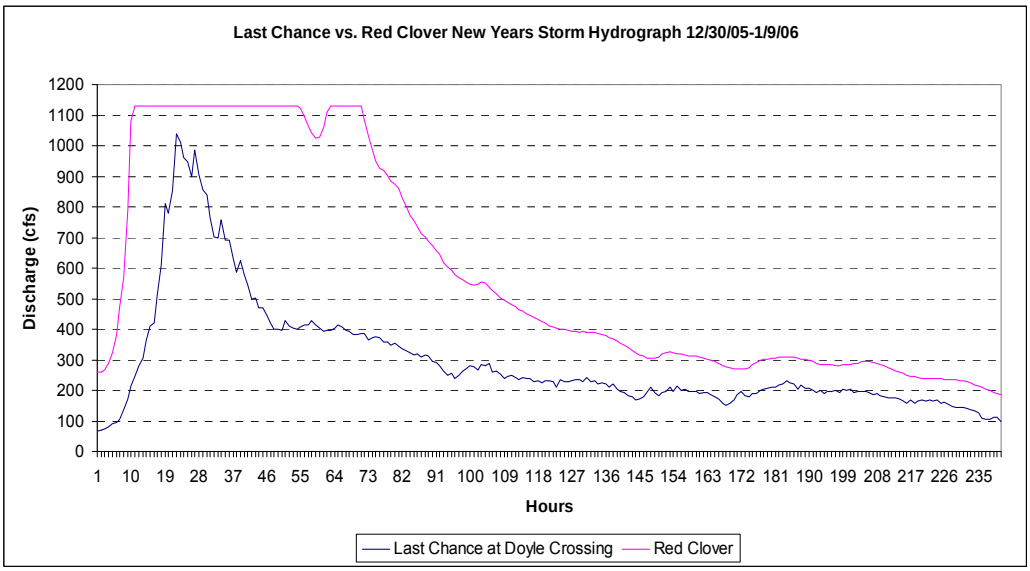

Figure 9. New Years Storm hydrograph for Last Chance & Red Clover Creeks

Last Chance Creek flow in wetter vs. drier water years:

Comparing precipitation and discharge at Doyle Crossing on Last Chance Creek, Figure 10 shows the different flow responses to rainfall in a drier (2005) vs. wetter (2006) water year. During the above normal precipitation water year of 2006, peak flow appeared at the end of December, whereas the peak flow during the drier 2005 water year did not appear until the end of March. Peak watershed wetness was achieved earlier in the 2006 water year.

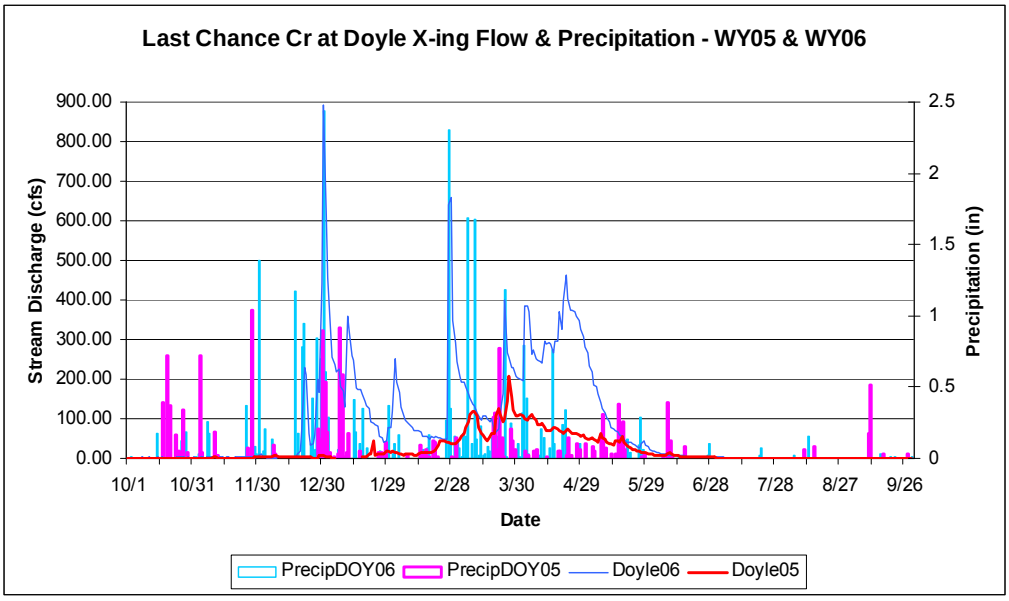

Figure 10. Rainfall and flow at Doyle Crossing on Last Chance Creek in WY 2005 and WY 2006.

Temperature in Last Chance Watershed above and below project sites:

The following graphs show temperature readings 2 years after project completion above and below four project sites (constructed 2003-4) in the Last Chance Watershed: Bird, Jordan Flat, Alkali Flat and Ferris Creek. Bird, Jordan Flat and Alkali Flat are all reaches of Last Chance Creek, with Ferris Creek as a tributary. Jordan Flat had some supplemental project work done in 2005.

Looking at one-time Maximum Daily Water Temperature (°F) readings in WY2006, temperatures at Alkali Flat show a decrease of 8°F and samples from Bird show a 2°F temperature decrease from the top to the bottom of the project area (see Figure 11). The slight increase in temperature at Jordan Flat may be due to a spring that enters Last Chance Creek at the top of the Jordan reach.

Maximum Weekly Water Temperatures (°F) decreased in WY 2006 at Jordan Flat and Alkali Flat project sites by 1°F and 6°F respectively (see Figure 12). Maximum daily and weekly water temperatures recorded above and below Ferris Creek remained stable with undetectable change (Figures 11 & 12).

Figure 13 shows that aside from the Jordan Flat project, which received modification work in the summer of 2005, two years after project completion on Bird, Alkali Flat and Ferris Creek, diurnal water temperature fluctuations decrease dramatically from above the project site to below the project site. Results show diurnal fluctuations of water temperature decrease 13°F through Alkali Flat, 2°F through the Ferris Creek project site, and 3°F through the Bird project in the Last Chance watershed (Figure 13).

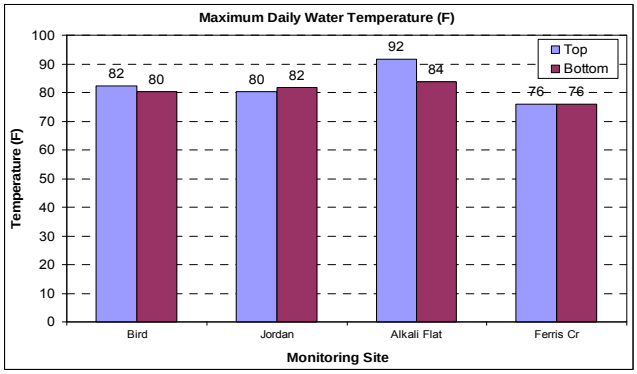

Figure 11. Maximum Daily Water Temperature above & below Last Chance projects

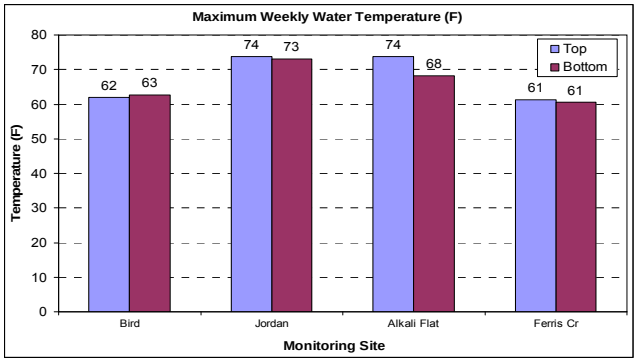

Figure 12. Maximum Weekly Water Temperature abv & blw Last Chance projects

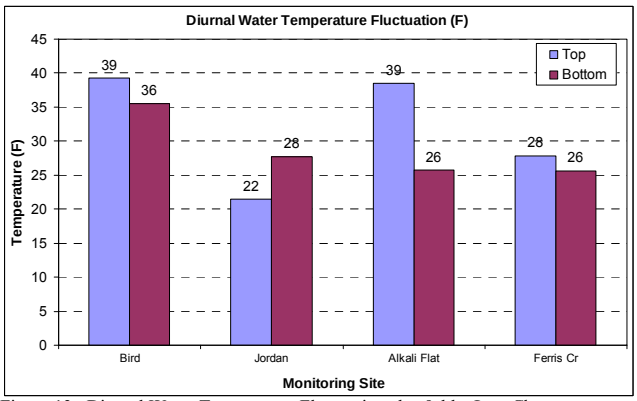

Figure 13. Diurnal Water Temperature Fluctuation abv & blw Last Chance projects

Figure 14 illustrates the dramatic reduction of weekly average water temperature readings that exceed 70°F (considered harmful to coldwater trout fisheries) in water that flows through the Alkali Flat project area. Above the project area, 11 readings of weekly average temperature above 70°F were recorded, whereas none were recorded in the stream channel as it flows out of the project area. Having experienced the most recent project construction, Jordan Flat does not exhibit a change in the number of weekly average temperature readings exceeding 70°F. The spring entering Last Chance at the top of the Jordan reach may also be cooling the flow entering the project area.

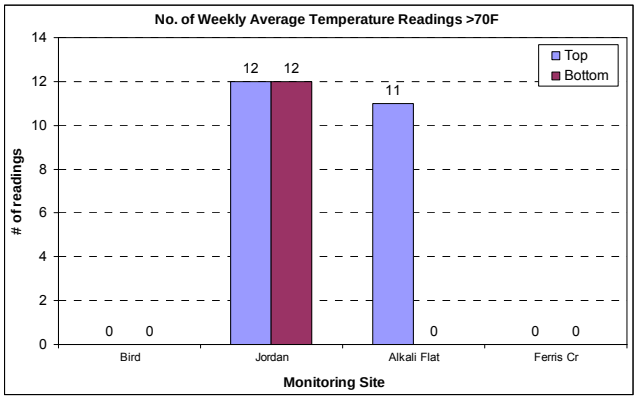

Figure 14. Number of Weekly Average Temperature Readings >70F abv & blw Last Chance projects

Figures 14 and 15 show that no weekly average temperature readings at the Bird or Ferris Creek project areas exceeded 66°F, and thereby are not considered impaired cold water fish habitat. Just one year after supplemental meadow restoration work on Jordan Flat, there are 11 fewer weekly average water temperature readings exceeding 66°F below the project area than were measured above (49 vs. 38 readings). As Figure 14 illustrates, Figure 15 also shows a dramatic reduction in weekly average water temperature readings exceeding 66°F through the Alkali Flat project area with 44 readings above vs. 10 below.

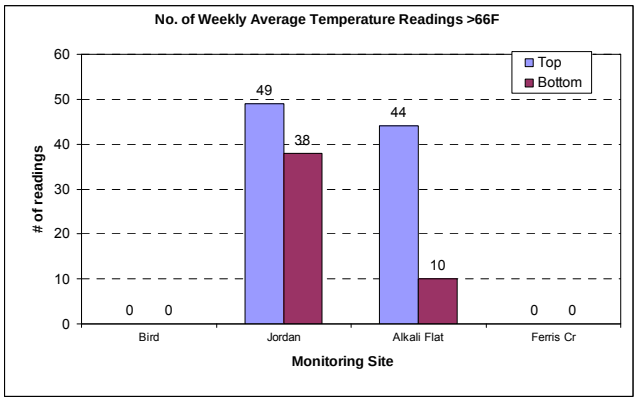

Figure 15. Number of Weekly Average Temperature Readings >66F abv & blw Last Chance projects

Figure 16 illustrates a reduction at all four project sites on Last Chance Creek in hourly temperature readings exceeding 75°F below vs. above the project area. The most dramatic reduction in the number of hourly temperature readings was recorded at Alkali Flat with 291 readings above the project area compared with 16 below. Hourly temperature readings exceeding 75°F are considered lethal to coldwater fish populations, and all of the project sites record a reduction in such readings through the project areas.

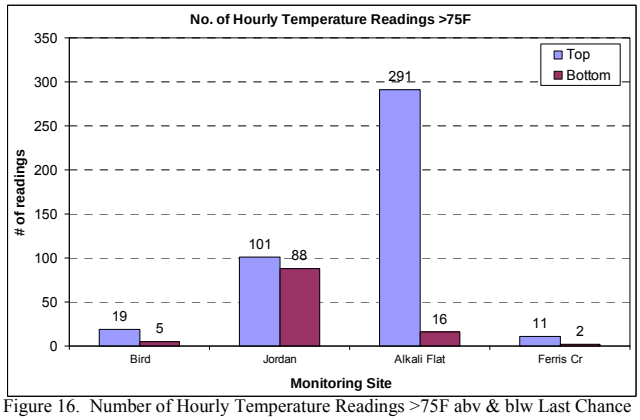

Figure 16. Number of Hourly Temperature Readings >75F abv & blw Last Chance projects

Watershed Temperature

The Central Valley Regional Water Quality Control Board has identified water temperature as a concern in the Feather River. A variety of water temperature parameters were used to compare between sites, and between years at each site to track trends in different water temperature parameters. Water temperature parameters were analyzed for six continuous recording stations with usable low flow data (all of which are in the Indian Creek subwatershed). The temperature sensor at Wolf Creek has been buried by sediment in 2005 & 2006, thus the data are inaccurate and not included in these analyses.

Maximum daily water temperature

Figure 17 graphs the highest 1 hour-long temperature that was recorded during the annual sampling period, which is a function of air temperature, volume of water, and surface interval for insolation. While the station on Indian Creek above the confluence with Red Clover maintains a fairly low daily maximum temperature from 2000-06, the maximum daily water temperature at Red Clover creek at Notson Bridge increased by about 10 degrees Fahrenheit in 2006. A warming influence of Red Clover Creek on Indian Creek is apparent with the higher maximum daily water temperatures on Indian Creek below the confluence with Red Clover (Flournoy) vs. above the confluence (DWR weir) in 2000-06 (except for 2002).

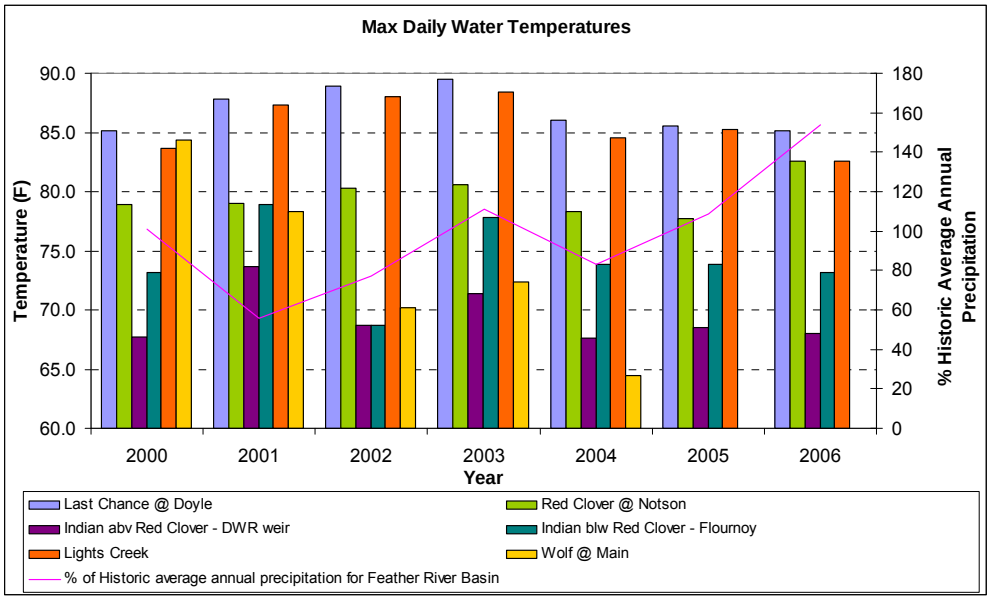

Figure 17. Maximum Daily Water Temperatures recorded 2000-06

Despite the warmer max water temperature on Red Clover Creek in 2006, no extra warming influence is noticeable on Indian Creek, based on temperature readings at Flournoy in 2005 vs. 2006. Wolf Creek portrays a fairly steady decrease in maximum daily water temperatures from 2000-04 (inaccurate data in '05-'06 due to buried sensor). Increase in riparian vegetation from drought years and CRM's restoration projects above the gage in 1992 (Wolf Creek, Phase 3), and 2002 (Anson bank) may be contributing factors to the maximum daily temperature decrease. Beaver dams on the reach have also increased water depth throughout. The maximum water temperature recorded on Last Chance Creek at Doyle Crossing has also been declining since 2003, despite the 8 miles of untreated stream channel above the gage where insolation can occur.

Maximum weekly average water temperature

The graph of maximum weekly average water temperatures (Figure 18) shows that Lights and Last Chance Creeks are consistently the two warmest channels, based on the highest of the running seven-day averages calculated throughout the sampling period from 2000-06. During the high precipitation water year of 2006, Red Clover Creek at Notson Bridge exhibited a dramatically higher maximum weekly average water temperature,

but it does not appear to have had an extra warming influence on Indian Creek above the normal temperature increase with the confluence of Red Clover.

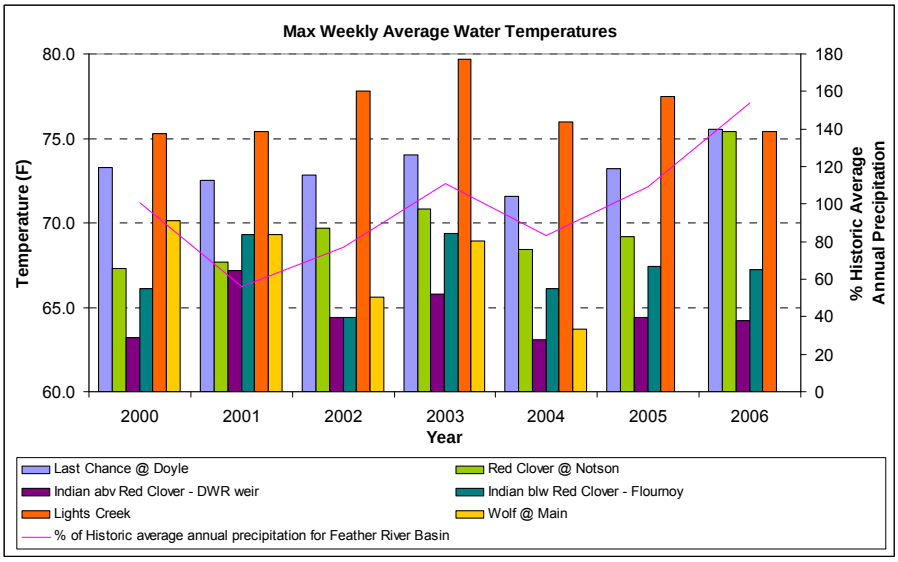

Figure 18. Maximum Weekly Average Water Temperatures 2000-06 at Continuous Recording Stations

Weekly Average Water Temperatures >66°F

Figure 19 displays the number of running seven day averages that were greater than 66 degrees Fahrenheit. This water temperature parameter is of biological importance since water that has an average temperature greater than 66°F for seven days is considered not conducive to a coldwater fishery. Lights Creek and Last Chance Creek consistently have the highest number of weekly average water temperatures greater than 66°F. There appears to be an inverse relationship between the number of weekly average water temperature exceedences and percent historical average annual precipitation on Lights Creek. In other words, wetter precipitation years have fewer periods of weekly average temperatures exceeding 66°F and drier precipitation years have an increased number of such periods.

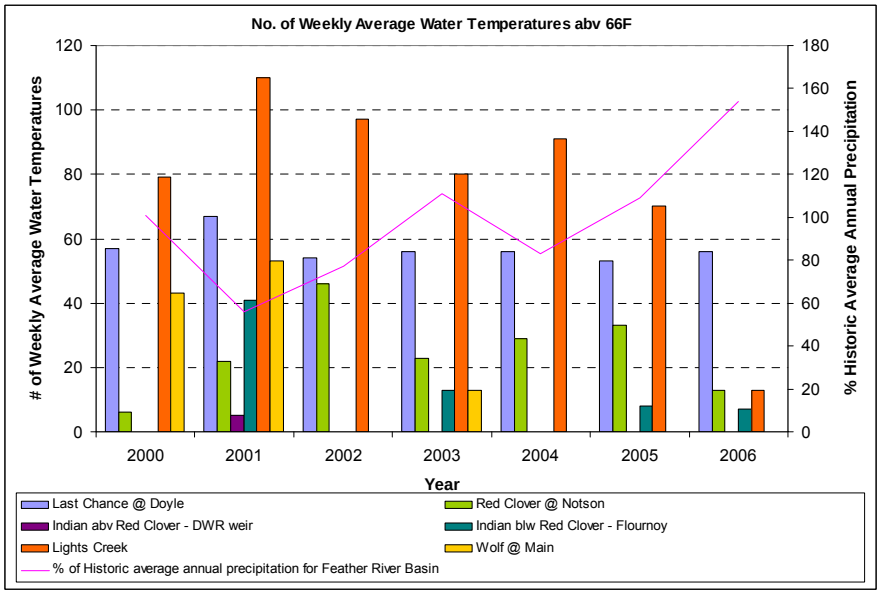

Figure 19. Number of Weekly Average Water Temperatures above 66F from 2000-06

Daily Maximum Water Temperature >75°F

Figure 20 displays the number of days that had an absolute 1-hour long temperature greater than 75°F among the six continuous recording stations with usable low flow data from 2000-06. A reading greater than 75°F can be lethal to coldwater fisheries, even if it is just a short-term maximum temperature reading. Based on the above two figures indicating the impairment of waters for trout fisheries, Last Chance and Lights Creeks appear to be the most impaired creeks monitored over the last 6 years. However, on Last Chance Creek, there is a significant downward trend in the number of days with maximum water temperatures above 75°F from 2001-06. The dramatic decline in number of days with maximum water temperature above 75°F is apparent in spite of the 8 mile distance (where insolation can occur) from the end of the project work on Last Chance Creek and the monitoring station at Doyle Crossing. On Red Clover Creek at Notson Bridge, the number of days with max water temperatures above 75°F has also been declining since 2002, though not as steadily as Last Chance Creek.

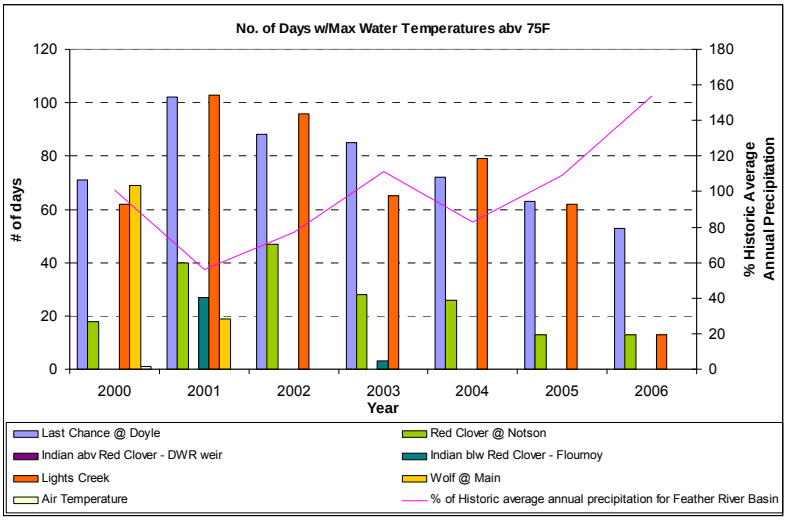

Figure 20. Number of days with maximum water temperature above 75F recorded from 2000-06

Maximum summer diurnal water temperature fluctuation

Figure 21 displays the greatest fluctuation in temperature in a 24-hour period during the sampling period. Since this parameter is heavily dependent on the volume of water and elevation, a comparison between years at the same site is most appropriate. Last Chance at Doyle Crossing exhibits a significant downward trend in diurnal fluctuation of maximum summer water temperature from 2004-06. Over the entire six year record, Wolf Creek portrays the most obvious decreasing trend in maximum water temperature diurnal fluctuation during the summer. Such a change could be due to a combination of factors such as increased riparian vegetation, CRM's restoration projects upstream of the gage, and beaver dams increasing water depth.

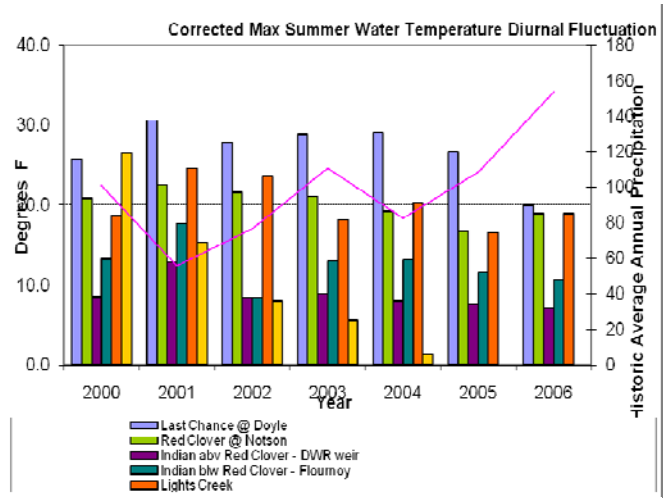

Figure 21. Maximum summer water temperature diurnal fluctuation recorded from 2000-06

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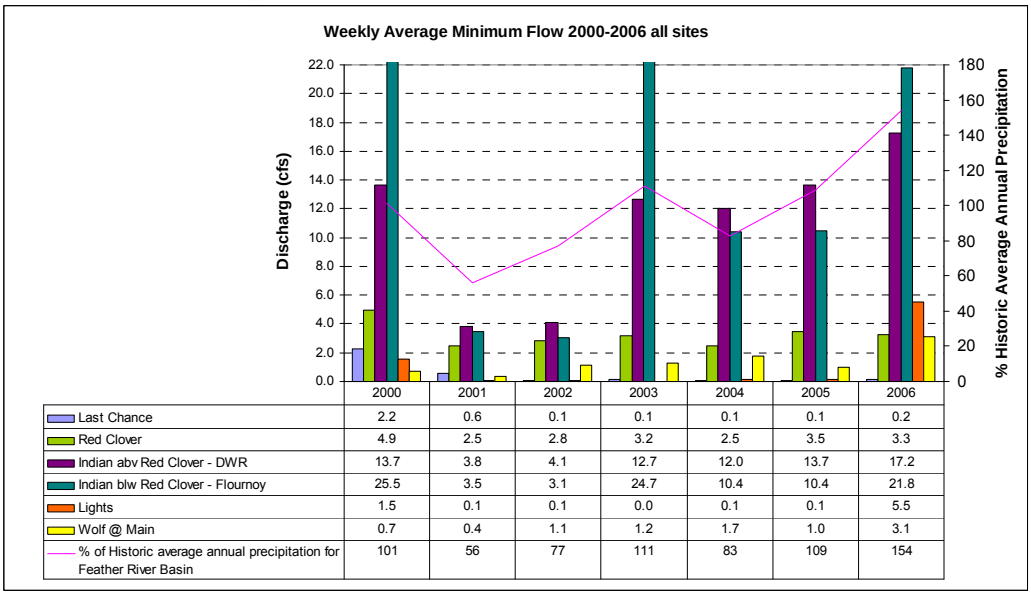
Temperature Impairment in the watershed

Last Chance Creek at Doyle Crossing continues to be the most heavily temperature impaired channel, followed by Red Clover and Lights Creeks. Locally high temperature readings at Doyle Crossing on Last Chance Creek can be attributed to enhanced solar collection from water sheeting over bedrock and a 400-foot long open pool above the recording station. Nevertheless, the previous two graphs (figure 20 & 21) exhibit downward trends in daily maximum water temperatures and diurnal fluctuations during the summer on Last Chance Creek at Doyle Crossing. The temperature impairment of Red Clover and Lights Creeks are assumed to be from channel degradation.

Weekly Average Minimum Flow

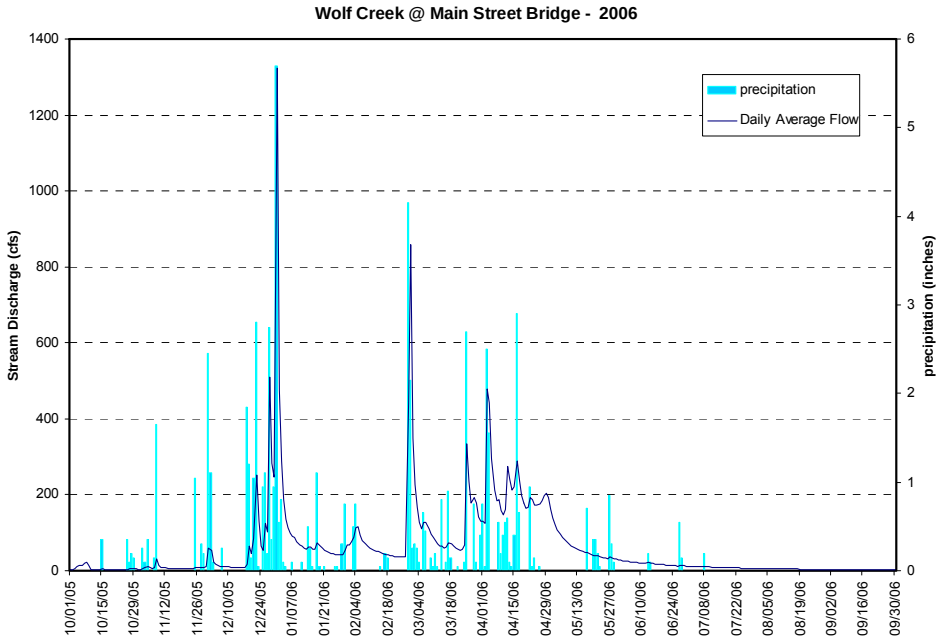
Figure 22 shows minimum weekly average flows (discharge in cfs) across the six continuous recording sites in the Indian Creek watershed from 2000-06. During the 2006 water year, the weekly average minimum flow recorded on Indian Creek below Red Clover at Flournoy Bridge (21.8 cfs) was over twice the minimum weekly average discharge (cfs) recorded in the 2005 Water Year (10.4 cfs). As precipitation levels increased from 2004-2006 water years, minimum flows on Indian Creek above Red Clover (DWR weir station) have followed a dramatic upward trend from 12 cfs in WY2004 to 17.2 cfs in WY2006, although this is a regulated system. Minimum weekly average flow on Red Clover at Notson Bridge stayed fairly stable through precipitation changes over the monitoring years, though Lights Creek and Wolf Creek exhibited higher weekly average minimum flows than in the past six years.

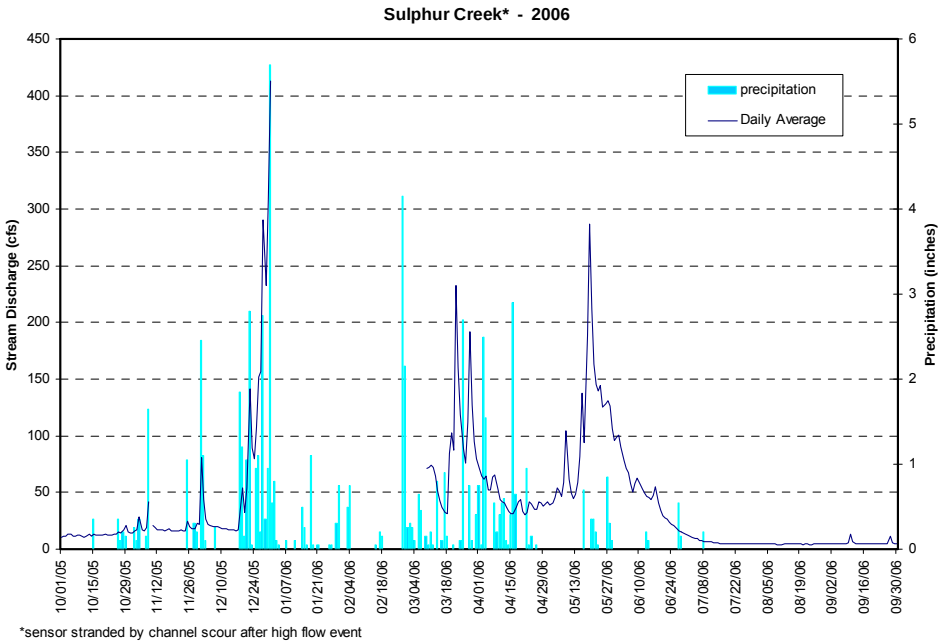


	2000	2001	2002	2003	2004	2005	2006
Last Chance	2.2	0.6	0.1	0.1	0.1	0.1	0.2
Red Clover	4.9	2.5	2.8	3.2	2.5	3.5	3.3
Indian abv Red Clover - DWR	13.7	3.8	4.1	12.7	12.0	13.7	17.2
Indian blw Red Clover - Flournoy	25.5	3.5	3.1	24.7	10.4	10.4	21.8
Lights	1.5	0.1	0.1	0.0	0.1	0.1	5.5
Wolf @ Main	0.7	0.4	1.1	1.2	1.7	1.0	3.1
% of Historic average annual precipitation for Feather River Basin	101	56	77	111	83	109	154

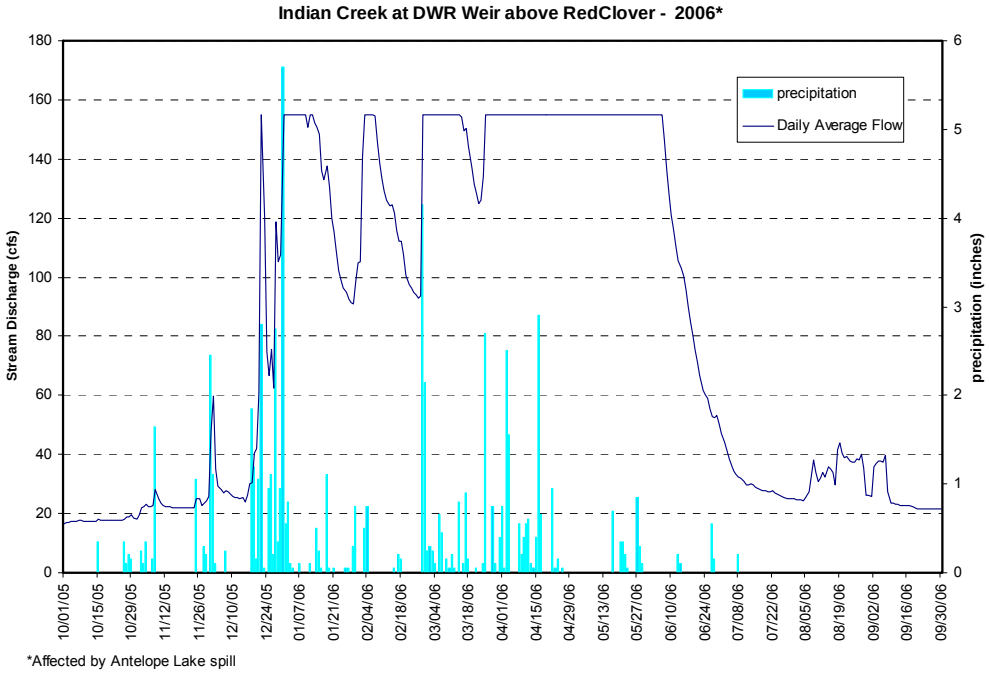
Figure 22. Weekly Average Minimum Flow from 2000-06 across CRS sites in Indian Creek Watershed

Appendix A. Annual hydrographs for continuous recording stations WY2006 (with precipitation at Genesee)

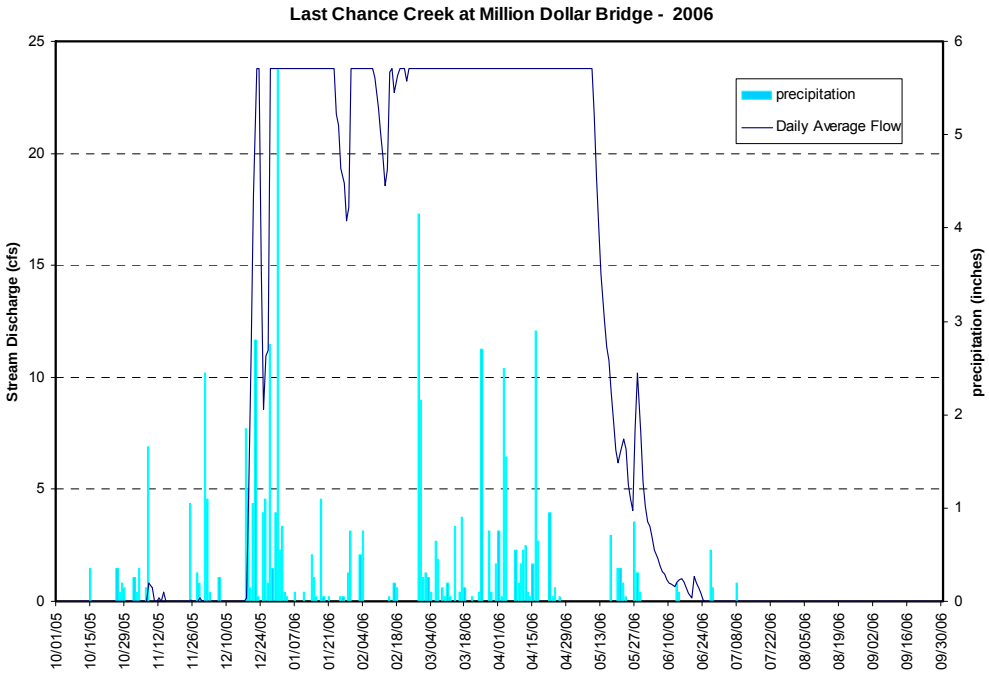


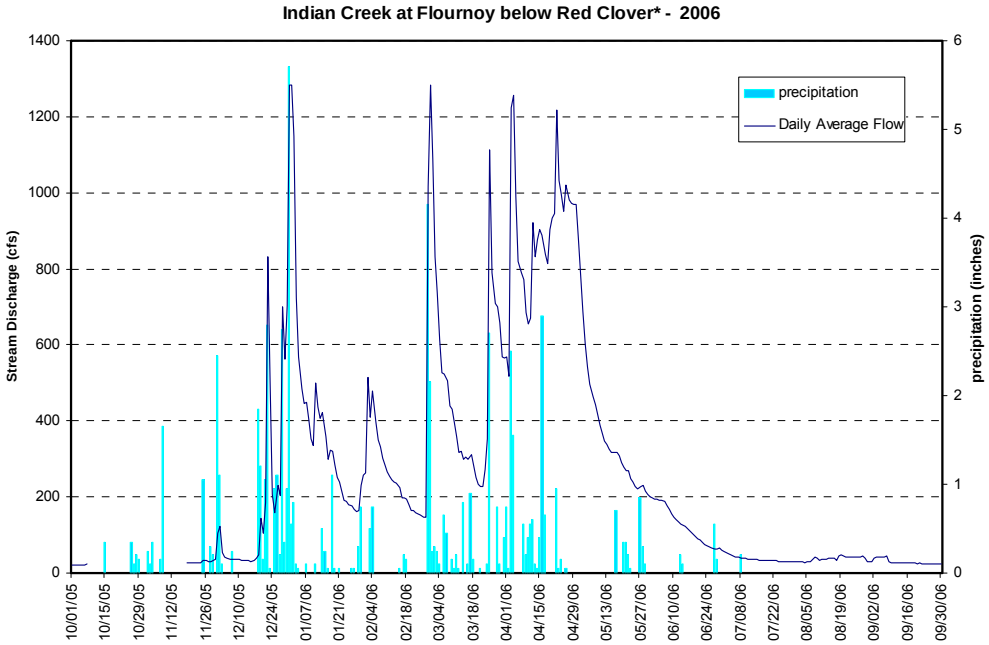


*sensor stranded by channel scour after high flow event

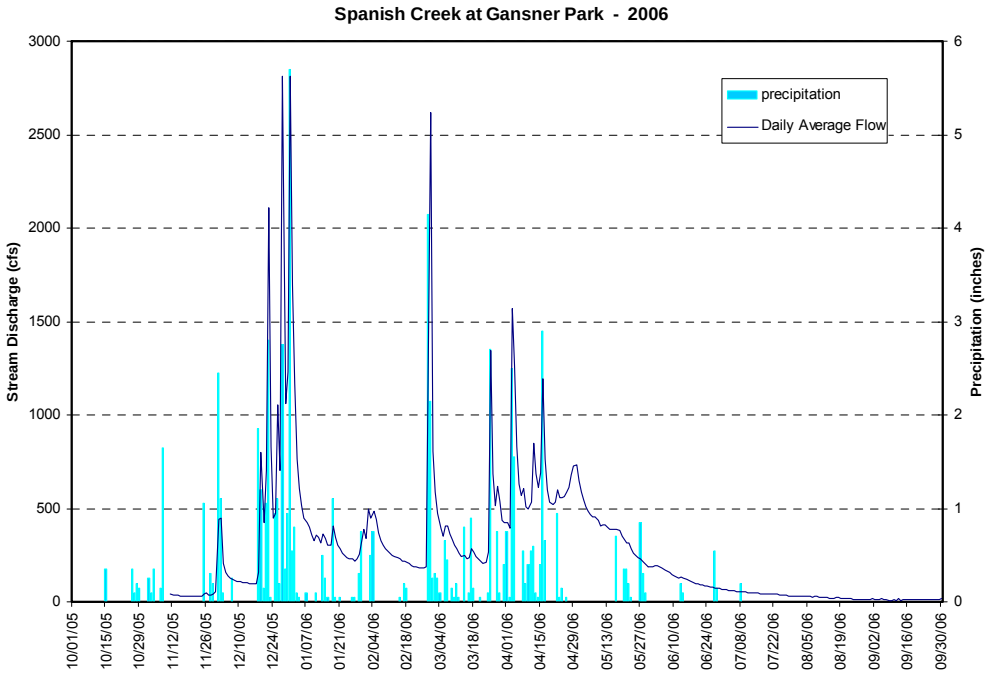


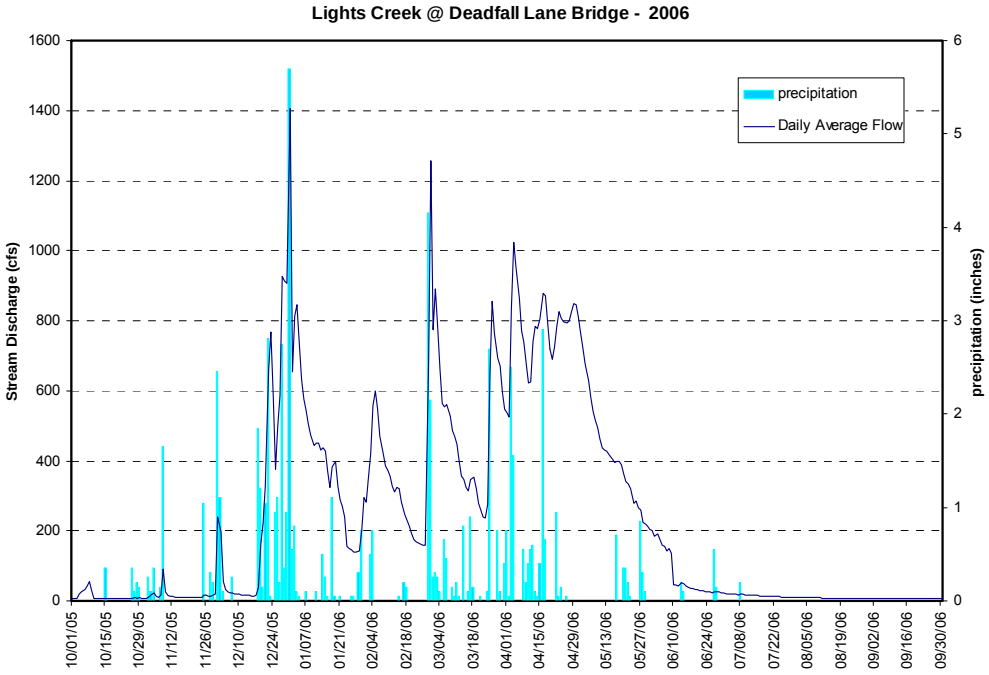
*Affected by Antelope Lake spill





*Discharge is Synthetic Estimate = DWR + Notson




Lights Creek @ Deadfall Lane Bridge - 2006
Stream Discharge (cfs)
precipitation (inches)
precipitation
Daily Average Flow
0
200
400
600
800
1000
1200
1400
1600
0
1
2
3
4
5
6
10/01/05
10/15/05
10/29/05
11/12/05
11/26/05
12/10/05
12/24/05
01/07/06
01/21/06
02/04/06
02/18/06
03/04/06
03/18/06
04/01/06
04/15/06
04/29/06
05/13/06
05/27/06
06/10/06
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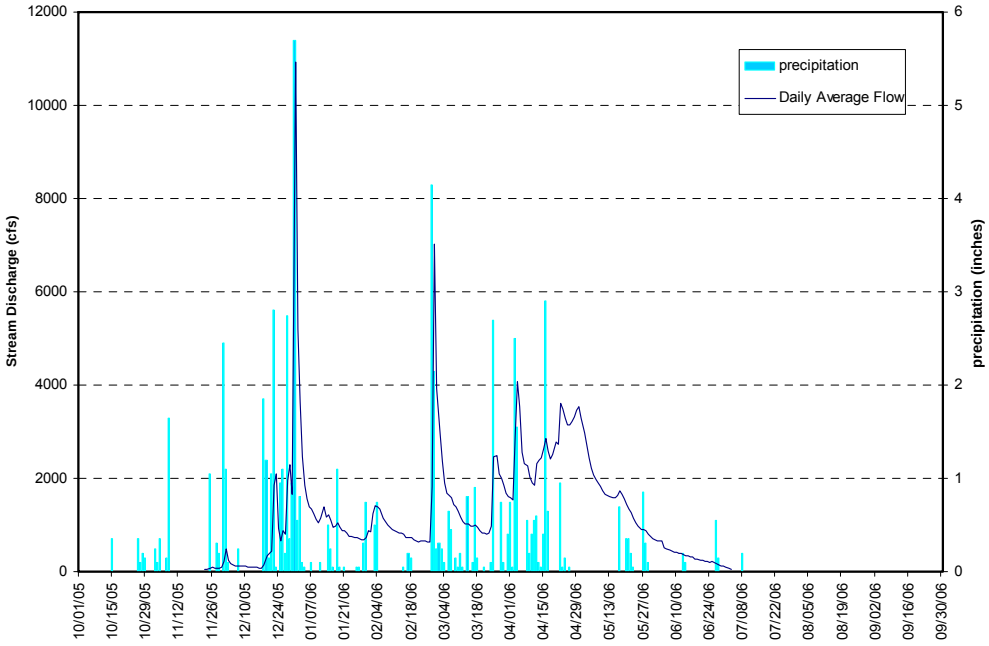
08/19/06
09/02/06
09/16/06
09/30/06


Indian Creek at Taylorsville - 2006
Stream Discharge (cfs)
precipitation (inches)
precipitation
Daily Average Flow
0
2000
4000
6000
8000
10000
12000
0
1
2
3
4
5
6
10/01/05
10/15/05
10/29/05
11/12/05
11/26/05
12/10/05
12/24/05
01/07/06
01/21/06
02/04/06
02/18/06
03/04/06
03/18/06
04/01/06
04/15/06
04/29/06
05/13/06
05/27/06
06/10/06
06/24/06
07/08/06
07/22/06
08/05/06
08/19/06
09/02/06
09/16/06
09/30/06

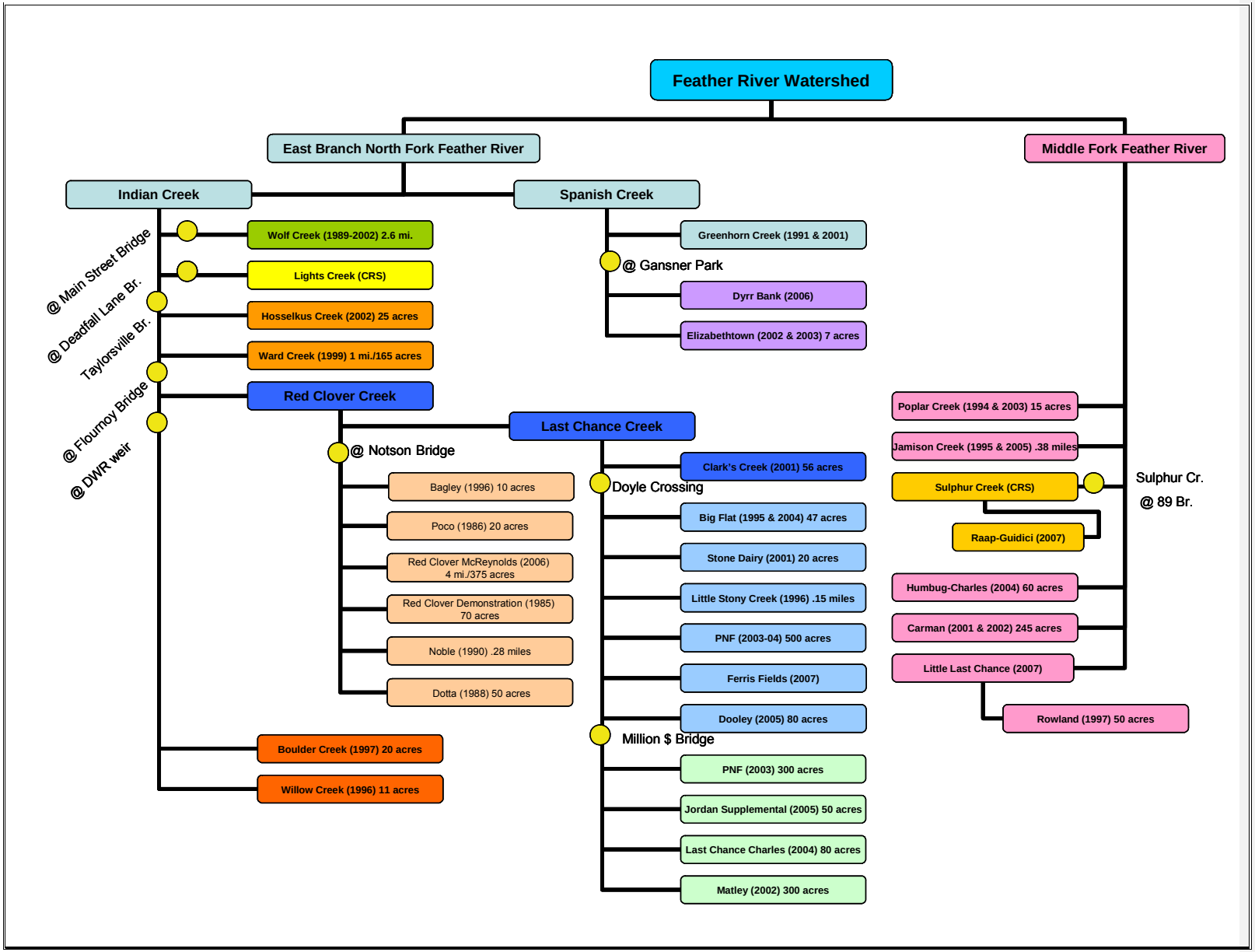
Conclusion:

The 2006 Water Year was an interesting water year for the Feather River Watershed Monitoring Program, due to the series of high flow events and associated hydrologic effects on meadow restoration project areas in the watershed. Many project areas are exhibiting watershed benefits of water temperature and peak flow reduction (i.e. Cottonwood Creek-Big Flat and Alkali Flat). As FR-CRM continues to collect data at the continuous recording stations, the value of the monitoring program is growing. With some necessary maintenance at the continuous recording stations, stronger results from meadow restoration are foreseen in the watershed monitoring program.

Maintenance:

The continuous recording stations (CRS) with performance issues include Wolf Creek @ Main Street Bridge, Lights Creek, Indian Creek @ Taylorsville, and Sulphur Creek @ Hwy 89. The transducer box at Wolf Creek has been continuously buried by sediment for the past 3 Water Years, therefore the water temperature data is unreliable. Due to the apparent instability of the bedload moving through the reach above and below the Main Street bridge in Greenville, FR-CRM has been discussing the potential to install a new station further downstream. The proposed new location is directly upstream of the bridge on Hot Springs Road on the east side of Hwy 89, providing access to the Greenville ball field. The location is directly downstream of FR-CRM's Wolf Creek Phase 2 project, and there is a nice gage pool provided by an old alder tree that creates a nice scour hole and would help disguise the transducer box. Another benefit of the location is that the bridge does not receive as much daily traffic as the Main Street bridge, so installing an air temperature sensor may be another possibility (since the air temperature sensor was bent & broken by passers-by at the other location). In conclusion, the current location of the water level and temperature transducer on Wolf Creek is very dynamic and the ball field bridge further downstream seems more stable with boulders directing the flow to the center of the channel.

The transducers on Lights Creek and on Indian Creek at Taylorsville go dry when both creeks drop to summer baseflow. The transducer box at Lights Creek, currently anchored on a large boulder, needs to be lowered deeper into the creek. The staff gage should also be relocated to accommodate lower stage readings. In Taylorsville, when Plumas County Department of Public Works finishes replacing the guard rails on the bridge spanning Indian Creek at the Rodeo grounds, the transducer box needs to be moved toward the center of the channel, since the left channel has become blocked with sediment and willows. This will require running a conduit along the new guard rail and down one of the center bridge abutments. The staff gage should also be relocated so that local citizen monitors can easily read the water level.


Feather River Watershed
East Branch North Fork Feather River
Middle Fork Feather River
Indian Creek
Spanish Creek
@ Main Street Bridge
@ Deadfall Lane Br.
Taylorsville Br.
@ Flournoy Bridge
@ DWR weir
Wolf Creek (1989-2002) 2.6 mi.
Lights Creek (CRS)
Hosselkus Creek (2002) 25 acres
Ward Creek (1999) 1 mi./165 acres
Red Clover Creek
Boulder Creek (1997) 20 acres
Willow Creek (1996) 11 acres
Greenhorn Creek (1991 & 2001)
@ Gansner Park
Dyrr Bank (2006)
Elizabethtown (2002 & 2003) 7 acres
Last Chance Creek
@ Notson Bridge
Bagley (1996) 10 acres
Poco (1986) 20 acres
Red Clover McReynolds (2006) 4 mi./375 acres
Red Clover Demonstration (1985) 70 acres
Noble (1990) .28 miles
Dotta (1988) 50 acres
Clark's Creek (2001) 56 acres
Doyle Crossing
Big Flat (1995 & 2004) 47 acres
Stone Dairy (2001) 20 acres
Little Stony Creek (1996) .15 miles
PNF (2003-04) 500 acres
Ferris Fields (2007)
Dooley (2005) 80 acres
Million $ Bridge
PNF (2003) 300 acres
Jordan Supplemental (2005) 50 acres
Last Chance Charles (2004) 80 acres
Matley (2002) 300 acres
Poplar Creek (1994 & 2003) 15 acres
Jamison Creek (1995 & 2005) .38 miles
Sulphur Creek (CRS)
Raap-Guidici (2007)
Humbug-Charles (2004) 60 acres
Carman (2001 & 2002) 245 acres
Little Last Chance (2007)
Rowland (1997) 50 acres
Sulphur Cr.
@ 89 Br.