Shasta River Tailwater Reduction: Demonstration and Implementation Project

Final Project Report

Proposition 40/50- Agricultural Water Quality Grant

State Water Resources Control Board

Grant Agreement No. 09-666-551

Total Grant Funds $751,442

December 2013

Presented by:
AquaTerra Consulting
Weed, California

For:
Shasta Valley Resource Conservation District
Yreka, CA

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GRANT SUMMARY

Completed Grant Summaries are made available to the public on the State Water Resources Control Board's (SWRCB) website at http://www.waterboards.ca.gov/funding/grantinfo.html
Use the tab and arrow keys to move through the form. If field is not applicable, please put N/A in field.
Date filled out: 12/20/13

Grant Information: *Please use complete phrases/sentences. Fields will expand as you type.*

1. Grant Agreement Number: 09-666-551

2. **Project Title:** Shasta River Watershed Tailwater Reduction Project (Phase 2)

3. **Project Purpose – Problem Being Addressed:** improving water quality in the Shasta River by decreasing temperatures and increasing dissolved oxygen through improved agricultural water management.

4. Project Goals

a. **Short-term Goals:** Reduce the amount of agricultural run-off (tailwater) that returns to the Shasta.

b. **Long-term Goals:** Improved water quality.

5. **Project Location:** (lat/longs, watershed, etc.) Shasta River, Klamath Watershed.

a. **Physical Size of Project:** (miles, acres, sq. ft., etc.) 790 sq miles

b. Counties Included in the Project: Siskiyou County

c. **Legislative Districts:** (Assembly and Senate) State Assembly=2 State Senate=4

6. Which SWRCB program is funding this grant? Please "X" box that applies.

☐ Prop 13 ☐ Prop 40 ☐ Prop 50 ☒ EPA 319(h) ☐ Other

Grant Contact: *Refers to Grant Project Director.*

Name: Dave Webb **Job Title:** Project Coordinator

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Grant Time Frame: *Refers to the implementation period of the grant.*

From: January 2010 **To:** March 2013

Project Partner Information: *Name all agencies/groups involved with project.* Natural Resources Conservation Service

Nutrient and Sediment Load Reduction Projection: (If applicable) NA

Please provide a hard copy to your Grant Manager and an electronic copy to your Program Analyst for SWRCB website posting. All applicable fields are mandatory. Incomplete forms will be returned.

Executive Summary

This project further developed the watershed-wide planned and prioritized approach that guided efforts to reduce tailwater's negative impacts to water quality. The prioritization approach is split into three different criteria: tailwater impacts, project screening and project scoring.

After high priority neighborhoods were identified and prioritized for impacts, outreach to individuals and neighbors in high priority tailwater areas was initiated to solicit the planning and development of tailwater reduction projects. A list of potential projects was created and scored based on the screening criteria to ensure the project would be aligned with the goals of the project. Once screening was completed more in-depth project planning was initiated and project scoring was finalized. A total of six projects were funded through this agreement and went through this scoring process. Three of the project were tailwater re-use improvement projects, two were efficiency projects and one was a diversion redesign.

Piping of the irrigation ditches is intended to improve water use efficiency for landowners (reducing the amount of water needed for irrigation), thus reducing the amount of tailwater returning to the Shasta River. The tailwater re-use improvement projects allow irrigators to more readily use tailwater, in-lieu of diverting a water right out of the river. The diversion redesign assisted a landowner to have a more consistent supply of irrigation water, reducing surprise flows and reducing unintended tailwater. Projects were implemented throughout the grant term, including during the last quarter of the grant timeline. Pre-project monitoring data was established for most of the projects and post project monitoring was obtained for four of the six. Any additional post project monitoring will occur in 2014. It should be noted that post project monitoring for projects implemented during Phase 1 of the tailwater project, is also reported in the water quality improvement report included in the appendix of this final report.

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Introduction

This project is located in the Shasta River Watershed, an important cold-water tributary to the Klamath River Basin in Northern California (see Figure 1). The Shasta River Watershed encompasses over 790 square miles and includes over 120 miles of streams. In 2005 the Southern Oregon and Northern California Coho (SONCC) salmon was listed as threatened by the State of California. In 2007, the Environmental Protection Agency formally adopted a Total Maximum Daily Load (TMDL) for the Shasta River, which lists the river as being impaired for elevated temperature and low dissolved oxygen levels. A majority of the Shasta River Watershed is in private ownership with some federal land-holdings mostly in the headwaters. Private land management activities adjacent to the Shasta River mainly consist of small cow-calf and hay farming operations, which predominantly depend on numerous surface water diversions from the Shasta River and tributary streams and springs to flood irrigate pastures.

Agricultural run-off or "tailwater" is identified in the Shasta River TMDL as being a major contributor to the poor water quality conditions in the river. Since 1991, the Shasta Valley RCD (SVRCD) has been looking at ways to reduce tailwater return flows and improve water quality throughout the valley while ensuring that agricultural operations would remain solvent. Prior to the original tailwater reduction funding, there was no watershed-wide planned approach to tackle tailwater return impacts.

This final report represents the results of this multi-year effort to continue to implement tailwater reduction efforts and change water management strategies to improve conditions for anadromous fish. Projects funded through this grant provide examples to other irrigators on how to make substantative improvements to protect water quality. Through outreach and education the SVRCD can point to these projects as successes for both improving water quality and ranch production.

Other contributing funders for this project include: the Natural Resources Conservation Service and the Shasta Valley Resources Conservation District.

1.0 Problem Statement

Pursuant to Section 303(d) of the Federal Clean Water Act, the USEPA listed the Shasta River as impaired due to organic enrichment/low dissolved oxygen levels in 1992, and for elevated stream temperatures in 1994. Low dissolved oxygen concentrations and elevated water temperatures in the Shasta River and its tributaries have negatively affected the river's ability provide adequate spawning, reproduction, and rearing habitat for salmonid species, including ESA listed Coho salmon, Steelhead trout and Chinook Salmon. Elevated stream temperatures and low dissolved oxygen levels are primary reasons that anadromous salmonid populations in the Shasta River and the Klamath River watershed have declined dramatically over the last half-century.

The North Coast Regional Water Quality Control Board has identified tailwater return flows as one of the five primary factors affecting both, elevated stream temperatures and nutrient enrichment/depressed dissolved oxygen levels in the Shasta River watershed. Accordingly, in order to improve water quality and habitat conditions in the Shasta River, tailwater return flows must be reduced through planning and project implementation efforts that are included in this grant project.

In the Shasta Valley, most farmland is flood irrigated. Water is diverted from the river and flows in irrigation ditches or pipelines, sometimes located many miles to it's place of use. It's then "turned out" and sheet flows across fields as a means of irrigating. Water that does not get used by the plants/crops, evaporate or percolate into the aquifer, runs-off as tailwater. Tailwater is not simply a case of over-application of water. In order to apply water from a ditch and across a field, excess must be applied. Depending on local conditions, that excess generally ranges from 25-50% more than is actually required by the plants themselves. Hence, flood irrigation and tailwater creation can result in a variety of unintended water quality impacts such as:

- *Temperature gain: As air temperatures increase during the daytime, and irrigation water sheet flows across a pasture or field, the temperature of that water also increases. So the water that is not consumed (used by plants, evaporated or percolated to groundwater) flows back to the river with elevated temperature, observed as high as 37 degrees Celsius (98 degrees Fahrenheit).*
- *Nutrient Loading: As water sheets across the pastures lands, it dissolves minerals, fertilizer elements, and organic matter, which suspends organic and inorganic fine materials in tailwater. Tailwater returning to the river then delivers these materials to receiving waters.*
- *Low Dissolved Oxygen Levels: The increase nutrient loading encourages aquatic vegetation growth, which was identified by the North Coast Regional Water Quality Control Board (North Coast Regional Water Board) as the primary source of low levels of dissolved oxygen observed in the Shasta River at night when plant metabolism requires oxygen to sustain those plants. Oxygen levels can be reduced to the point that salmonids and other aquatic organisms cannot survive.*
- *Coho Rearing: Cold water is imperative for Coho and steelhead survival because they rear in fresh water for at least one year prior to migrating to the ocean. Those rearing in the Shasta River must find cool water throughout the summer months when the above irrigation practices are underway. Tailwater returns have a cumulative effect on river temperatures. It was found that much of the Shasta has Mean Weekly Maximum Temperatures above 18 degrees C (64.4 degrees Fahrenheit), which has been found to be above the long-term temperature tolerance of Coho (Welsh et al. 2001).*
- *Improved water use efficiency: With most irrigation systems, owners and operators divert water into open ditches. To operate efficiently, these ditches require maintenance in the form of periodic reconstruction, regular vegetation control with herbicides, and ongoing minor repairs. Poorly maintained open ditches contribute to increased water consumption and water losses to percolation/leakage. Beyond the conveyance losses, the transfer of water from ditches to the irrigated fields is difficult to precisely control, resulting in areas of over and under irrigation, and/or increases in tailwater creation. Replacing ditches with pipelines and associated risers or gated pipe allows the water users to better manage and distribute their water across their fields in a shorter amount of time, in more equal quantities and without the risks to water quality impacts associated with herbicide use. Ditch lining could also have unintended consequences of impacting cold river base flows and groundwater recharge, which must be evaluated and weighed against any potential benefits.*

2.0 Project Goals

The goal of the Shasta River Watershed Tailwater Reduction Project (Phase 2) is to implement projects based on a prioritized approach that would meet TMDL water quality objectives while insuring that water users meet anticipated regulatory requirements and maintain the economic viability of their agricultural operations. The summarized goal was to keep warm tailwater out and cold water in the Shasta (and its tributaries).

The following steps accomplished these goals:

1. Education and outreach to landowners regarding water transactions and project conceptualization within tailwater neighborhoods and irrigation districts.

2. Refinement of the tailwater accumulation model, which involves the addition of adjudication maps and digitization of ditch distribution networks.

3. Refinement of the tailwater prioritization matrix to make sure projects meet the goals of the tailwater project and are a beneficial use of public funds.

4. Continue to identify tailwater and water management projects that will improve water quality in the Shasta River and tributaries.

5. Implement a project on the Shasta Big Springs Ranch to increase available spring water flows to the river and reduce tailwater returns.

6. Implement a project on the Shasta River Water Association to collect tailwater and re-use in-lieu of pumping river water.

7. Implement other projects that meet the prioritization criteria.

8. Continue to monitor pre and post project conditions to determine if tailwater reduction efforts are improving water quality.

9. Monitor river conditions for dissolved oxygen and temperature.

10. Conduct post project tours for agencies and landowners and interested parties to educate them on ways to reduce, capture and re-use tailwater.

11. Create a webpage that will assist landowners in to determining whether they are in a high priority tailwater neighborhood and recommended strategies to reduce impacts to water quality and fisheries.

3.0 Project Description

The purpose of this project is to familiarize landowners with the requirements identified in the Shasta River TMDL Action Plan. The SVRCD was awarded this grant, to continue implementing projects developed through a strategic and planned approach to addressing water quality impacts associated with tailwater returns. Tailwater can be defined as run-off from agricultural irrigation practices, usually related to flood irrigation. (Tailwater can also run onto a neighboring property, from where it may eventually return to the river). In terms of management, a discrete area contributing to a single tailwater return flow has been given the name "Tailwater Neighborhood", which can be defined as a geographic area, mini-basin or watershed that produces tailwater; where one to several landowners contribute to a single tailwater return to the river. Approaching tailwater reduction efforts from a "neighborhood" perspective requires shared responsibility for reducing tailwater impacts and can result in the development of the most efficient tailwater reduction program. The identification of tailwater neighborhoods and construction of demonstration projects was the primary goal of Phase 1 tailwater project (grant agreement # 06-271-551-0) and Phase 2 (this grant) focused on continuing outreach and education to neighborhood landowners and implementing projects that will reduce tailwater impacts in the Shasta River.

The State Water Resources Control Board (SWRCB) approved this grant agreement in 2010 and grant implementation began immediately. This grant built upon work performed in Phase 1, with the focus on more project implementation and outreach, which included project tours and the creation of an interactive tailwater webpage. The grant also outlined efforts to refine the tailwater prioritization criteria and tailwater model. The model refinement was to be based on actual water rights allocations and adjudication mapping.

The immediate project task was to get the adjudication map digitized in a way that it could be overlaid onto the tailwater neighborhood maps. This work was performed with much greater ease than initially estimated, once this was completed, the maps were evaluated. The refinement of the tailwater model was simply accomplished by overlaying the adjudication maps with the tailwater neighborhood information. This information is extremely useful in tailwater reduction project planning and educating landowners on how to manage their water right allocation and tailwater return flows.

Through the two tailwater reduction grants funded by the SWRCB, a list of 38 projects were conceptualized and screened. Once designed they were scored using the criteria established during Phase 1 and refined during Phase 2 (Appendix A). Six of these identified projects were completed during Phase 1 and six more were implemented during Phase 2. All conceptual projects were screened using criteria created by the Tailwater Advisory Committee (TAC), to ensure the proposed projects met the goals of the grant. A few other projects were initially identified for implementation, however due to excessive budget requirements, those projects have been delayed. Two of these projects had matching funds and three had technical assistance through Natural Resources Conservation Service (NRCS). One project had matching funds for design and planning through Proposition 50 IRWM.

The following is a description of the completed demonstration and implementation projects, and includes their prioritization scores:

- Shasta Big Springs Ranch North Ditch Head gate and Water Control Structure: (41°36'10.27" N latitude, 122°25'12.99" W longitude) This project included the construction of a new head and water control structure. The ranch shares a diversion and conveyance ditch with a neighbor. Often times, the irrigator would have the irrigation set for a certain flow and return to find as much as twice the amount coming onto the property. This management issue was contributing to excessive tailwater returns to Big Springs Creek. The project included a new head gate structure and a water control weir, so the irrigator can set the weir boards to a certain level and any water over the amount needed for the ranches irrigation is returned to Big Spring Creek as cold water.
  Neighborhood Score= 462 Screening Score= 982 Project Score= 1182

- Meamber Tailwater Re-use Improvement Project: (41°42'32" N latitude, 122°32'11" W longitude) The Meamber tailwater re-use improvement project included a*pproximately* 68 feet of 8" PVC (Sch 40) pipe, 65 feet of 18"CPP (20 ft and 45 ft), 6 feet of ¼"thick 8" steel pipe and one 5'diameter by 14' long Galvanized CMP. Also included in the project is the installation of a magnetic flowmeter (8"). The project was intended to collect and gather tailwater from the neighborhood and direct it back to the Meamber ranches river pump, so tailwater is used in lieu of river water. Thus reducing the amount of water diverted from the Shasta River.
  Neighborhood Score= 256 Screening Score= 626 Project Score= 863

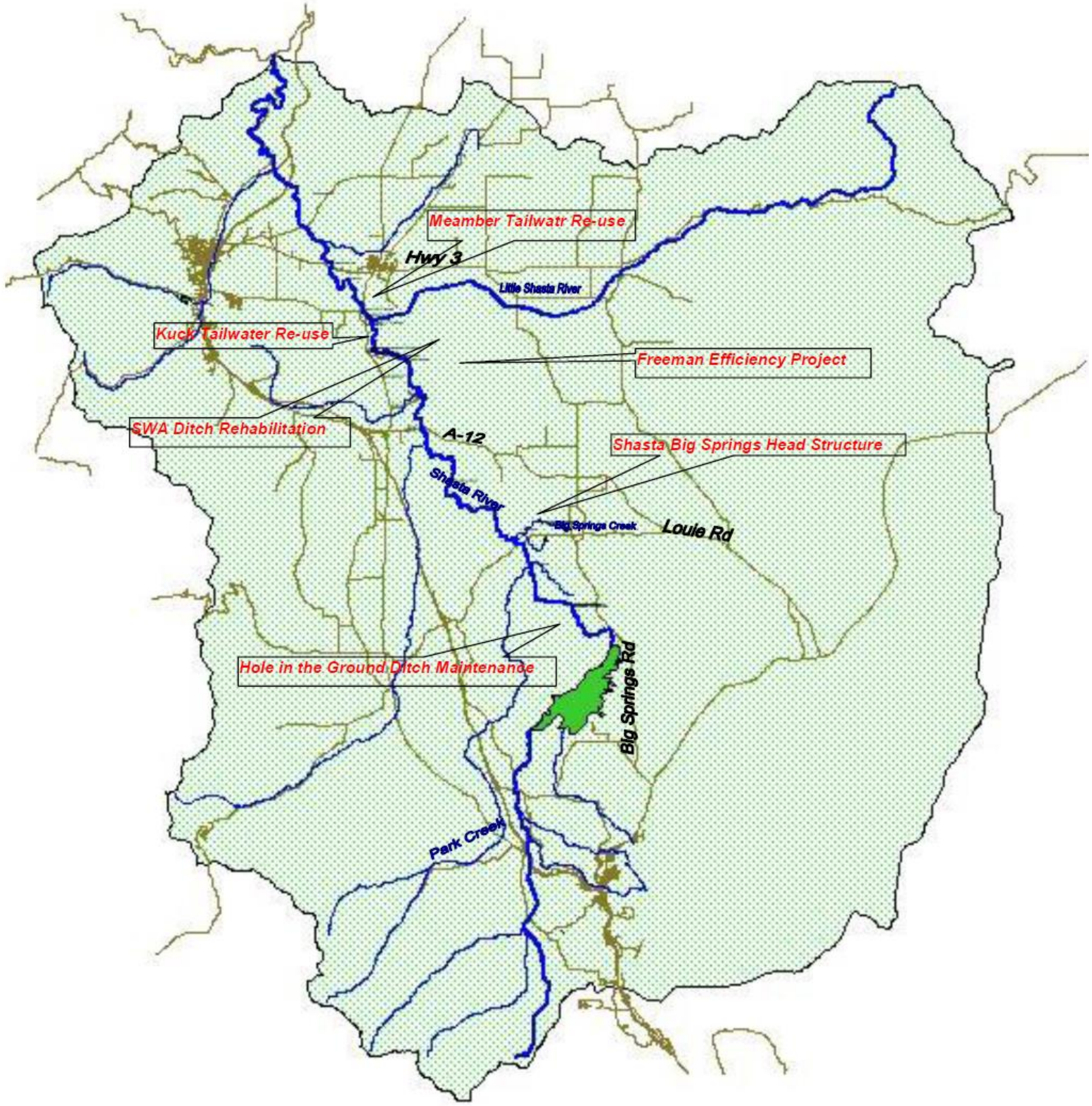
- Freeman Ranch Pipeline Efficiency Project: (41°40'56.65"N latitude, 122°30'58.45" W longitude) This site included installation of approximately 3,365-feet of 10-inch (80 psi) transmission line, which will be run from an existing repositioned river pump to 565-feet of 12-inch (80 psi) irrigation pipeline with risers and 2,500-feet of 12-inch PVC gated pipe. The project also includes 2,100-feet of 1 ¼ -inch Sch 40 and 3 troughs and a new ½ horsepower pump and pressure tank for the stock-water system and 2,610-feet of electric fencing. The intention of this project was to allow the landowner to manage irrigation water more efficiently, use less water and create less tailwater.
  Neighborhood Score= 268 Screening Score=758 Project Score= 1031

- Hole in the Ground Ranch Ditch Maintenance Project: (41°33'52.4" N latitude, 122°25'50.61" W longitude) The project included the installation five 18"diameter by 20' long Galvanized CMP, with a mounted waterman slide gate (C-8E). Also included in the project is necessary earthwork to remove old broken concrete and re-grade to match existing concrete lining and re-build/pour up to 1500-feet of concrete lined ditches. The intention of this project was to improve water management, there were many sections of ditch that were broken and leaking, the project went through and repaired the sections that needed rehabilitation. The project will reduce the amount of water diverted from the Shasta River by reducing ditch loss or leakage.
  Neighborhood Score= 504 Screening Score= 874 Project Score= 1126

- Kuck River Ranch Tailwater Re-use Project: (41°42'01.87"N latitude, 122°32'05.51" W longitude) The project included the purchase and installation of all materials to connect an existing tailwater pond to a pump station. Including, but not limited to a*pproximately* 2725 feet of 10" PVC (63 psi) pipe, 85 feet of 14 gauge 10" steel pipe and one 5'diameter by 8' long precast concrete manhole with constructed baffle and a 7.5horsepower turbine pump. Tailwater from the Shasta Water Association was collected in an old river channel and was used to wild flood a small section of pasture on the Kuck Ranch. The intention of this project was to connect this source of tailwater to an existing irrigation ditch on the Kuck Ranch, to reduce the amount of water diverted from the river and reduce the amount of tailwater returned to the river from this ponded area.
  N*eighborhood Score= 276* *Screening Score=816* *Project Score= 1083*

- Shasta River Water Association tailwater Ditch Rehabilitation Project: (41°41'11.15"N latitude, 122°31'53.12" W longitude) Several tailwater neighborhoods within the Shasta River Water Association return tailwater back to the river just upstream of the SWA pump station. There was an existing ditch system along the river that was identified for rehabilitation, that is used to pick up tailwater from these neighborhoods and deliver it back to the pump station for re-use in-lieu of river water. This will reduce tailwaer returning to the river and reduce the amount of water diverted from the river.
  Neighborhood Score= 356 Screening Score= 736 Project Score=1011

Pre-project, Construction and Post project photos are provided in the Appendix C. The locations of these construction projects are identified on Figure 1.



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Shasta Valley RCD- Tailwater Reduction Project
Figure 1
Tailwater Reduction Project Location Map

A. Project Type

This project was funded as an Implementation and Planning Grant by the State Water Resources Control Board (State Water Resources Control Board) through the USEPAs Clean Water Act 319h grant. This project is consistent with the requirements of the Shasta River TMDL Action Plan, the Recovery Strategy for California Coho Salmon, and the Shasta River Watershed Plan.

B. Project Costs

A total of $996,648.00 was spent to implement this project. Table 1 below summarizes project expenses by category and a summary of specific construction related contracted services performed.

PROJECT LINE ITEM	Total Project Budget	MATCH	319h BUDGET
RCD Personnel Services	**$ 164,438.00**		**$ 164,438.00**
Operating Expenses	**$ 55,500.00**		**$ 55,500.00**
Professional Consulting	**$ 381,834.00**		**$ 274,404.00**
NRCS		*$ 50,540.00*	
MWCD		*$ 48,000.00*	
Prop 50		*$ 8,890.00*	
Construction	**$ 394,876.00**		**$ 257,100.00**
Big Springs Ranch Head Structure	*$ 12,470.00*		*$ 12,470.00*
Freeman Efficiency (NRCS match)	*$ 162,272.00*	*$ 114,408.00*	*$ 47,864.00*
Hole in the Ground Ditch Maintenance	*$ 54,486.60*		*$ 54,486.60*
Meamber Tailwate Re-use Project	*$ 39,355.00*		*$ 39,355.00*
Kuck Tailwater Re-use Project (NRCS Match)	*$ 69,088.00*	*$ 23,368.00*	*$ 45,720.00*
Kuck Tailwater Re-use Project-Electrical Portion	*$ 14,348.00*		*$ 14,348.00*
SWA Pick-up Ditch Rehabilitation	*$ 27,122.50*		*$ 27,122.50*
Totals	**$ 996,648.00**	**$ 245,206.00**	**$ 751,442.00**

Funding provided by Clean Water Act 319h totaled $751,442.00. Table 1 also summarizes other federal and state funds acquired for project implementation. The $245,206 of matching funds declared as part of this program came from partnership programs from Natural Resources Conservation Service's (NRCS), funds acquired by Montague Water Conservation District (MWCD) and Prop 50 IRWM.

C. Project Methodologies:
Since this is a diverse project with many elements and methodologies the only way to synthesize them all is to summarize the project timeline describing all elements and how they fit together to meet the project goals. A list of project submittals is included in Appendix B. The SVRCD received the final 319h grant agreement in January 2010; project initiation began in March 2010 and finished with tailwater reduction project implementation in Spring 2012 to Fall 2013. Appendix C includes project photos, which documents the construction activities on all selected projects.

The following is a description of all project activities that took place between March 2010 and February 2014 shown by grant task.

A. Plans and Compliance Requirements

2. A Project Assessment and Evaluation Plan (PAEP) was completed for the project on March 24, 2010.

3. The Monitoring Plan (MP) was completed on March 25, 2010.

4. Quality Assurance Project Plan (QAPP) in accordance with the State Water Board's Surface Water Ambient Monitoring Program's (SWAMP) was prepared April 30, 2010.

5. A California Environmental Quality Act (CEQA)- Mitigated Negative Declaration was prepared on February 2, 2011, which included implementation projects funded by this grant and the previous tailwater reduction grant. Due to the timing and process of this project, two supplemental CEQA documents were prepared as there were some scope of work changes on one project and another was added. Supplemental #1 was prepared on August 7, 2012 for the Freeman Ranch Efficiency Project and Supplemental #2 was prepared on April 18, 2013 for the Kuck Tailwater RE-use Project. A Notice of Exemption was completed and filed for the Shasta Water Association Tailwater Ditch Project on August 10, 2012.

6. Landowner agreements were prepared and signed for each implementation project completed. This occurred on an on-going basis while project were approved and contracted.

7. Permits were only required for the Meamber Tailwater Re-use Improvement Project and were prepared July 3, 2012 and approved by the Army Corps of Engineers in November 2012.

B. Work To Be Performed by Grantee

1. Education and Outreach

1.1 Several public presentations were given to educate landowners and agencies on the process required by the State Water Board to evaluate water quantity determination for potential water transactions, transfers and/or evaluation of net water use for efficiency projects. Public workshops were given on January 24, 2012 and on April 3, 2013 and one workshop was given to the Siskiyou County Board of Supervisors was given in July 2013.

1.2 Training to evaluate and assess tailwater discharges as they relate to the Shasta River Adjudication has been an on-going process to get RCD staff updated on how to prioritize tailwater.

1.3 Landowner meetings are an on-going part of the tailwater project. Meeting with landowners and neighborhoods has produced many of the projects identified on the prioritized project list. Some of the projects that have moved through to implementation have not been in neighborhoods with multiple landowners and the outreach was solely to the landowner involved in the project, as they were the sole contributors of the tailwater in a targeted neighborhood.

1.4 Several irrigation district board meetings and member meeting were attended to discuss the Grant Project and identify implementation projects. Through this outreach process, the design projects for the Montague Water Conservation District were identified to help them improve water quality leaving the lake and entering the river for prior water rights users and flow requirements for fish. Significant outreach was done within the Shasta Water Association (SWA), through that process the SWA Tailwater Ditch Rehabilitation Project was identified and conceptualized, as well as improvements that were accomplished with the previous tailwater reduction grant (Prop 40/50) and the need to change the fee structure within the district to reduce tailwater creation.

2. Planning and Refinement of the Tailwater Accumulation Model

The first task completed on this grant was to digitize the water rights/adjudication maps and overlay them with the tailwater maps. This efforts was to assess if any significant refining of the tailwater accumulation model created in Phase One of the Shasta River Watershed Tailwater Reduction Project needed to be done and if it would give a better understanding of what was contributing to water quality impacts. Upon reviewing and comparing the current irrigated acreage (using aerial photography) versus historical irrigated acreage based on adjudication maps, it was discovered there was an insignificant difference between the two. It was also recognized that management play such an enormous role in tailwater production, water use and efficiency, as well as water quality, along with water year dynamics (storage amount in Dwinnell, spring production due to winter precipitation, temperature, smoke cover, etc). After careful consideration, it was decided not to spend important resources on refining a model which that has already proven to be quite helpful as it stands in prioritizing projects and identifying problem spots and refining it would not get us closer to remedying the issues in the watershed. The money that was budgeted for this task was reallocated to assist Montague Water Conservation District in designing projects that would improve water conditions in the high priority area of the watershed, see Task 3.5 and 3.6.

3. Design and Implementation of Tailwater Reduction Projects

3.1 The prioritization matrix which was started in Phase I of the tailwater project initially entailed two different lists of criteria. The "Neighborhood Impact Criteria" was run on every tailwater neighborhood in the watershed (that was included in the LiDAR flight) and this helped determine the water quality impact associated with each neighborhood and if an individual tailwater project occurs in a high priority tailwater neighborhood. The second list of criteria initially created was a "Project Score Criteria" and it evaluated if an individual tailwater project will meet the implementation criteria developed by the Grantee. After using this in the beginning phases of tailwater project, a third list of criteria was developed in July 2011 that changed the "Project Score Criteria" and created a "Project Screening Criteria". The "Project Screening Criteria" evaluates the project based on whether it solely meets the objectives of the Grantee and the "Project Scoring Criteria" evaluates whether the project is a worthwhile project based on cost benefit, ease of construction, management required, and operations costs. This way a project could be conceptualized and screened, then if it meets the objectives of the grant then design and further planning can ensue. Many of the "Project Scoring Criteria" can only fully be evaluated after the project has been designed, because costs associated with the project can not be estimated until all the designs are finalized. The revised version of the criteria was also submitted in the final report for Phase 1 and is included in the Appendix A of this report.

3.2 Thirty-eight implementation projects were identified using the prioritization matrix (impact scored and screened). The following tailwater projects had been previously identified and ranked high in the tailwater prioritization: Big Springs Ranch North Ditch Head Structure Project and the Banhart/Rice Tailwater Ditch Rehabilitation Project (Shasta River Water Association Tailwater Reuse Projects). The other four projects implemented with the Phase 2 funding were identified through our outreach efforts identified above. The following table outlines the projects implemented as part of this task and includes important dates associated with them. The project design services by NRCS, were considered matching dollars for this grant under professional/consulting services.

Project Name	Date of Final Design	Designed by	Date Contracted	Contractor	Date Finaled
Shasta Big Springs Ranch North Ditch Head Structure	Oct-11	Davids Engineering	Mar-12	Mike Peters, Inc	Apr-12
Meamber Tailwater Re-use Improvement Project	Aug-12	NRCS	Oct-12	Timberworks	Jan-13
Freeman Ranch Efficiency Project	Oct-12	NRCS	Dec-12	Woody Tannaci/Johnson Electric	Apr-13
Hole in the Ground Ditch Rehabilitation	Jan-13	SVRCD	Feb-13	North Rivers	Mar-13
Kuck Ranch Tailwater RE-use Project	Aug-13	NRCS	Sep-13	GS Black Inc/Johnson Electric	Dec-13
Banhart/Rice Tailwater Ditch Rehabilitation	Jul-13	Bray Engineering	Sep-13	Mike Peters, Inc	Nov-13

3.5 Montague Water Conservation District (MWCD) design projects were added to the scope of work late in the contract schedule, due the realized importance releases from Dwinnell play on water quality in the upper Shasta River. Four different design projects were designed in part with funds under this grant agreement by an outside consultant hired by the MWCD. The releases from MWCD's Dwinnell Reservoir can be limited by water quality, especially during the latter part of the summer on years when storage volumes are low. Current infrastructure also limits the volume of water available to be released to the Shasta River. This line item seeks to design and permit the following improvements at the base of Dwinnell Dam to improve water quality and quantity opportunities:

1.) Increase the capacity of the cross canal (which transports water from the main canal to the river for prior rights): Currently the cross canal channel can only handle an estimated 30-40 cfs of flow to the Shasta River. The current gauging site on the cross canal can only measure flow under 23 cfs. Increasing the channel capacity and installing a gauging facility would allow MWCD to provide increased pulse volumes, spring flow releases and releases with the intent of providing channel forming flows and sediment transport. A component of increasing the capacity of the cross canal includes retro-fitting the cross canal gates and gate screens. MWCD seeks permitting, survey and design assistance to advance an engineered plan to 100% complete status.

2.) Incorporate the Flying L Pumps: MWCD owns and operates the Flying L pumps which produce an estimated 6.0 cfs of cold groundwater. Currently, the Flying L Pumps deliver water to MWCDs Main Canal for irrigation purposes. This alternative source of cold water will be provided to prior rights or even water in addition to prior rights when water quality released from Dwinnell is not suitable for cold water dependent species. MWCD seeks permitting, survey and design assistance to pipe the cold water from the Flying L pumps to the cross canal to release to the Shasta River.

3.) Develop a cold water refuge with the Dwinnell seeps at the base of the dam. MWCD intends to collect the cold water generated by an area of sub-surface seeps that develop at the base of the dam to develop a cold water refuge. Because the volume of water is typically less than 1.5 cfs during the summer months, the cold water refuge is expected to be a small but critical habitat related to expanding cold water over-summering habitat. MWCD seeks survey and design assistance to advance an engineered plan to 100% completion.

3.6 Eleven water measuring devices/structures were designed throughout the Shasta River Water Association to assist the Association in converting to a measured used fee structure. This will require association members to pay for the amount of water used and reduce waste. The district has always been an allotment(or time) structure, allowing for water waste and over application. The designs were completed by Vestra and will be used to acquire future funds to convert the district. This conversion will reduce water usage and tailwater production.

4. Project Implementation and Monitoring

Each project was monitored pre- and post-implementation if timing and landowner agreement to monitoring could be established. Some projects that were implemented at the end of Phase 1, were post project monitored during Phase 2 and some projects implemented at the end of Phase 2, were only monitored pre-project and post project monitoring will have to be covered under the SVRCDs future grant.

Monitoring is an important aspect of this project; it can be used to evaluate the importance of a reduction project, help conceptualize what is needed to reduce impacts associated with a tailwater return flow or help design the project and evaluate if the implementation of the project was beneficial at reducing water quality impacts. As part of the outreach portion of the project, landowners were either contacted by the SVRCD or contacted the SVRCD themselves to do something on their property, the first step was discussing their existing tailwater returns and monitored the effects of large returns first. After data was collected and evaluated, then a project was conceptualized, screened, designed (based on monitoring data) and scored.

When a tailwater return was identified for monitoring a flow meter was installed in a pipe and sandbagged into place (if a culvert was not already present). Temperature sensors were also installed in returns, as well as in the river, usually upstream and downstream of where the return flowed back to the stream. Water quality samples were collected; one from the tailwater return and one from the river, downstream of the return point within the mixing zone, the samples were analyzed for total phosphorus, Total Kjiedahl Nitrogen, ammonia, nitrate, nitrite and biological oxygen demand (BOD) .

In additions to the tailwater monitoring stations, there were also ten dissolved oxygen sensors monitoring stations installed throughout the Shasta River. These stations recorded dissolved oxygen levels and temperature on an hourly basis. These stations have been running since 2008 and provide information regarding water quality improvements that have been realized from these efforts.

5. Post Implementation Activities

5.1 Two (2) tours of implementation project sites was offered for landowners and agencies interested in learning about tailwater reduction efforts that have taken place in the Shasta Valley. The tours were conducted on May 16, 2013 and July 31, 2013.

5.2 An interactive tailwater webpage was created and linked to the Grantee's website. The new website assists landowners in identify whether they are in a high priority tailwater area. It also shows the water quality and fisheries issues identified for each reach and the recommended strategies needed to reduce impacts associated with tailwater and improve conditions for fisheries.

D. Pre and Post Project Conditions

Tailwater Monitoring

Over the course of this grant agreement and the previous agreement, a total of 55 sets of tailwater returns have been monitored, some of these locations were repeated multiple years. Six sites had been prioritized and identified for implementation of tailwater reduction with Tailwater 1 funding and six sites were identified for implementation with Tailwater 2 funding, all figures showing location are included in Appendix D- Water Quality Improvement Report. All locations were monitored pre-project and post-project if the timing was possible within the grant schedule. Access was acquired for monitoring flow, temperature and water quality for pre-project conditions. Tailwater flow was measured using HACH 910 area-velocity meters in tailwater streams using existing culverts or sandbagged pipes. Temperature was logged using On-set Tidbits, which logged temperature every hour, in both the tailwater stream and river (where river access could be obtained).

Tailwater Reduction Conclusion

The efforts outlined above, has shown a tailwater return reduction of 589 acre-feet (per season) from re-entering the river. This water did not necessarily show up as increased discharge in the river at any of the weirs, as the watershed is over adjudicated and the water likely went to another user.

It must be noted that these monitoring results are assuming that tailwater would be returning to the river in the same location post project as pre project. However, project activities may have made the movement of water easier, thus tailwater may be coming back to the river in a different location or more readily available for application and more evaporation and/or transpiration resulted.

Shasta River Monitoring

In addition to tailwater monitoring, watershed monitoring was also attempted over the course of the two tailwater reduction projects (Phase 1 and 2). D-opt Loggers, which log both dissolved oxygen (DO) and temperature, were installed in the Shasta River at ten locations (under this grant agreement): Upper Shasta, Nelson Ranch, A-12 Bridge, two sites at Shasta River Water Association pump station, Montague-Grenada Bridge, and two sites at Araujo pump station. All locations are shown on Figures in the Water Quality Improvement Report included in Appendix D. River discharge at the Montague Weir as well as reservoir levels in Dwinnell, both sets of data was posted on-line at CDEC.

River Discharge

Discharge is an important aspect of measuring the impact any given tailwater input could have on water quality. Included in this report is data from the USGS gages at the Montague-Grenada Bridge (MG Rd-11517000). The discharge data set, as well as storage in Dwinnell illustrates the difference in water years. What was concluded was 2011 could be considered an above average water year. 2013, 2009 and 2008 were all comparable water years and considered below average water years, where 2010 and 2012 were similar and considered average for the sake of this analysis.

River Temperature Monitoring Conclusions

After reviewing the temperature data and the river discharge data from the previous six years, a few trends have been observed. Considering the correlation of the water years, all stations in 2011 recorded the lowest 7-DADMax temperatures throughout the season, there was ample water in the system and ambient air temperature were also considered below average. Comparing the below average years of 2008, 2009 and 2013, from Big Springs Creek to A-12, temperatures in 2013 are considerably lower than 2008/2009 even though the water year/discharge is comparable. Downstream of A-12, the 7-DADMax Temperatures are similar for the three below average water years, with 2013 being the highest at some stations for the majority of the season. In August 2013 the temperatures dropped to 2011 levels at some stations, likely due to air quality conditions (smoke cover). Air quality would reduce solar gain on tailwater returning to the river, thus reducing river temperatures.

Dissolved Oxygen Monitoring Conclusion

When reviewing the Dissolve Oxygen Data results, it could be inferred that conditions in the Shasta River are improving, when comparing 2013 data against the other years. From Big Springs Creek to Shasta Water Association Dam site the daily minimum Dissolved Oxygen levels for 2013 are higher than 2011 levels and rarely drop below 6 ppm, even though 2013 would be considered a below average water year and 2011 is above average. At the Montague Weir site daily minimum Dissolved Oxygen levels for 2013 are comparable to 2010/2012 levels and not dropping below 5 ppm. At Highway 3 and down through the Araujo Dam site daily minimum dissolved oxygen levels in 2013 are comparable to 2008/2009 levels and the lower Shasta site is back up to levels comparable to 2010/2012, not dropping lower 5 ppm for the most part with some late season levels close to 4. The conclusion is that water quality (DO and Temperature) are improving, especially upstream of A-12. This is likely due to management changes at Shasta Big Spring Ranch, but also the tailwater reductions due to the tailwater project's activities and landowner education in the high priority area of the watershed.

4.0 Public Outreach:

Periodic progress presentations were made at public SV RCD Board meetings and KBMP meetings. In addition the SVRCD has made presentations about this project at a variety of different public forums, including Regional Water Quality Control Board public workshops on progress of the Shasta River TMDL implementation efforts. The Regional Water Board and their staff have been impressed by the progress made by the SVRCD. Several presentations were given about the Shasta Valley Water Transaction Program, to Distircts and individual tailwater neighborhoods, presentation material (if used) is included Appendix E.

The Shasta Valley RCD has also hosted two tours as part of this grant to the implementation project sites for various agencies, and organizations. Below is a short list of agencies/groups who have requested tours of the project site over the course of this grant contract.

CA Department of Fish and Wildlife	U.S. Fish and Wildlife Service
National Oceanic Atmospheric Administration	CA Department of Water Resources
Regional Water Quality Control Board	State Water Resources Control Board
Siskiyou County	Independent landowners.

5.0 Conclusions:

A. Project Evaluation & Effectiveness Results (PAEP)

The PAEP included below describes the pre-project targets and the post-project achievements. Project targets included an increase in the Dissolved Oxygen and a reduction in the temperatures in the Shasta River and its tributaries. These project targets could not be fully evaluated due to the delayed timing of implementation, however some water quality improvements have been measured during the monitoring of this project. Although these targets were not necessarily achieved as a result of this project the activities conducted will most likely lead to eventual achievement of TMDL targeted goals and data collected under this funding will provide essential baseline data for that evaluation. The following includes a brief discussion of what goals were included in the PAEP, how the goals were accomplished and if not why. There is also a discussion on what actions may be needed to achieve targeted goals in the future.

Category of Project Activities: Planning, Research, Monitoring and Assessment

PAEP Goal: Identify and understand how tailwater impacts water quality in the Shasta Valley.

2010 Desired Outcomes:

a. A more complete tailwater impact model, taking into account water adjudications
b. Decision making tool for analyzing highest priority tailwater inputs for reduction
c. Predicting water quality improvements expected due to implementation of tailwater reduction projects.

Post Project Assessment:

The adjudication maps for the Shasta Valley were digitized and over laid on the tailwater neighborhood maps to evaluate the necessity of revising the tailwater accumulation model. The initial model was based on presumed water applied and calibrated with actual monitoring data. It was intended that the model would be revised based on where water is actually applied and how much based on the adjudication. After evaluating the maps and recognizing much of the water use is dependent upon landowner management and not on the adjudication, it was determined that revising the model based on the adjudication would not prove significantly more useful than the existing model. The money allocated for the model revisions was used to design projects for future phases of work.

The prioritization criteria was finalized in July 2011and approved as part of the Tailwater Reduction Plan. This criteria allows the SVRCD to evaluate the degree a project would meet the overall goals of the tailwater reduction project and how worthwhile a project would be to implement.

Predicting how effective certain types of projects are at improving water quality is very dependent upon on-farm management of the new project and a landowner's commitment to water quality improvement objectives. There has to be an incentive for landowners to pay increased attention to irrigation water that goes beyond the effect it has on their ranches. So predicting improvements expected from implementing certain types of strategies is nearly impossible. The only concept that is possible is continued landowner education about the importance of water/project management, why the project is being implemented, stipulate the expectations of the projects benefit to water quality and then hoping for the best.

PAEP Goal: Identify clear and implementable solutions for a high priority tailwater neighborhoods.
<u>2010 Desired Outcomes:</u>

a. Development of specific alternatives to consider for neighborhood-wide tailwater reduction.
b. Agreement between project team and landowners on preferred alternatives for implementation.

<u>Post Project Assessment:</u>

PAEP Goal: Increase the scientific understanding and knowledge about the Shasta River tailwater problem to inform solutions.

<u>2010 Desired Outcome:</u>
Foundation (via LiDAR) to broaden planning to roll out watershed-wide tailwater reduction to the project level.

<u>Post Project Assessment:</u>
During the tailwater neighborhood and project prioritization planning process a lot of outreach to landowners was accomplished. Through the outreach process a lot of conceptual and on the ground planning occurred, which informed the recommended strategies identified in the watershed-wide Tailwater Reduction Evaluation Matrix (Table 4) included in the Shasta Valley Tailwater Reduction Plan date September 2011. This matrix is a watershed-wide effort, which is the foundation that informed implementation project planning.

Shasta River Tailwater Reduction Project						
Category of Project Activites: Planning, Research, Monitoring and Assessment						
Project Goals	**Desired Outcomes**	**Output Indicators**	**Outcome Indicators**	**Measurement Tools and Methods**	**Targets**	**2013 Target Assessment**
Identify and understand how tailwater impact water quality in the Shasta Valley	1. A more complete tailwater impact model, taking in to account water adjudications.	1. Digitized map of tailwater drainage areas and likely quantity of inputs based on drainage area and other features.	1. Acceptance of tailwater neighborhood maps by peer review.	1. Digitized map showing general locations of highest priority tailwater reduction project areas.	1. List approved and adopted by project team of high priority tailwater reduction project areas in the Shasta River between Dwinnell Dam to the mouth, + 6 miles of the Little Shasta River, and 10 miles of Parks Creek.	1. The list is continually added to as outreach efforts grow in the Shasta Valley. The latest version had 38 projects listed.
	2. Decision making tool for analyzing highest priority tailwater inputs for reduction.	2. List of highest priority tailwater areas, based on expected water quality improvements predicted by model if tailwater reduction were implemented.	2. Acceptance of initial list of high priority tailwater reduction project areas based on peer review.		2. List used by RCD for field verification, outreach and project development, and by the local NRCS office for assisting interested landowners with project development and to use to rank tailwater reduction projects for funding by their agency	2. The list was developed through the outreach portion of the project and shared with NRCS for project development.
	3. Predicting water quality improvements expected due to implementation of tailwater reduction projects.					
Identify clear and implementable solutions for high prioirty tailwater neighborhoods	1. Development of specific alternatives to consider for neighborhood-wide tailwater reduction	1. Conceptual tailwater reduction plan for high priority neighborhoods.	1. Approval of conceptual tailwater reduction plan for high priority neighborhood between project team and landowners within neighborhood.	1. Detailed written project description(s) suitable for seeking funding that addresses first 20% of SWA originating tailwater.	1. Schedule for implementation of preferred alternatives to tailwater reduction within neighborhood.	1. Between Phase 1 and 2, a total of 12 projects have been implemented from the prioritized list.
	2. Agreement between project team and landowners on preferred alternatives for implementation.					

Shasta River Tailwater Reduction Project						
Category of Project Activites: Planning, Research, Monitoring and Assessment						
Project Goals	**Desired Outcomes**	**Output Indicators**	**Outcome Indicators**	**Measurement Tools and Methods**	**Targets**	**2013 Target Assessment**
Increase scientific understanding and knowledge about Shasta River tailwater problem to inform solutions.	1. Foundation (via LiDAR surveys and model) to broaden planning to roll out watershed-wide tailwater reduction to the project level.	1. Gain knowledge and experience with landscape scale tailwater estimating and conceptual project planning	1. List of lessons learned via neighborhood planning effort	1. Design for development of basin-wide approach to tailwater reduction planning, with timelines and estimated costs for planning effort.	1. Plan to be adopted by RCD to use to guide future efforts to minimize negative impacts of tailwater.	1. The tailwater reduction plan was adopted by the RCD in September 2011. This plan outlines related issues within each reach and recommended strategies to improve water quality and fisheries conditions
		2. Avoid unforeseen or negative outcomes when operating at a larger scale.	2. List of lessons learned via monitoring process.		2. Plan to be used by RCD, NRCS and other funders to rank future tailwater reduction projects in Shasta Watershed.	2. What has been learned through the tailwater project has been passed on to other funders to inform ranking of future projects.

Category of Project Activities: Load Reduction

PAEP Goal: Demonstrate effective ways to alter on-farm practices that will result in water quality improvements.

2010 Desired Outcomes:

a. Implement tailwater reduction projects within high priority neighborhoods to demonstrate on-farm management practices that reduce tailwater inputs to the Shasta River.

b. Reduce tailwater inputs to the Shasta River thereby improving water quality (increase DO, decrease temperature and increase flow)

c. Assist additional Shasta Valley irrigators that want to implement tailwater reduction projects on their land.

Post Project Assessment:
During 2012 and 2013 the following projects were selected for funding:

- The Big Springs Ranch North Ditch Head Gate Structure was intended to maintain a consistent amount of irrigation flow being delivered to the ranch via its shared ditch system. The new head gate structure allows the irrigator to set the flow for a certain amount and any excess delivered to the ranch is returned to Big Springs Creek. This project was located within an area of the Shasta River that was ranked high priority and was identified for implementation during the writing of this grant.

- The Shasta Water Association (Banhart/Rice) Tailwater Ditch Rehabilitation Project was intended to pick up tailwater from four different neighborhoods and deliver it to the Shasta Water Association pump station. Any tailwater produced in these neighborhoods will be re-used at the pump station instead of returning to the river and then being pumped out by the Association. The Association will use the tailwater in-lieu of river water.

- The Hole in the Ground Ranch Ditch Rehabilitation Project was intended to reconstruct portions of a leaky concrete ditch to improve water use efficiencies. By improving efficiencies the amount of water diverted from this high priority area and the amount of tailwater returning could both be reduced.

- Kuck Ranch Tailwater Re-use Project was intended to improve how tailwater is being utilized for irrigation purposes on the Kuck Ranch. Prior to the project, tailwater from the Shasta Water Association was collected in an old river ox bow and then released to wild flood a small pasture adjacent to the Shasta River, while the landowner pumped water out of the river upstream to irrigate other pastures. The project utilizes the existing method of collecting the tailwater, but instead of the inefficient method of irrigating adjacent pastures (that were already being sub-irrigated), the tailwater will be pumped over to the pastures that need the water in-lieu of pumping out of the river.

- The Freeman Efficiency Project was intended to demonstrate improved irrigation efficiency, reduced tailwater production by providing better water management capabilities and reduced river diversion. This project was located within an area of the Shasta that has tremendous potential for salmon production. This project had matching funds from NRCS.

- The Meamber Tailwater Re-use Improvement Project was intended to demonstrate ways to improve an existing tailwater capture pond. By improving the ranches capacity to use the captured tailwater, the pond will overflow less frequently, meaning less hot water returning to the river, and reduced river diversion quantity. This project was implemented after efficiency was improved on the ranch and ties the existing tailwater pond to the river pump. This allows the landowner to regulate the amount of water that is released from the pond to sufficiently supply irrigation demands. This project had matching technical assistance funds from NRCS.

The desired outcome of constructing these projects was to reduce tailwater return impacts but also reduce the amount of water diverted from the river. It has been increasingly clear that the Shasta is in dire need of cold water flows, so most of these projects are on properties where the landowners have control of their diversion. This enables the landowner to manage the project and their irrigation in a way that meets the needs of the river, as well as their ranch. The projects many have an in-lieu of component, so tailwater is being used instead of river water and/or they improve efficiency to reduce the amount of water they need to divert.

By continuing the success with on-farm management projects/practices and then offering tours and getting the word out on how these projects have helped landowners, the desired outcome of having additional irrigators looking to implement projects has occurred. The project list continues to grow and change. It should be noted that due to what we understand about the importance of management and incentives, it has been harder to predict where future projects will benefit in river or if they will solely benefit the landowner and ranch operation. The desired outcome of reduced tailwater inputs and improving water quality is hoped to be quantified, however since some of these projects have been implemented in 2013 and it takes time to learn how to manage new facilities effectively, the outcomes of how much these projects benefit water quality cannot be fully quantified at this time. The SVRCD will need to continue to educate landowners who have projects to ensure the proper water management occurs in the future.

Shasta River Tailwater Reduction Project						
Category of Project Activites: Load Reduction						
Project Goals	**Desired Outcomes**	**Output Indicators**	**Outcome Indicators**	**Measurement Tools and Methods**	**Targets**	**2013 Target Assessment**
Demonstrate effective ways to alter on-farm practices that will result in water quality improvements.	1. Implement tailwater reduction projects within high priority neighborhoods to demonstrate on-farm management practices that reduce tailwater inputs to the Shasta River.	1. Amount decrease in water temperature as a result of demonstration projects.	1. % change in water temperature returning to the river.	1. Photo documentation of demonstration projects.	1. Describe the quantity and quality of all tailwater creation on both demonstration projects—both before and after implementation of projects.	1. The quanity and quality of tailwater reduced due to project effort has been assessed as part of this report, see appendix D.
	2. Reduce tailwater inputs to the Shasta River thereby improving water quality (increase DO, decrease temperature and increase flow).	2. Amount increase in DO levels as a result of demonstration projects.	2. % reduction in NBOD elements originating from project sites	2. Continuous temperature recorders	2. 75% or higher decrease in the amount of tailwater returning to the river on each demonstration project site.	2. Not all sites had a reduction of tailwater as high as 75%. Due to management adjustments that need to be made after a project is implemented, longer term monitoring and additional education and incentives need to be added to project objectives.
	3. Additional Shasta Valley irrigators that want to implement tailwater reduction projects on their land.	3. Increase in water quantity of the Shasta River for in-stream benefits.	3. % change in water being diverted from the river.	3. Paired grab samples (river and tailwater) 1x/month.	3. Have 75% or > of the Shasta Valley irrigators with high priority tailwater reduction projects, willing to participate in the program on their property.	3. Extensive outreach has been done to landowners in the high priority area of the Shasta Valley. 90% of the landonwers in the high priority area have either already implemented tailwater reduction efforts as part of Phase 1 or 2, and/or have conceptualized projects for future implementation.

Shasta River Tailwater Reduction Project Category of Project Activites: Load Reduction						
Project Goals	**Desired Outcomes**	**Output Indicators**	**Outcome Indicators**	**Measurement Tools and Methods**	**Targets**	**2013 Target Assessment**
Demonstrate effective ways to alter on-farm practices that will result in water quality improvements (continued)		4. Number of Shasta Valley irrigators willing to implement tailwater reduction projects on their land.	4. Number of Shasta Valley irrigators willing to implement a tailwater reduction project on their land.	4. Flumes or weirs with Flow Loggersto measure quantity of tailwater return both pre- and post-project implementation.		
				5. List of Shasta Valley irrigators willing to participate.		
				6. Documentation of change in consumptive use by documenting changes in irrigated acreage before and after project.		

Category of Project Activities: Education, Outreach, and Capacity

PAEP Goal: Educate Shasta Valley irrigators about the importance of tailwater reduction projects for the health of the Shasta River.

2007 Desired Outcome:

a. Increase the number of irrigators who are willing to implement a tailwater reduction project on their land.
b. Increased knowledge of how water law relates to tailwater.

Post Project Assessment:

Throughout the implementation of this agreement, significant effort was dedicated to outreach and education. Landowners that were not aware of impacts associated with their tailwater returns, were informed of potential impacts and of regulatory issues that could ensue because of these impacts. Many of these landowners allowed tailwater monitoring to occur on their properties and some became willing to discuss conceptual projects for tailwater reduction project evaluation. A list of thirty eight projects were conceptualized and included in the SVRCD 2012 Potential Tailwater Reduction Project Identification and Screening Results (dated September 2012). From this list six projects were selected for receiving funding through the phase 1 and six projects were selected for implementation during this agreement. The desired outcome was met and a list of projects is ready for additional planning and implementation.

Shasta River Tailwater Reduction Project						
Category of Project Activites: Education, Outreach, and Capacity-building						
Project Goals	**Desired Outcomes**	**Output Indicators**	**Outcome Indicators**	**Measurement Tools and Methods**	**Targets**	**2013 Target Assessment**
Educate Shasta Valley irrigators about water law and the importance of tailwater reduction projects for the health of the Shasta River.	1. Increase number of Shasta Valley irrigators who are willing to implement a tailwater reduction project on their land.	1. Number of targeted meetings with people owning land in high priority projects areas.	1. Increase in landowner understanding of NPS pollution related to agricultural production in the Shasta Valley.	1. Survey of Shasta Valley irrigators.	1. Have 75% or > of the Shasta Valley irrigators with high priority tailwater reduction projects, willing to participate in the program on their property.	3. Extensive outreach has been done to landowners in the high priority area of the Shasta Valley. 90% of the landonwers in the high priority area have either already implemented tailwater reduction efforts as part of Phase 1 or 2, and/or have conceptualized projects for future implementation.
	2. Increased knowledge of how water law relates to tailwater	2. Number of Shasta Valley irrigators in high priority project areas signed up to implement tailwater reduction projects on their land.	2. Increase in landowner involvement in tailwater reduction projects in the Shasta Valley.			

B. Next Steps

While projects funded by this grant are essentially complete, the overall work to reduce tailwater impacts in the Shasta River is far from completed. Planned future work includes:

Adaptive Management & Real-time Monitoring

One of the most relevant issues associated with tailwater production is water management. A missing component in all of the constructed tailwater projects were adaptive management plans or agreements. However, plans to assist landowners with managing the newly implemented tailwater reduction projects is underway. The SVRCD tried adaptive management assistance on the two tailwater projects with funding assistance from California Trout, however the landowner backed out and refused the assistance. SVRCD has included language in its draft tailwater reduction policy to call for an adaptive management agreement to be signed by any project participants that accept funding for tailwater reduction. This will help ensure that proper adaptive management of future projects occurs.

In order to implement a valley-wide adaptive management plan to improve water quality, real time monitoring is essential. If landowners, agencies and other stakeholders have a better idea of what temperatures are at certain strategic locations, an adaptive management plan could be created and acted upon to reduce temperatures.

Individually identified projects:

Consistent Cold Water Releases

The Shasta River below Dwinnell Dam and Parks Creek from I-5 to the confluence has been identified as important refugia for Coho Salmon and essential for improving water quality in the entire watershed. One priority is to change spring water impoundments in the priority area, so a consistent discharge of cold water is released to the river while the landowners can continue to irrigate. The SVRCD has identified two springs on Parks Creek where outreach has been initiated where future projects can be implemented when the next phase of funding becomes available.

Projects Identified in the Upper Watershed Landowner Roundtable

Currently there are funds to form a landowner group in the Upper Watershed to identify different ways to improve water quality and conditions for fisheries. A working group has already been identified, with the goal of creating a Safe Harbor Agreement that will include projects that each landowner is willing to implement that will improve water quality conditions. Some projects that could be identified through this process are:

- Improved Infrastructure Below Dwinnell
- Improve Irrigation Efficiency on Cardoza Ranch
- Combining Diversions to Reduce Impacts to Spring Water
- Upper Shasta Spring Release/Management

- Barrier Removal

- Riparian Planting
- ‘
- Tailwater management

<u>Other Future Plans</u>

- Post project monitoring for all the projects funded under this grant agreement will be completed during the 2014 irrigation season.   Funded by Water Management Project – Phase 3.

- Working with the Shasta Valley Water Trust to ensure there are incentives in place to encourage better water management practices.

Appendix A

Tailwater Prioritization Criteria

Neighborhood/Area Impact Scoring Sheet

Neighborhood/Area Name: ______________________ TW Neighborhood Codes: ______________________

Impact Criteria of Neighborhood		Score	Wt	Totals	Notes:
1. Location in relation to identified salmon rearing areas:			**30**		
	Big Spring Creek	10			
	Upper Shasta River (RM 33 to 45)	10			
	Parks Creek (RM 0 to 9)	10			
	Shasta River (RM 24 to 33)	8			
	Parks Creek above I-5 (RM 9 to 17)	8			
	Shasta River (RM 16 to RM 24)	4			
	Other	1			
2. Quantity of total tailwater re-entering waterway in acre-feet per season:			**20**		
(May be calucated from neighborhood acreage and NRCS efficiency estimates)					
	>400	10			
	350 to 400	8			
	300 to 350	7			
	250 to 300	6			
	200 to 250	5			
	150 to 200	4			
	100 to 150	3			
	50 to 100	2			
	less than 50	1			
3. Temperature Effect (Degree TW affects River Temp)					
A. Individual tailwater neighborhoods potential temperature effect on river temperature.					
	degree C		**8**		
$(Temp_{TW} \times Q_{TW}) + (Temp_{R} \times Q_{R(w/o\ TW)})$ = Temp $_{R(w/\ TW)}$ - Temp $_{R\ (w/o\ TW)}$ = Temp change	>1.0	15			
$Q_{R\ (w/TW)}$	1.0 to 0.6	10			
Q-----cfs Temp----C	0.6 to 0.5	6			
**Use Average Daily Maximum Tailwater Temperture = 23 degrees (based on	0.4 to .05	5			
monitoring data)	0.3 to 0.4	4			
**Use Average Daily Maximum Tailwater Flow generated in TW accumulation	0.2 to 0.3	3			
model or monitoring data	0.1 to 0.2	2			
**Use Average Daily River Temperature and Flow (Best estimates used where	.001 to 0.1	1			
monitoring data was unobtainable)	0/unknown	0			
B. Accumulated temperature effect of reach due to tailwater			**10**		
Upper Shasta (RM34 to 45)	>10 degrees	10			
Parks Creeks	8>10 degrees	8			
Mid Shasta (RM 16 to 34) and Big Springs Creek	4>8 degrees	6			
Lower Shasta (RM 7 to RM 16)	<4	2			
	Unknown	1			
4. Monitoring Data Available			**4**		
	YES	10			
	NO	0			
5. Are exising tailwater reduction strategies implemented within this neighborhood?					
(needed if monitoring data not available)	YES	**			
Exisitng ponds and other TW projects can effect the accuracy of the	MAYBE	**			
model calculations.	NO				
Total Impact Score for Neighborhood:					

Initial Project Screening Sheet

Basic Project Concept: ______________________________

Landowners Involved: ______________________________

TW Neighborhood Codes: ______________________________

	Project Specific Tailwater Criteria		Score	Wt	Totals	Notes:
1.	**Is there direct tailwater re-entry to river within the Shasta watershed?**			**10**		
		YES	10			
		NO	**Project eliminated from funding consideration**			
2.	**Impact Score for "Neighborhood(s)" that project is within:**					
3.	**Is landowner(s) willing to participate in project:**			**10**		
		YES	10			
		NO	0			
		MAYBE	5			
4.	**Will project keep cold water in the river?**			**10**		
	-OR-	YES	10			
	Will project return cold water to the river?	NO	0			
		MAYBE	5			
5.	**Degree improvement is easily constructed:**			**6**		
	(based on access, permitting issues, proximity to	Easy	10			
	import materials, existing soil conditions, grade	Moderate	5			
	conditions, risk of failure)	Difficult	0			
6.	**Is the project intent to assist landowners in increasing water management?**					
	Or has increased water management already been implemented					
	in the neighborhood to reduce tailwater return flow?					
	(score yes if project is intended to improve existing tailwater	YES	40			
	reduction strategy)	NO	-40			
7.	**Would project further compromise water quality?**					
		YES	-40			
		NO	40			
8.	**Would project create a net increase in consumptive use of water?**					
	(ie. new ground in production, increase off channel storage, etc)	YES	-40			
		NO	40			
9.	**Would project negatively impact third parties?**					
	(reduce stream flow, change natural drainage patterns, etc)	YES	-40			
		NO	40			
10.	**Does project only benefit one landowner?**					
		YES	0			
		NO	20			
11.	**Would realized water savings (if any) from project be dedicated river flow?**					
		YES	50			
		NO	0			
	Total Screening Score for Tailwater Project:					

Project Scoring Sheet

Specific Project Description: ____________________

Neighborhoods/Area Name: ____________________

**(Project design is needed to effectively evaluate project, including pre-project tailwater monitoring data, cost estimates and baseline assessments)

Project Specific Tailwater Criteria			Score		Totals	Notes:
		Total Impact Score for Neighborhood:				
		Total Screening Score for Tailwater Project:				
12.	**A. Amount of management required by landowner to realize project benefits.**			**4**		
		Low	10			
		Moderate	5			
		High	0			
	B. Potential operations cost ($/acre-ft/yr) required by landowner to realize project benefits.					
		Low	10			
		Moderate	5			
		High	0			
13.	**Degree which landowner will share in the project implementation cost?** *(in-kind labor at NRCS rates- can use agency as cost share)*	*Scored as 1 point per percent*		**2**		
14.	**Has landowner implemented tailwater reduction in past?** *(which reduced tailwater return and/or improved WQ in river?)*			**2**		
		YES	10			
		NO	0			
15.	**% of neighborhoods TW that would be reduced due to project** *(Must also meet criteria #4 in order to be scored)*		=			
Neighborhood TW Q=	ac-feet Project's TW reduction=					
	Assess percent TW reduced due to existing system and adjust impact score)					
16.	**Estimated water quality benefit expected from project activities**		*River Temp reduced*		10	*Note: Circle score if project will likely accomplish*
	(note:temperature, flow, dissolved oxygen and/or nutrient loading		*Flow increased*		10	*water quality improvement.*
	improvements to assist in project evaluation)		*DO increased*		10	
			Nutrient load reduced		10	
17.	**Cost Effectiveness:**			**8**		
	(Impact Score#15 score)/ Cost of Project* life span of project (NRCS chart) =*					
18.	**Would project impact groundwater due to recharge loss?**					
		YES	-10			
		NO/UNKNOWN	0			
		Total Score for Tailwater Project:				

<u>Appendix B</u>

Items for Submittal

Item	DESCRIPTION	CRITICAL DUE DATE	Date Submitted
EXHIBIT A – SCOPE OF WORK			
A.	PLANS AND COMPLIANCE REQUIREMENTS		
1	Stream Reach for Project Site and Monitoring Locations	Complete	3/24/2010
2	Project Assessment and Evaluation Plan (PAEP)	Complete	3/24/2010
	Non Point Source Pollution Reduction Project Follow-up Survey Form		Annually by 12/15
3	Monitoring Plan (MP)	Complete	4/2/2010
	Monitoring Reports		Annually
4	Quality Assurance Project Plan (QAPP)	Complete	4/2/2010
5	Copy of Final CEQA/NEPA Documentation	Complete	**4/15/2011**
6	Land Owner Agreement(s)		7/26/12 &12/12/13
7	Applicable Permits		3/15/2012
B.	WORK TO BE PERFORMED BY GRANTEE		
1	EDUCATION AND OUTREACH		
1.1	Presentation on water transaction		9/17/2013
1.3	Meetings Notes from Three (3) Tailwater Landowner Meetings		12/20/2013
1.4	Meeting Notes and Maps of Potential Project Locations		12/20/2013
2	PLANNING AND REFINEMENT OF THE TAILWATER ACCUMULATION MODEL		
2.3	Update Mapping including Digitized Water Right Information		Dec-13

Item	DESCRIPTION	CRITICAL DUE DATE	Date Submitted
EXHIBIT A – SCOPE OF WORK			
3	IMPLEMENTATION OF TAILWATER REDUCTION PROJECTS		
3.1	Complete Prioritization Matrix		7/25/2012
3.2	List of Projects to be Implemented		10/23/2013
3.3	Final Designs of Implementation Projects		Continuously
3.4	As-built Plans for Projects Implemented		3/14/12, 7/9/12, 11/5/13,12/12/13
3.5	Final Designs for MWCD		12/31/2013
3.6	Final Designs for SWA		12/31/2013
4	MONITORING		
4.1.2	Pre-project Monitoring Report		12/9/2013
4.1.2	Post-project Monitoring Reports – Two (2)		12/9/2013
4.2.1	Maps Showing Locations of Monitoring Sites.		4/19/11, 7/26/12, 3/25/13
4.2.2	Sites Monitored and Data Collected Reports		12/17/2013

Item	DESCRIPTION	CRITICAL DUE DATE	Date Submitted
EXHIBIT A – SCOPE OF WORK			
5	POST IMPLEMENATION ACTIVITIES		
5.1	Photos and Attendee List From the Two Project Implementation Tours		8/14/2013
5.2	Page Shots of Tailwater Web Page Created on the Grantee’s Webpage		8/14/2013
EXHIBIT B – INVOICING, BUDGET DETAIL, AND REPORTING PROVISIONS			
A.	INVOICING		Monthly
E.	REPORTS		
1	Progress Reports by the Twentieth (20th) of the Month.		Monthly
2	Natural Resource Projects Inventory (NRPI) Project Survey Form	Before Final invoice	
3	Draft Project Report	12/31/2013	10/8/2013
4	Final Project Report	1/15/2013	12/31/2013
5	Final Project Summary	Before final invoice	

<u>Appendix C</u>

Project Photos

Big Springs Ranch Head Gate Structure

Pre-Project

The return channel was closed with the head gate

Post Project

The new head gate keeps a consistent flow delivered to the ranch's irrigation system, while anything extra is returned to Big Springs Creek

Meamber Tailwater Re-use Improvement Project

During Implementation

Installing new stand pipe to collect and direct tailwater to the river pump, to use in-lieu of river diversion.

Post Project

Tailwater can be ponded up and released to fulfill irrigation demands in-lieu of river diversion

Freeman Irrigation Efficiency Project

Pre-Project

Buried transmission lines, gated pipe and stock water system

During Construction

Hole in the Ground Ditch Rehabilitation

Pre- Project

Concrete lined ditch is broken and leaky

Post Project

Portions that were leaky, were removed and replaced with new poured in place concrete lining

Rice-Banhart Tailwater Pick-up Ditch Rehabilitation

Pre-Project

Existing ditch has been over grown and non-functioning

Post-Project

Ditch was re-shaped and a drop structure installed to collect water and direct it to the SWA pump station. Tailwater will be used in-lieu of river diversion

Kuck Ranch Tailwater Re-use Improvement Project

Pre-Project

Post Project

Section 1- Water Quality Improvement Monitoring

<u>Introduction</u>

The Shasta Valley Resource Conservation District (SVRCD) has a contract with the State Water Resources Control Board (SWRCB) for tailwater reduction (Tailwater 2- Agreement No. 09-666-551). The purpose of this project is to reduce water quality impacts associated with returns of agricultural run-off (tailwater). Outlined in the contract as pre and post project monitoring, the monitoring of tailwater quantity and quality is an essential project component in demonstrating improvements in water quality. AquaTerra Consulting has been implementing the monitoring plan that has been approved by the SWRCB and has gained access from private landowners during the term of this agreement. The monitoring data has assisted in the neighborhood and project prioritization process, as well as pre-project monitoring. Comparing pre and post project monitoring data will enable SVRCD and SWRCB to determine the effectiveness of tailwater reduction efforts. This report will outline the pre-project and post-project conditions for the projects where funding was allocated under the Tailwater 1 grant (Agreement No. 06-271-551-2), where only pre-project conditions were reported for those implementation projects due to grant timelines. This report will also show the pre-project and post-project conditions for projects implemented under this grant agreement where both sets of data were collected, otherwise only pre-project conditions are reported.

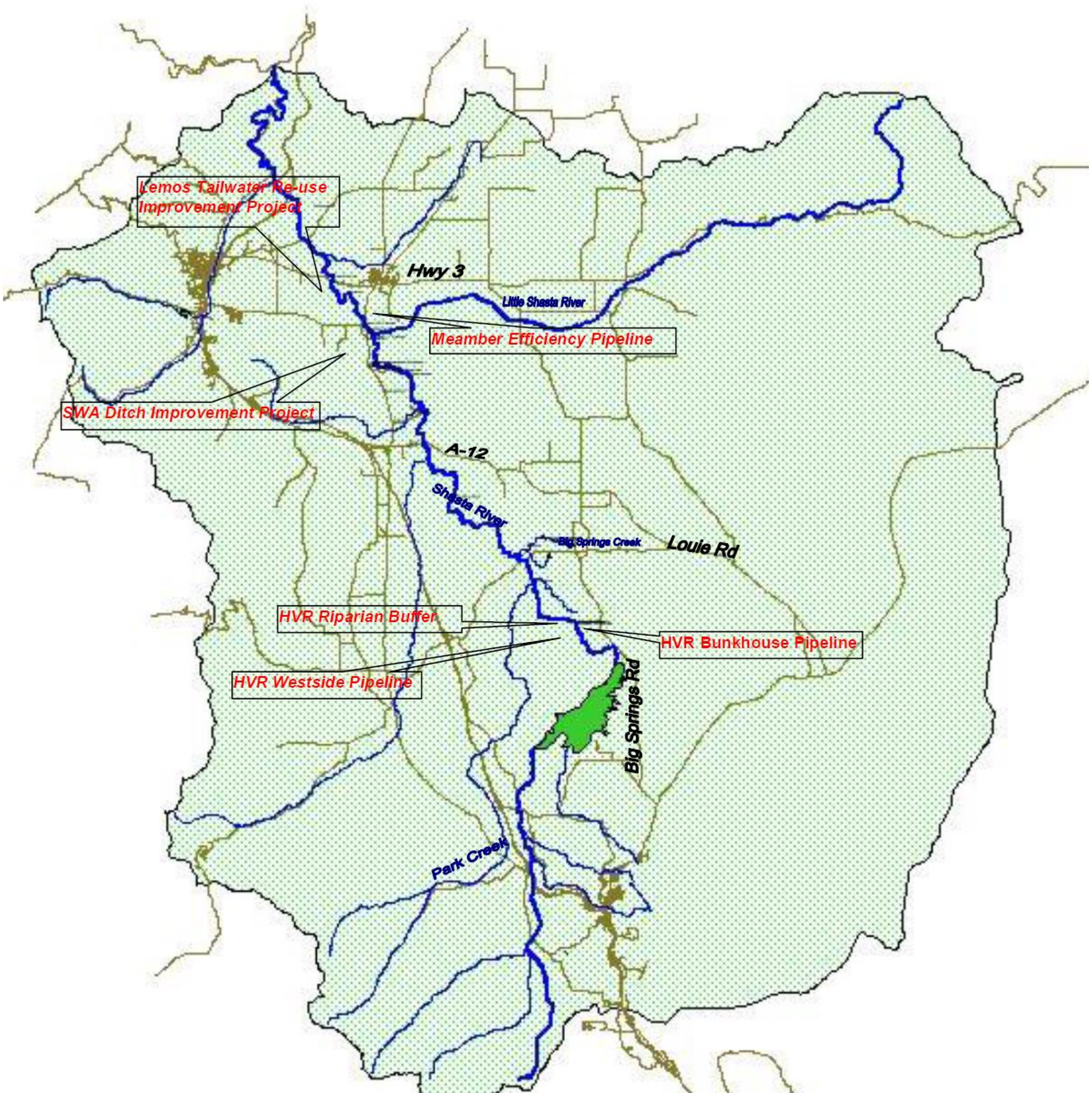
<u>General Monitoring Details</u>

Tailwater Monitoring Summary

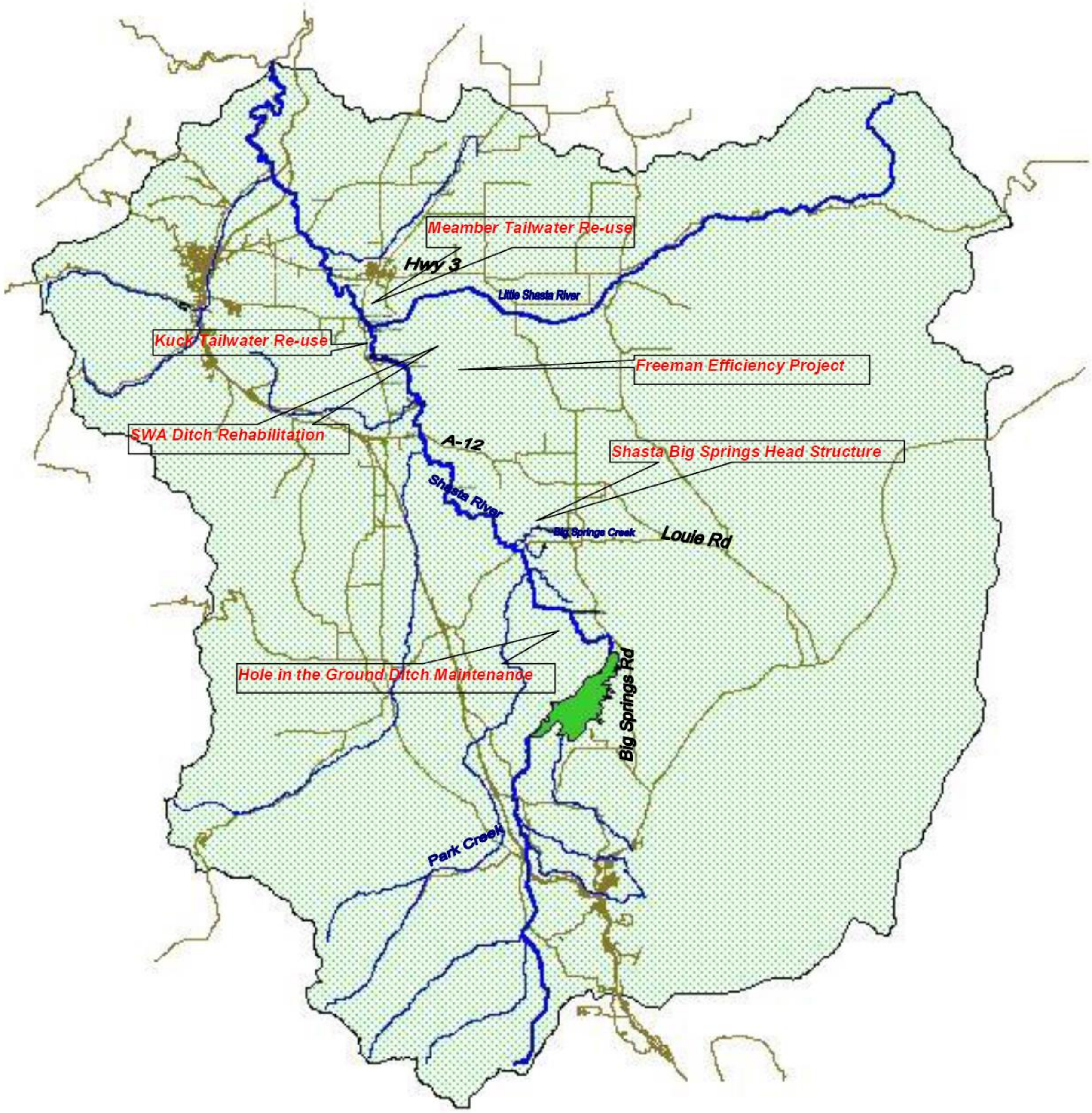
Over the course of this grant agreement and the previous agreement, a total of 55 sets of tailwater returns have been monitored, some of these locations were repeated multiple years. Six sites had been prioritized and identified for implementation of tailwater reduction projects (locations shown on Figure 1) with Tailwater 1 funding and six sites were identified for implementation with Tailwater 2 funding (location shown on Figure 2). All locations were monitored pre-project and post-project if the timing was possible within the grant schedule. Access was acquired for monitoring flow, temperature and water quality for pre-project conditions. All tailwater monitoring locations *<u>related to the tailwater reduction construction projects</u>* are shown on Figure 3- Tailwater Monitoring Location Map. Tailwater flow was measured using HACH 910 area-velocity meters in tailwater streams using existing culverts or sandbagged pipes. Temperature was logged using On-set Tidbits, which logged temperature every hour, in both the tailwater stream and river (where river access could be obtained).

Shasta River Monitoring Summary

In addition to tailwater monitoring, watershed monitoring was also attempted. D-opto Loggers, which log both dissolved oxygen (DO) and temperature, were installed in the Shasta River at ten locations (under this grant agreement): Upper Shasta, Nelson Ranch, A-12 Bridge, two sites at Shasta River Water Association pump station, Montague-Grenada Bridge, Big Springs Creek, Lower Canyon, and two sites at Araujo pump station. All locations are shown on Figure 4- Dissolved Oxygen Monitoring Location Map. River discharge data review was performed on data collected from USGS maintained gage at the Montague Weir gage and this location is shown in Figure 5- River Gage Location Map. A brief summary of ambient air temperature is included in this summary, as it has a dramatic effect on tailwater and river conditions.



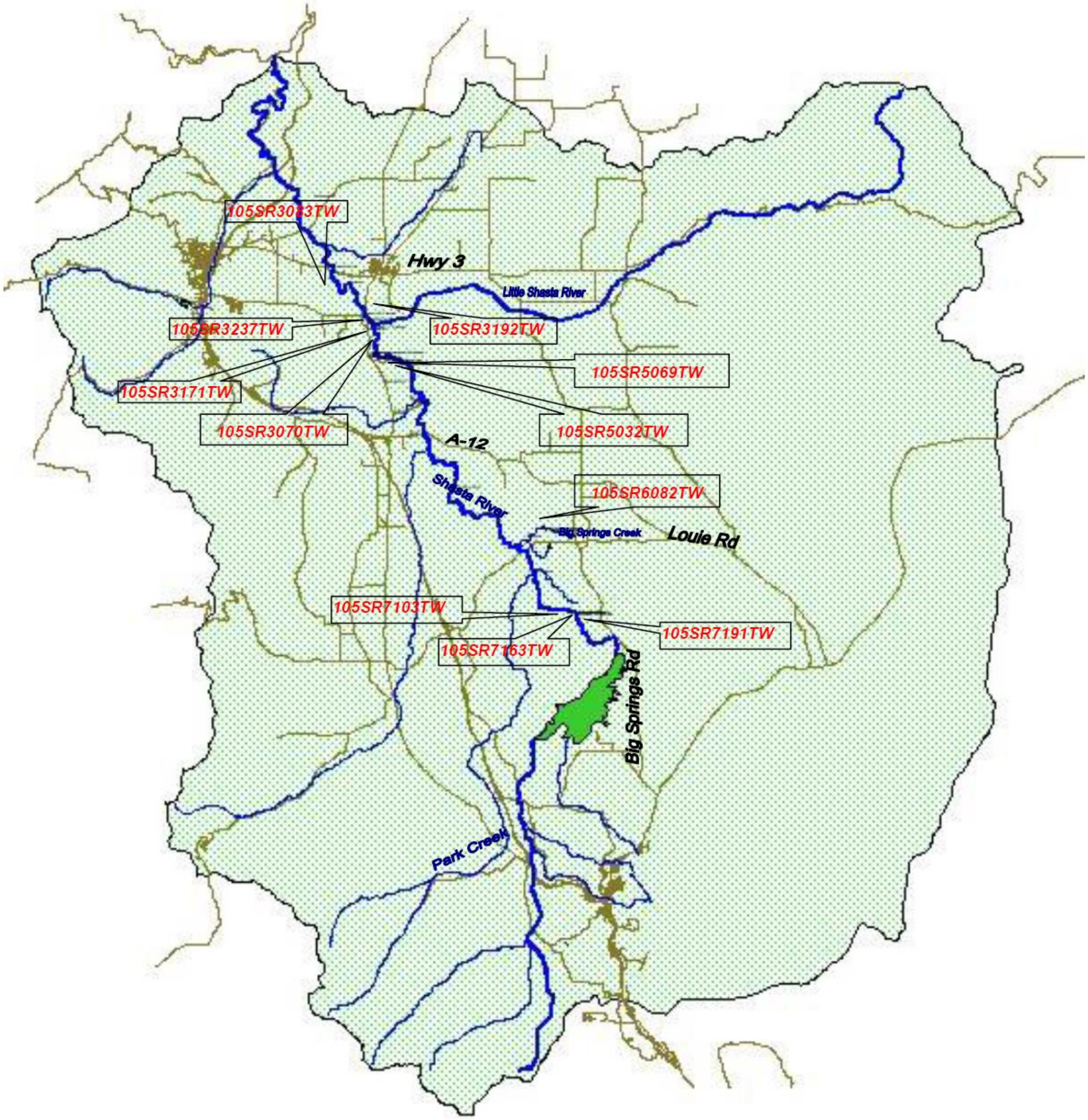
Shasta Valley RCD- Tailwater 1 Project
Figure 1
Tailwater 1 Reduction Project Location Map



Shasta Valley RCD- Tailwater 2 Project

Figure 2

Tailwater 2 Reduction Project Location Map



AquaTerra CONSULTING

Shasta Valley RCD- Tailwater Reduction Project
Figure 3
Tailwater Monitoring Location Map

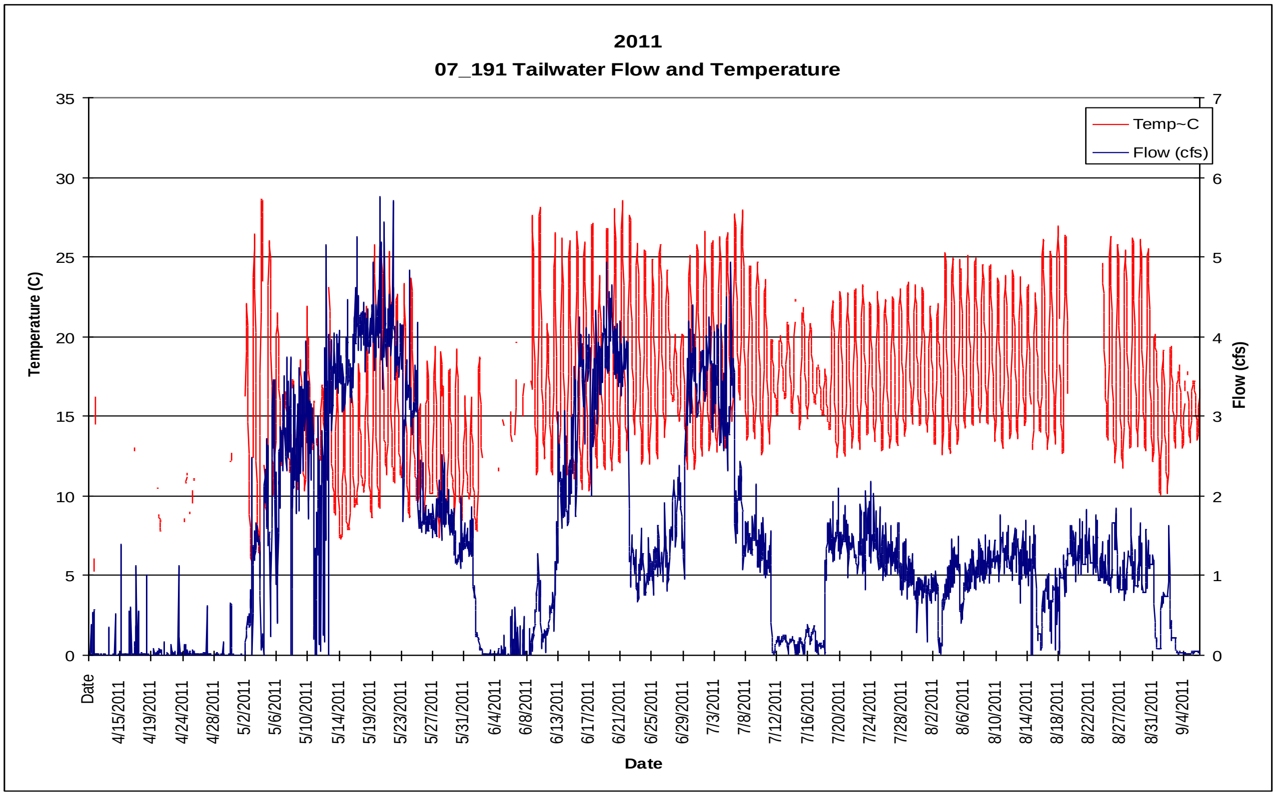
Section 2- Tailwater 1 Pre & Post Project Monitoring Results

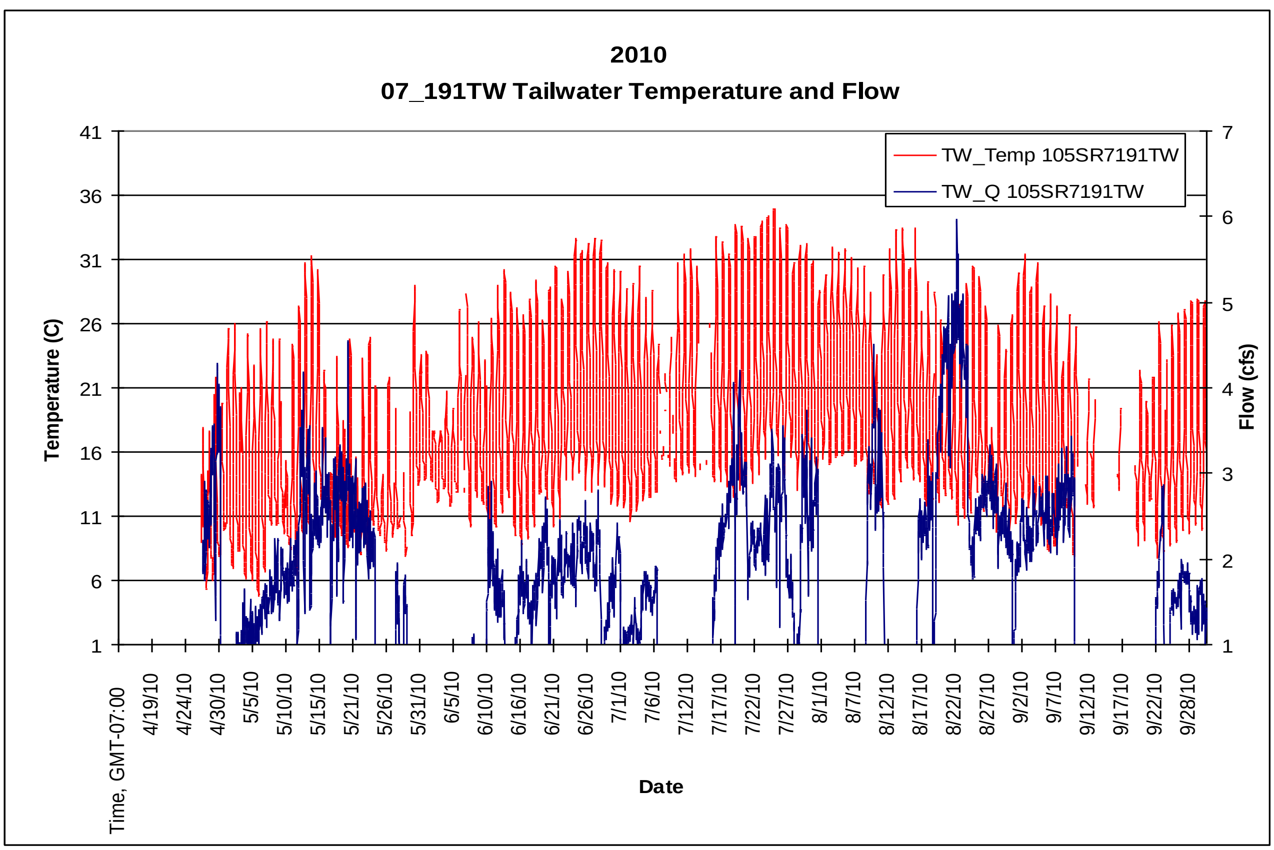
Hidden Valley Bunkhouse Project

Pre/Post-Project Results at 07-191TW

This return was monitored over the 2010 and 2011 irrigation seasons, documenting pre-project conditions. An irrigation efficiency project, called Hidden Valley Ranch Bunkhouse Pipeline Project was implemented within this neighborhood to reduce the amount of tailwater produced. The project was constructed in September 2011. The site was also monitored in 2012 and for a limited amount of time in 2013 to document post project conditions. Included below is a comparison of the monitoring data before and after project, as well as the graphical data.

Photo: Site 07_191
Taken looking downstream of tailwater stream. (Sensor in the black pipe, center frame).
Shasta River in background.


2011
07_191 Tailwater Flow and Temperature
Temp~C
Flow (cfs)
Temperature (C)
Flow (cfs)
Date
4/15/2011
4/19/2011
4/24/2011
4/28/2011
5/2/2011
5/6/2011
5/10/2011
5/14/2011
5/19/2011
5/23/2011
5/27/2011
5/31/2011
6/4/2011
6/8/2011
6/13/2011
6/17/2011
6/21/2011
6/25/2011
6/29/2011
7/3/2011
7/8/2011
7/12/2011
7/16/2011
7/20/2011
7/24/2011
7/28/2011
8/2/2011
8/6/2011
8/10/2011
8/14/2011
8/18/2011
8/22/2011
8/27/2011
8/31/2011
9/4/2011
Date


2010
07_191TW Tailwater Temperature and Flow
TW_Temp 105SR7191TW
TW_Q 105SR7191TW
Temperature (C)
Flow (cfs)
Time, GMT-07:00
4/19/10
4/24/10
4/30/10
5/5/10
5/10/10
5/15/10
5/21/10
5/26/10
5/31/10
6/5/10
6/10/10
6/16/10
6/21/10
6/26/10
7/1/10
7/6/10
7/12/10
7/17/10
7/22/10
7/27/10
8/1/10
8/7/10
8/12/10
8/17/10
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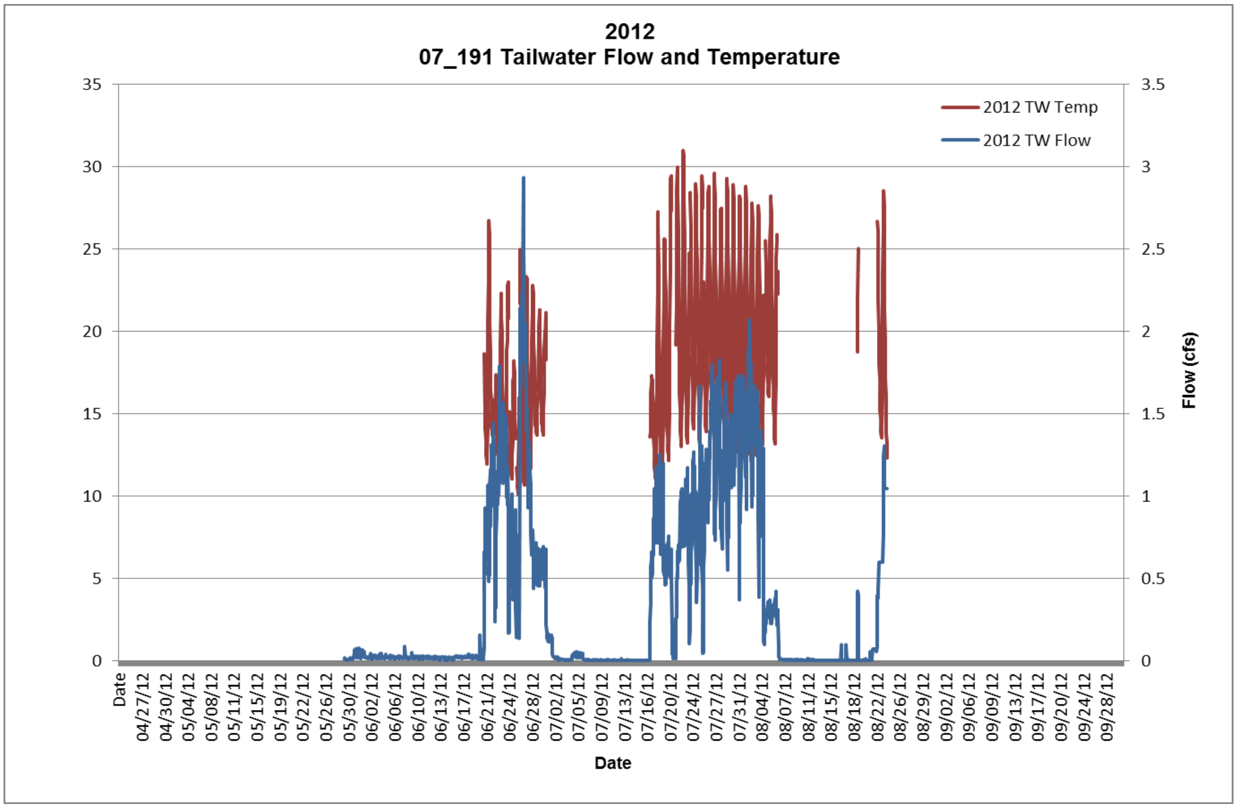
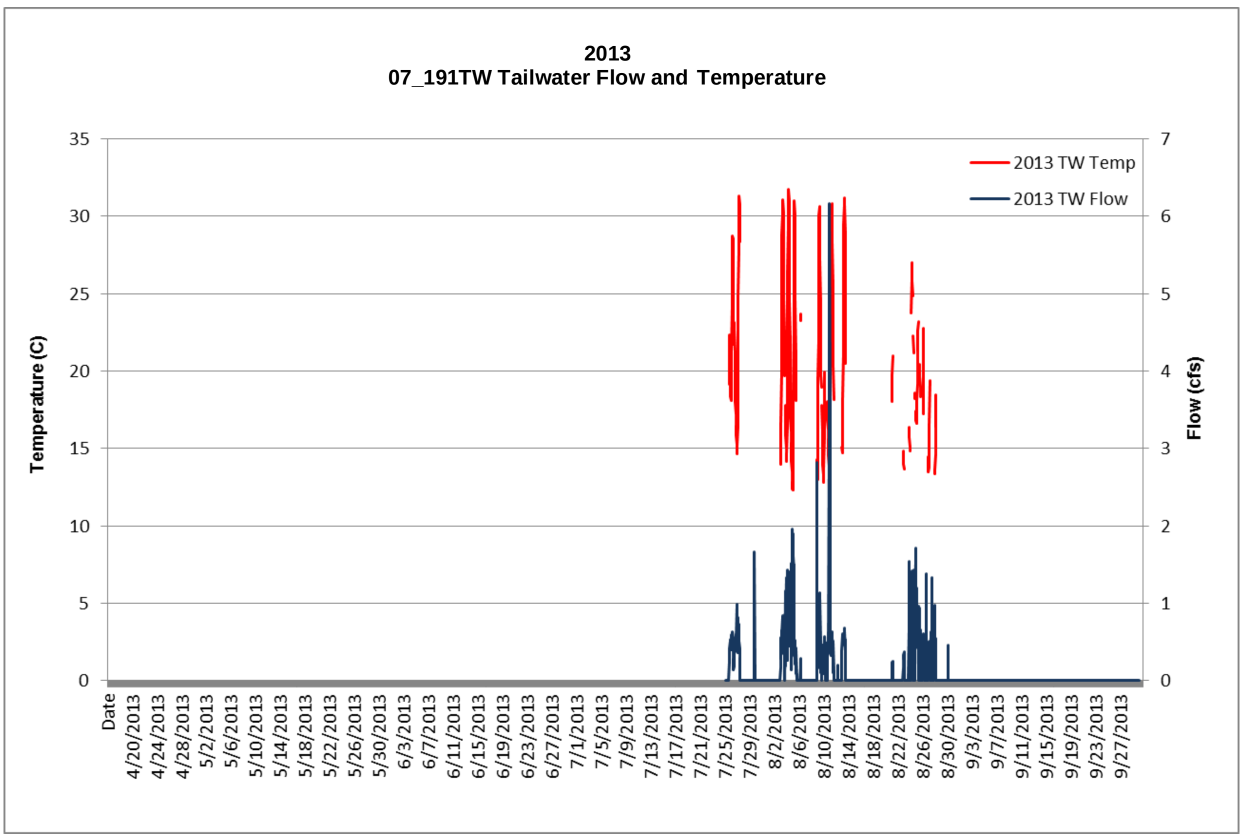
9/2/10
9/7/10
9/12/10
9/17/10
9/22/10
9/28/10
Date


2012
07_191 Tailwater Flow and Temperature
2012 TW Temp
2012 TW Flow
Flow (cfs)
Date


2013
07_191TW Tailwater Flow and Temperature
2013 TW Temp
2013 TW Flow
Temperature (C)
Flow (cfs)

Pre-Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR7191TW	2011	5.76	1.37	499.00	5.25	28.60	16.68
105SR7191TW	2010	5.97	1.51	546.75	5.82	34.97	18.72

The pre and post project summary tables show that the total acre feet of tailwater returning to the Shasta was greatly reduced after the project was completed (at this monitoring location). It should be noted the data set for both 2012 and 2013 is a shorter time period than 2010 and 2011 and could be a factor for the reduced amount tailwater measured. Total acre-feet is calculated based on the average discharge that was actually measured and assumed that average would be the same for the entire irrigation season. Reviewing the tailwater flow graphs, pre-project conditions at this site frequently went over four cubic feet per second (cfs) and after the project, flow generally stayed below three cfs. If that assumption is correct, doing this project reduced the amount of tailwater produced at this site by almost 75%. The maximum temperature of the tailwater has increased, which is to be expected as irrigation coverage has improved, thus spreading the water out more and causing increased heating, but because the volume is smaller the overall impact is improved.

Post-Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR7191TW	2013	*6.171*	*0.102*	*158.5*	*12.3*	*31.74*	*20.43*
105SR7191TW	2012	*2.934*	*0.347*	*126.11*	*10.05*	*30.95*	*18.27*

Hidden Valley Westside Pipeline Project

Pre/Post-Project Results at 07-103TW

This location was monitored in 2010 and 2011, the yearly data is included below to document the pre-project conditions. This return could be affected by two different tailwater reduction projects that were implemented in Fall 2011; Hidden Valley Westside Pipeline Project and Hidden Valley Ranch Riparian Buffer Project. Both projects were constructed in September 2011. The site was also monitored in 2012 to document post project conditions. Included below is a comparison of the monitoring data before and after project, as well as the graphical data.

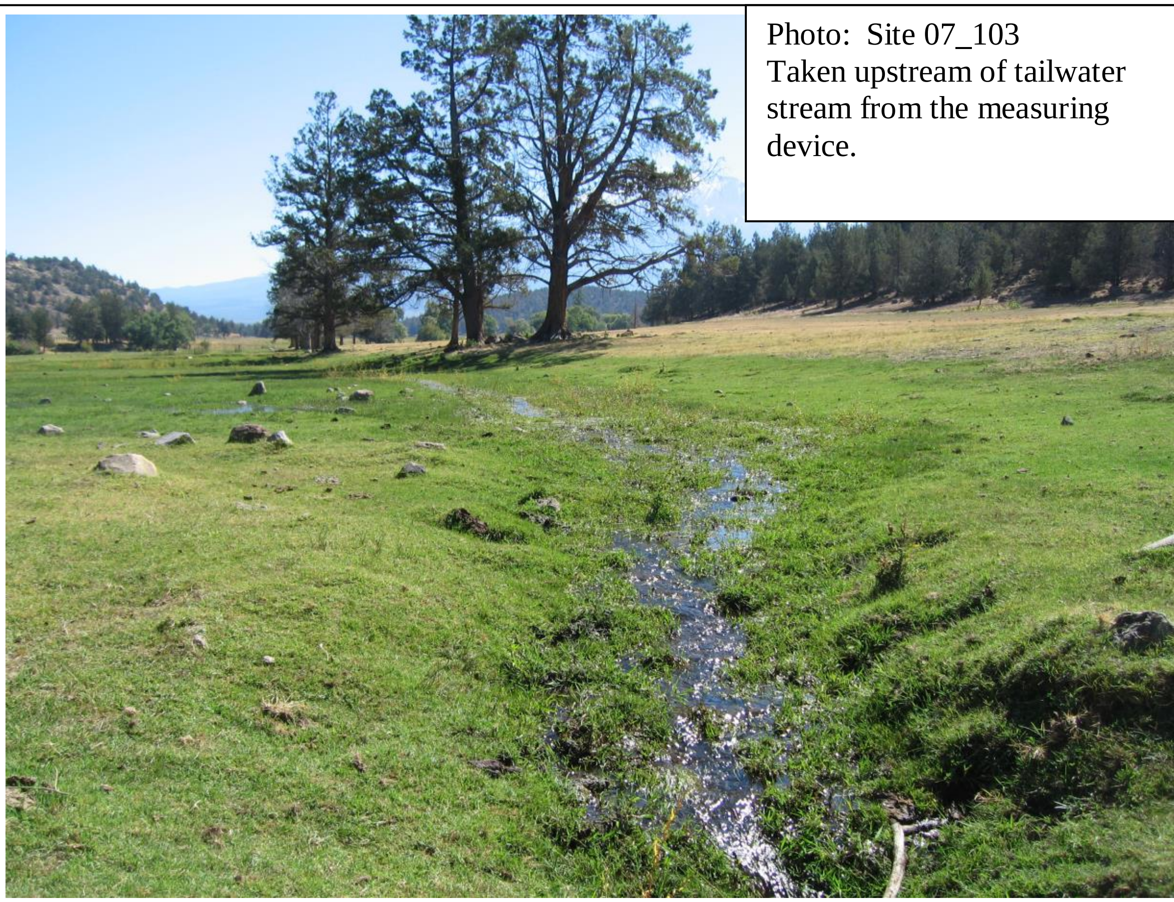
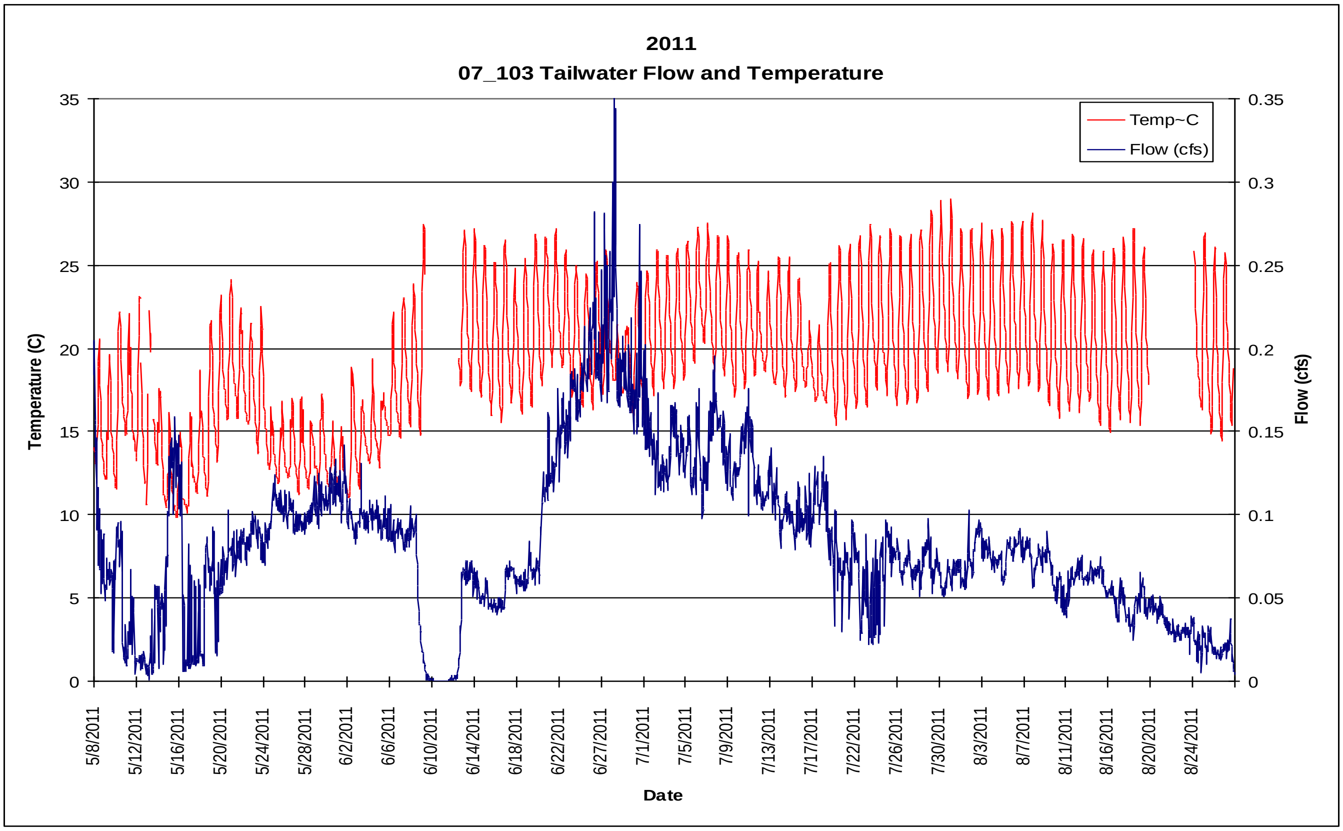
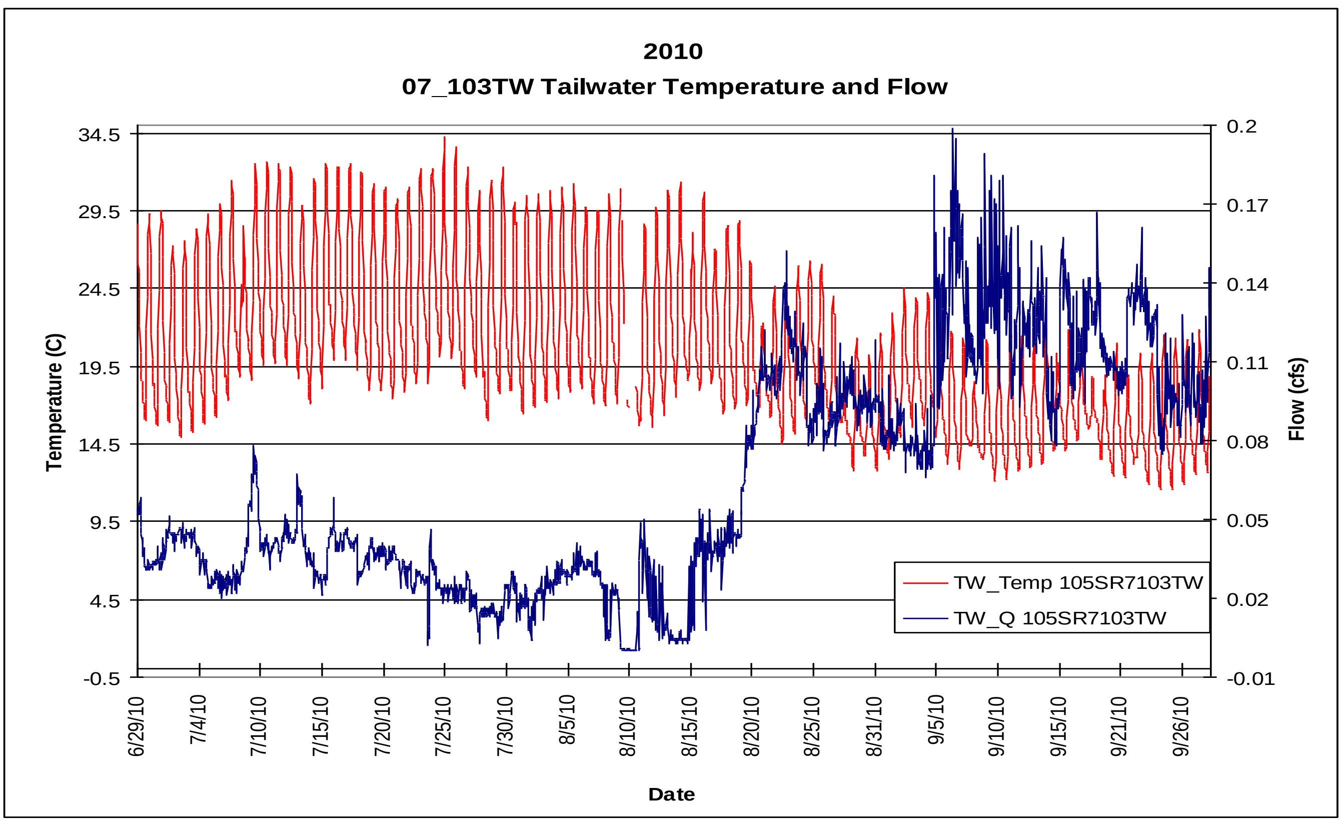


Photo: Site 07_103
Taken upstream of tailwater stream from the measuring device.


2011
07_103 Tailwater Flow and Temperature
Temp~C
Flow (cfs)
Temperature (C)
Flow (cfs)
Date
35
30
25
20
15
10
5
0
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
5/8/2011
5/12/2011
5/16/2011
5/20/2011
5/24/2011
5/28/2011
6/2/2011
6/6/2011
6/10/2011
6/14/2011
6/18/2011
6/22/2011
6/27/2011
7/1/2011
7/5/2011
7/9/2011
7/13/2011
7/17/2011
7/22/2011
7/26/2011
7/30/2011
8/3/2011
8/7/2011
8/11/2011
8/16/2011
8/20/2011
8/24/2011


2010
07_103TW Tailwater Temperature and Flow
TW_Temp 105SR7103TW
TW_Q 105SR7103TW
Temperature (C)
Flow (cfs)
Date
34.5
29.5
24.5
19.5
14.5
9.5
4.5
-0.5
0.2
0.17
0.14
0.11
0.08
0.05
0.02
-0.01
6/29/10
7/4/10
7/10/10
7/15/10
7/20/10
7/25/10
7/30/10
8/5/10
8/10/10
8/15/10
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9/5/10
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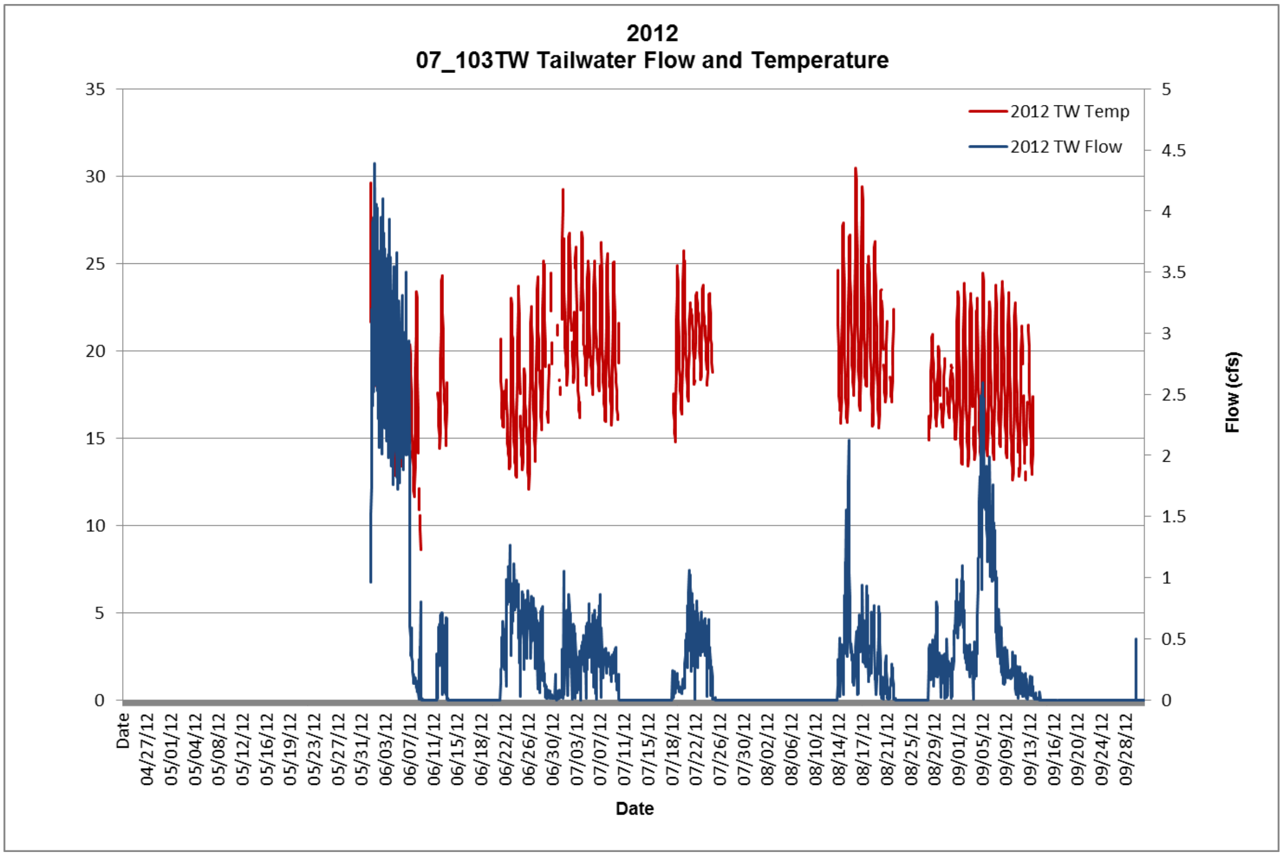
9/15/10
9/21/10
9/26/10



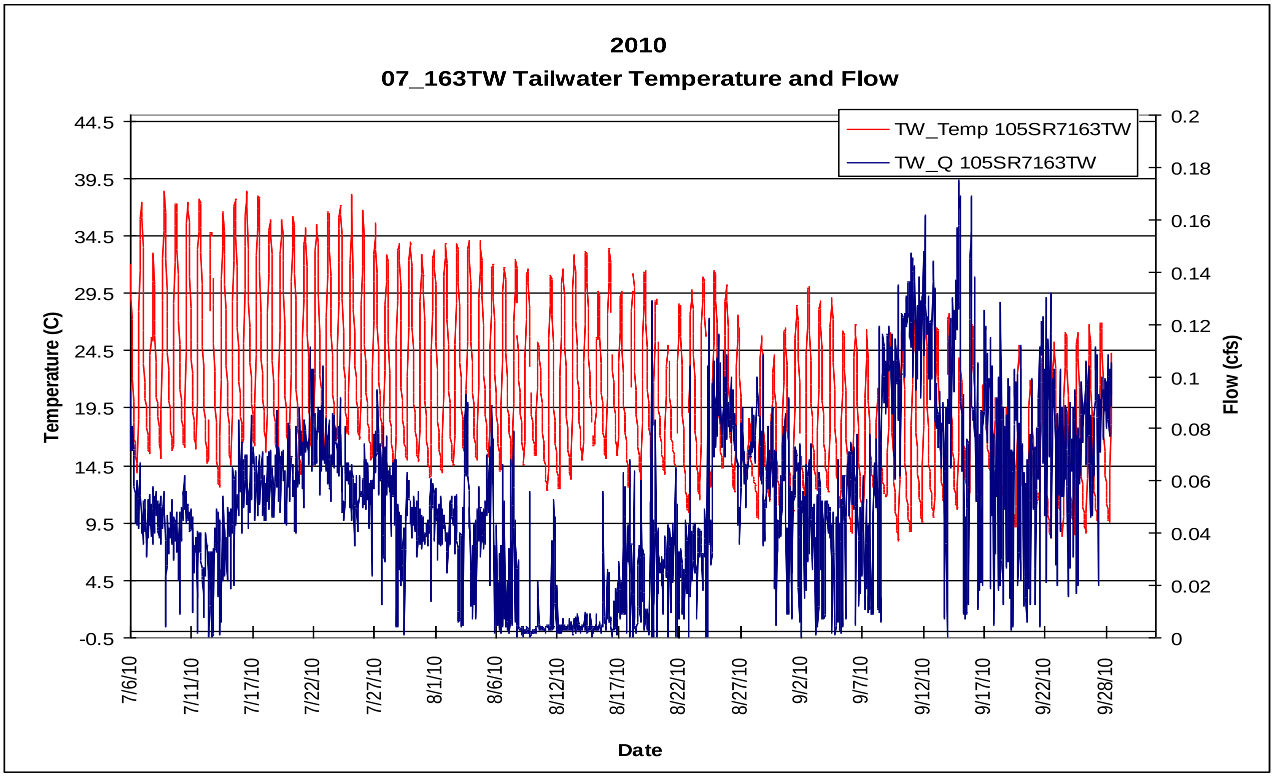
This site saw a large increase in tailwater production after the project was implemented. This can be expected to some extent, as it does take some time to fine tune the different irrigation practices that come with a new pipeline. This site was monitored in 2013, however the site was not set up correctly and the data not useable. It is recommended that this site be monitored in the future and the landowner/irrigator be alerted when tailwater production becomes excessive.

Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR7103TW	2012	*7.65*	*0.37*	*134.8*	*6.97*	*30.47*	*17.25*
105SR7103TW	2011	0.36	0.05	20.09	9.82	28.90	19.27
105SR7103TW	2010	0.20	0.06	23.57	11.57	34.20	20.49

Pre/Post-Project Results at 07-163TW

This location was monitored in 2010 and 2011. This return could be reduced by the construction of Hidden Valley Westside Pipeline Project. The project was constructed in September 2011. The site was also monitored in 2012 to document post project conditions. Included below is a comparison of the monitoring data before and after project, as well as the graphical data.

Photo: Site 07_163
Taken of tailwater measuring device.
(Sensor in pipe, sandbagged in place)


2010
07_163TW Tailwater Temperature and Flow
TW_Temp 105SR7163TW
TW_Q 105SR7163TW
Temperature (C)
44.5
39.5
34.5
29.5
24.5
19.5
14.5
9.5
4.5
-0.5
Flow (cfs)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
7/6/10
7/11/10
7/17/10
7/22/10
7/27/10
8/1/10
8/6/10
8/12/10
8/17/10
8/22/10
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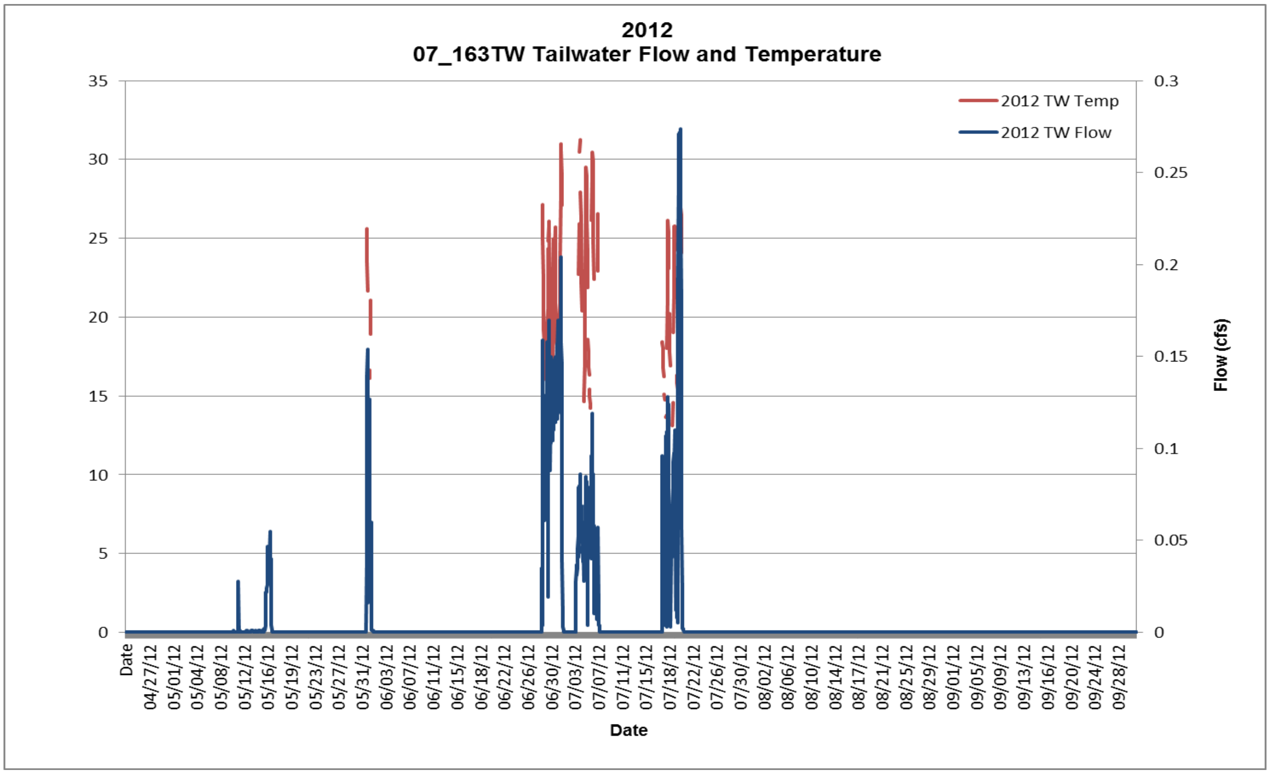
9/2/10
9/7/10
9/12/10
9/17/10
9/22/10
9/28/10
Date



The results shown in table below summarize the amount of tailwater reduced from the Hidden Valley West Forty Pipeline Project. It would be fair to consider the 2010 data a more reasonable estimate for pre-project conditions, as 2011 data was affected by repeated delayed start of the actually construction project, thus was removed from the this comparison. Ninty-percent of the tailwater was reduced at this site due to the project activities and altered irrigation management.

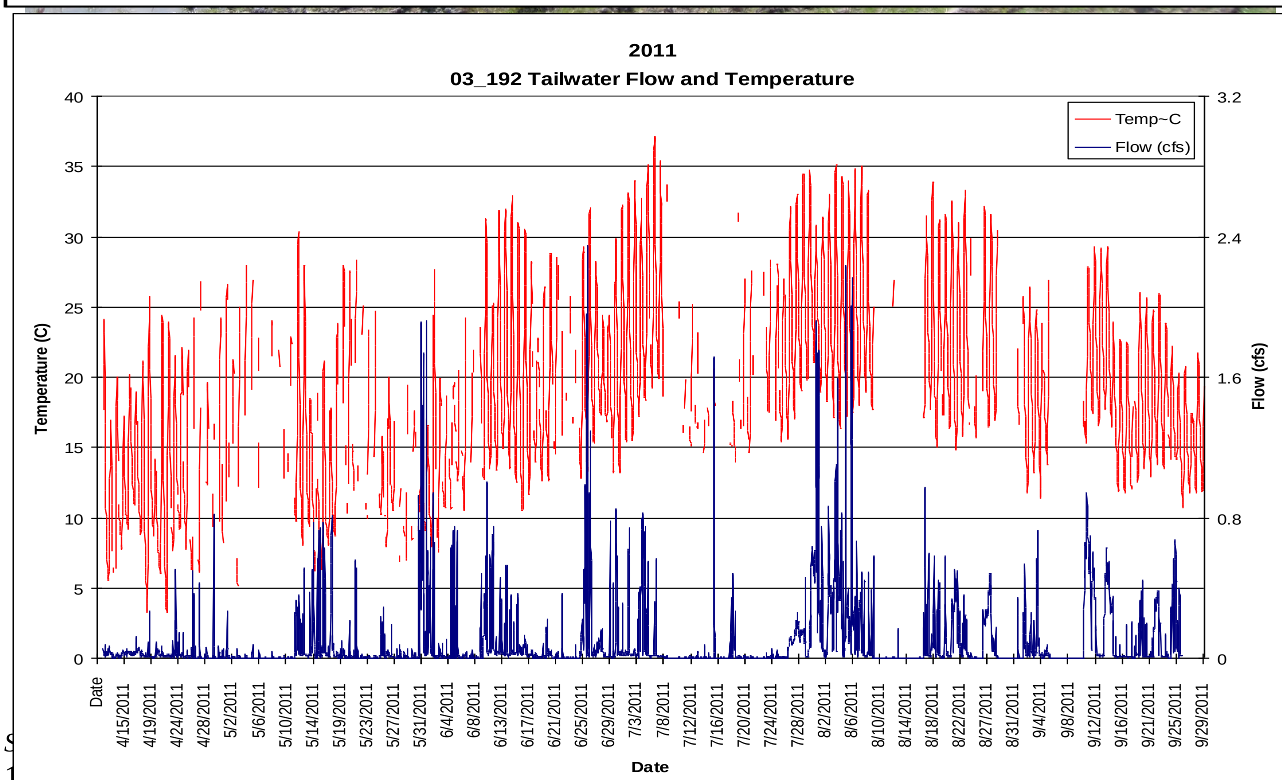
Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR7163TW	2012	*0.274*	*0.005*	*1.91*	*6.86*	*31.25*	*20.53*
105SR7163TW	2010	0.18	0.05	19.04	7.97	38.39	20.45

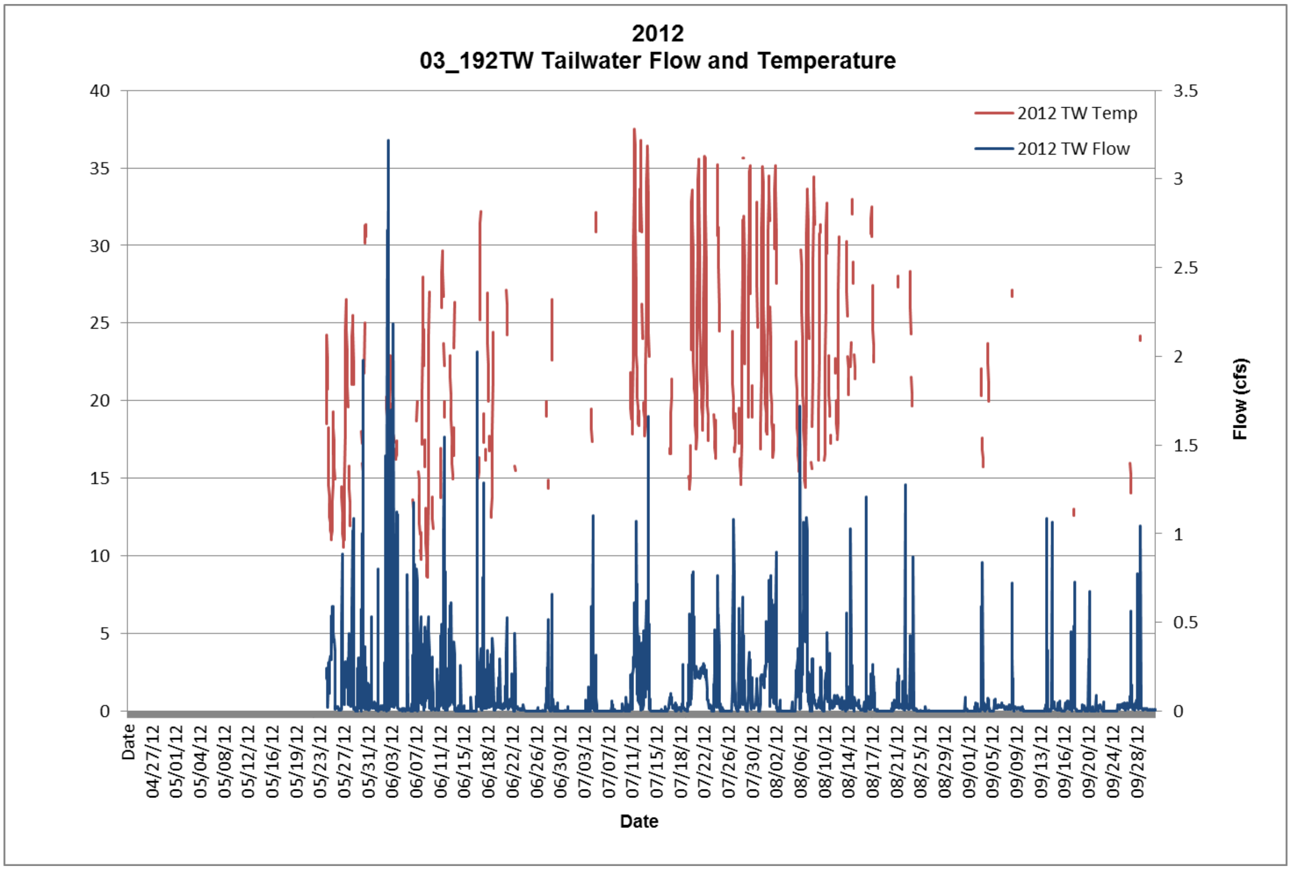
Meamber Efficiency Project

Pre/Post-Project Results at 03-192TW

Site 03_192TW was monitored in 2011 and tailwater was present fairly consistently, with a maximum flow of 2.351 cfs, which occurred fairly consistently on rotation. This return could be affected by Meamber Efficiency Project, which was implemented in October 2011. The site was also monitored in 2012, prior to the implementation of the Meamber Tailwater Re-use Improvement Project.

Photo: Site 03-192TW
Tailwater accumulated in this low-lying area and flowed through the black culvert (in the center of the photo) to be returned to the Shasta River





Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR3192TW	2011	*2.35*	*0.087*	*31.66*	*2.79*	*37.12*	*18.79*
105SR3192TW	2012	*3.216*	*0.085*	*30.86*	*8.62*	*37.53*	*21.59*

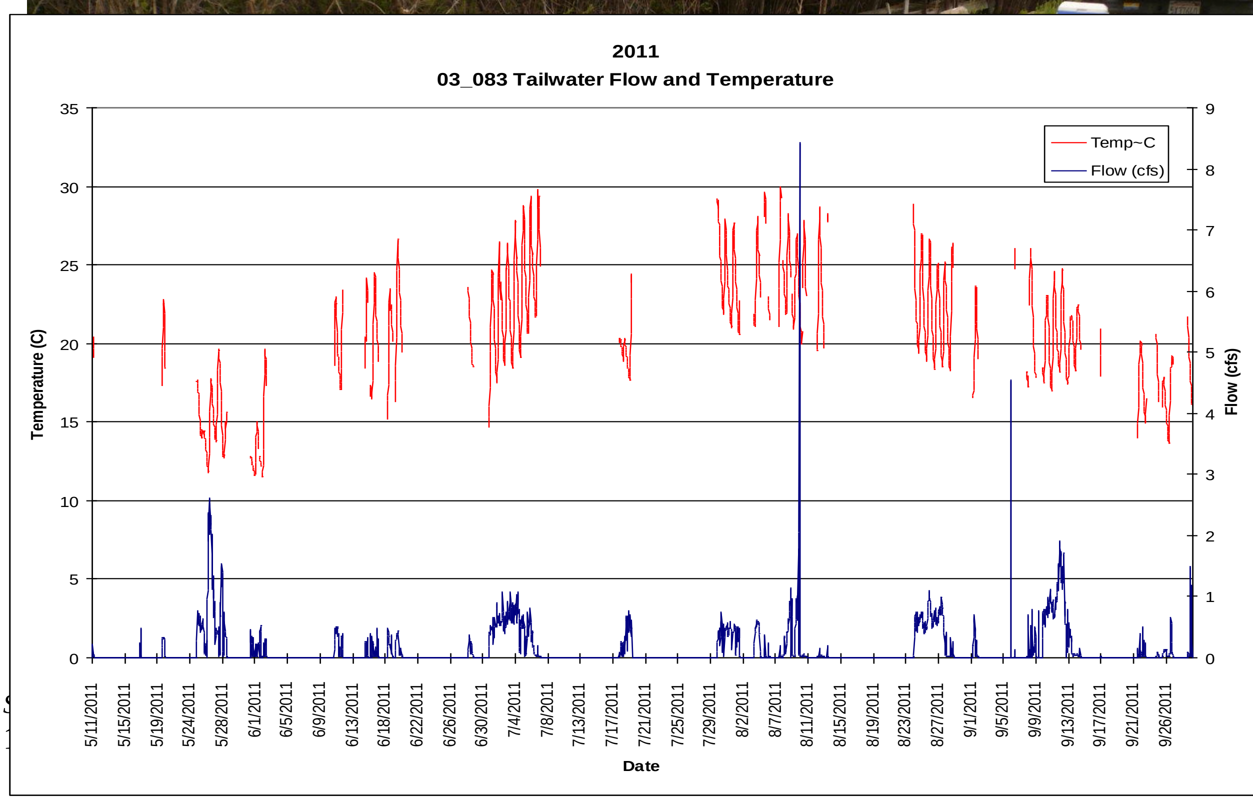
The pipeline efficiency project did not prove to reduce tailwater drastically on the Meamber Ranch, however the final step of improvements was implemented under Tailwater 2. The Meamber Tailwater Re-use Improvement Project connects the existing tailwater pond to the river diversion pump, so tailwater is used in-lieu of river water. This resulted in close to a 100-percent reduction in tailwater re-entering the stream and equally reduced amount of water diverted from the system.

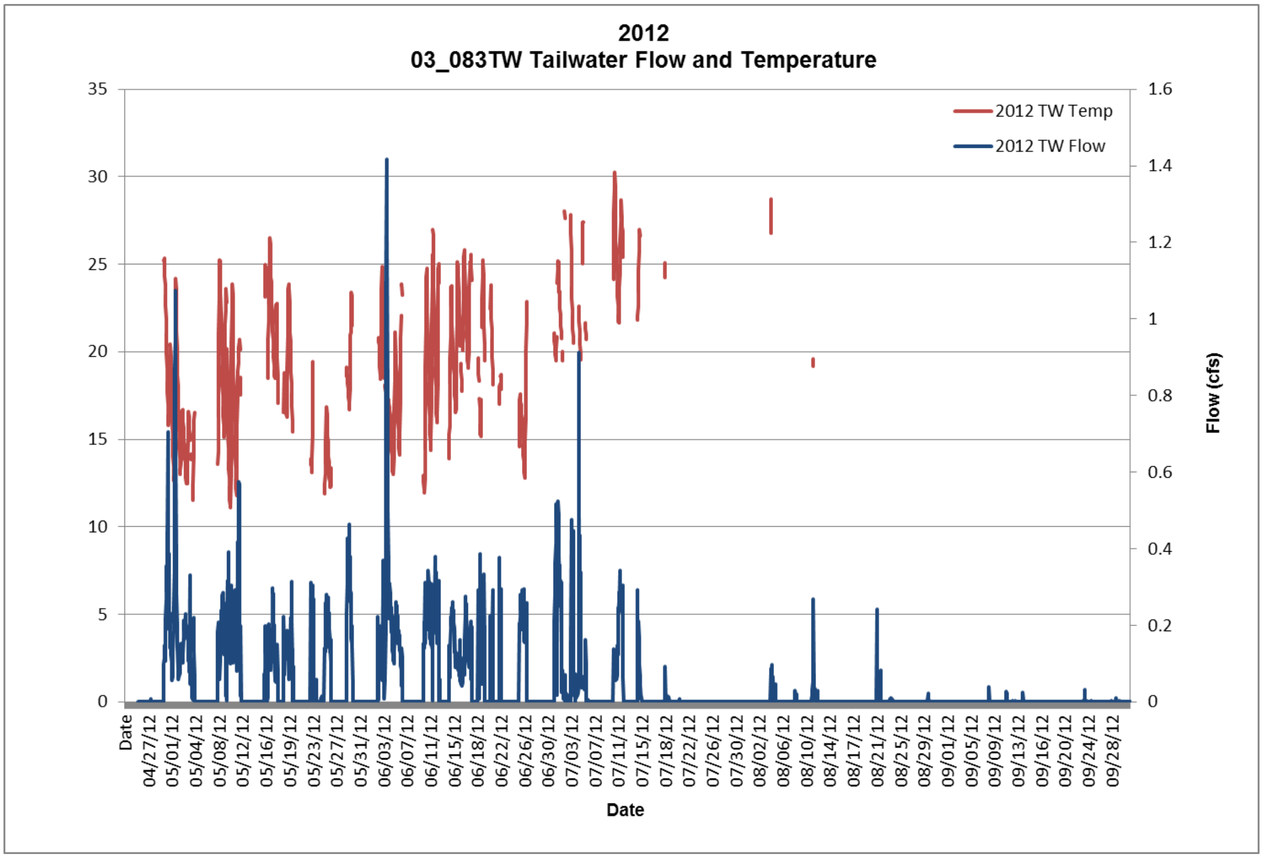
Lemos Tailwater Re-use Improvement Project

Pre/Post-Project Results at 03-083TW

03_083TW was monitored in 2011 and tailwater was present on a consistent rotation, as it is located within the Shasta Water Association. The Lemos Tailwater Re-use Improvement Project is intended to reduce the amount of tailwater produced at this site and also reduce the amount of water diverted from the river, by improving an existing tailwater capture and re-use project. This project was implanted in November 2011. Post project data was collected in 2012; the comparison of yearly data is included below.

Photo: Site 03-083TW
Tailwater collected in a pond (part shown at lower right) and overflowed through the culvert back to the Shasta River.





Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR3083TW	2012	*1.42*	*0.04*	*14.98*	*10.9*	*30.268*	*19.66*
105SR3083TW	2011	8.42	0.13	47.18	11.49	31.05	20.74

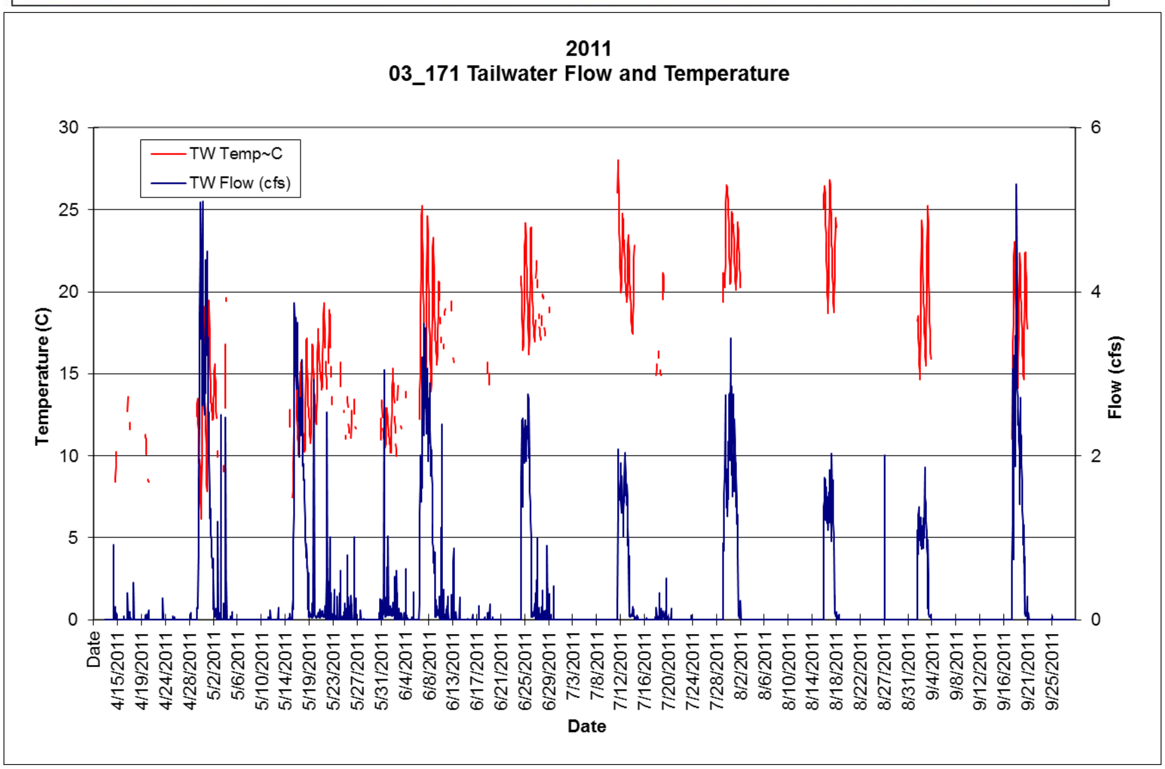
The above table summarizes the amount of tailwater that was reduced at this site, from 47 acre-feet in 2011 to 14.9 acre-feet in 2012, more than 60-percent reduction. This project also reduced the amount of river water that was diverted and utilized tailwater from an up gradient source to irrigate the ranch's pastures, reducing the total pumping requirements on the ranch.

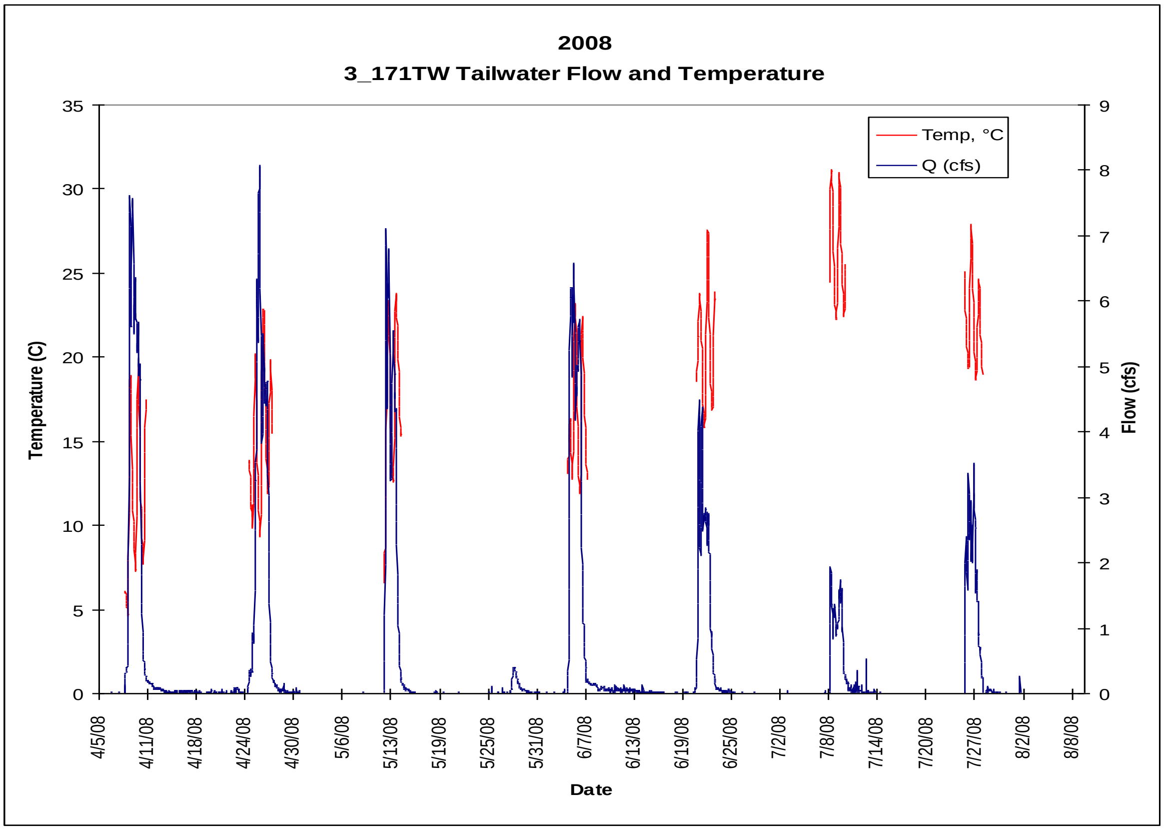
SWA Turn-out Improvement Project

Pre/Post-Project Results at 03_171TW

Site 03_171TW was monitored in 2011 and 2008; the yearly data is included below and is considered pre-project monitoring data. This neighborhood's tailwater impacts may be affected by the SWA Turn-out Improvement Project (implemented in Spring 2012) and monitoring continued in 2012 to document post-project conditions, see site graphs and summary table shown below.

Photo: Site 03-171TW
View down the tailwater stream just before it re-enters the Shasta River





2008
3_171TW Tailwater Flow and Temperature
Temp, °C
Q (cfs)
Temperature (C)
Flow (cfs)
Date
0
5
10
15
20
25
30
35
0
1
2
3
4
5
6
7
8
9
4/5/08
4/11/08
4/18/08
4/24/08
4/30/08
5/6/08
5/13/08
5/19/08
5/25/08
5/31/08
6/7/08
6/13/08
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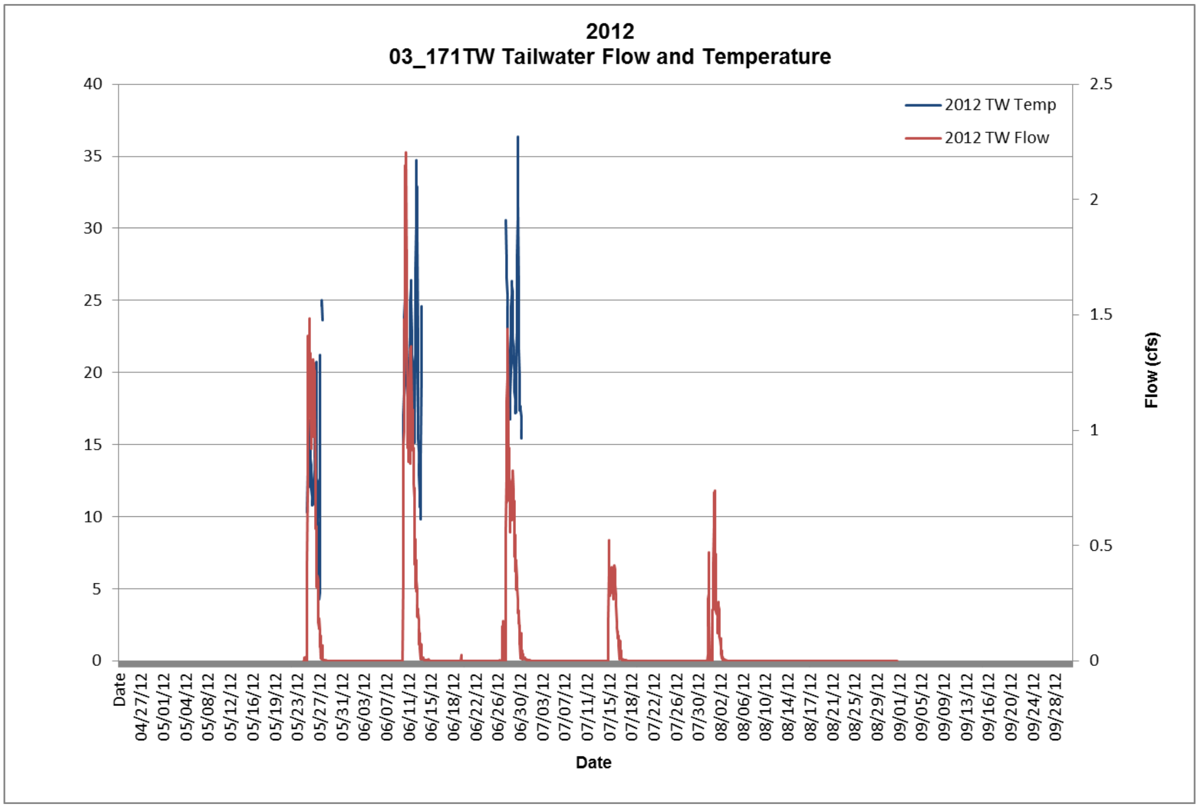
7/27/08
8/2/08
8/8/08



From the table below, the summarized data shows a reduction in tailwater production at this site by at least sixty-percent. The post-project maximum tailwater temperature is also significantly lower at 26.34 degrees C. This site has many influences in the neighborhood, it's also a difficult site to monitor, as it has been vandalized multiple times over the last several years. Despite this issue, this site would be good to monitor as management changes occur in the Shasta Water Association.

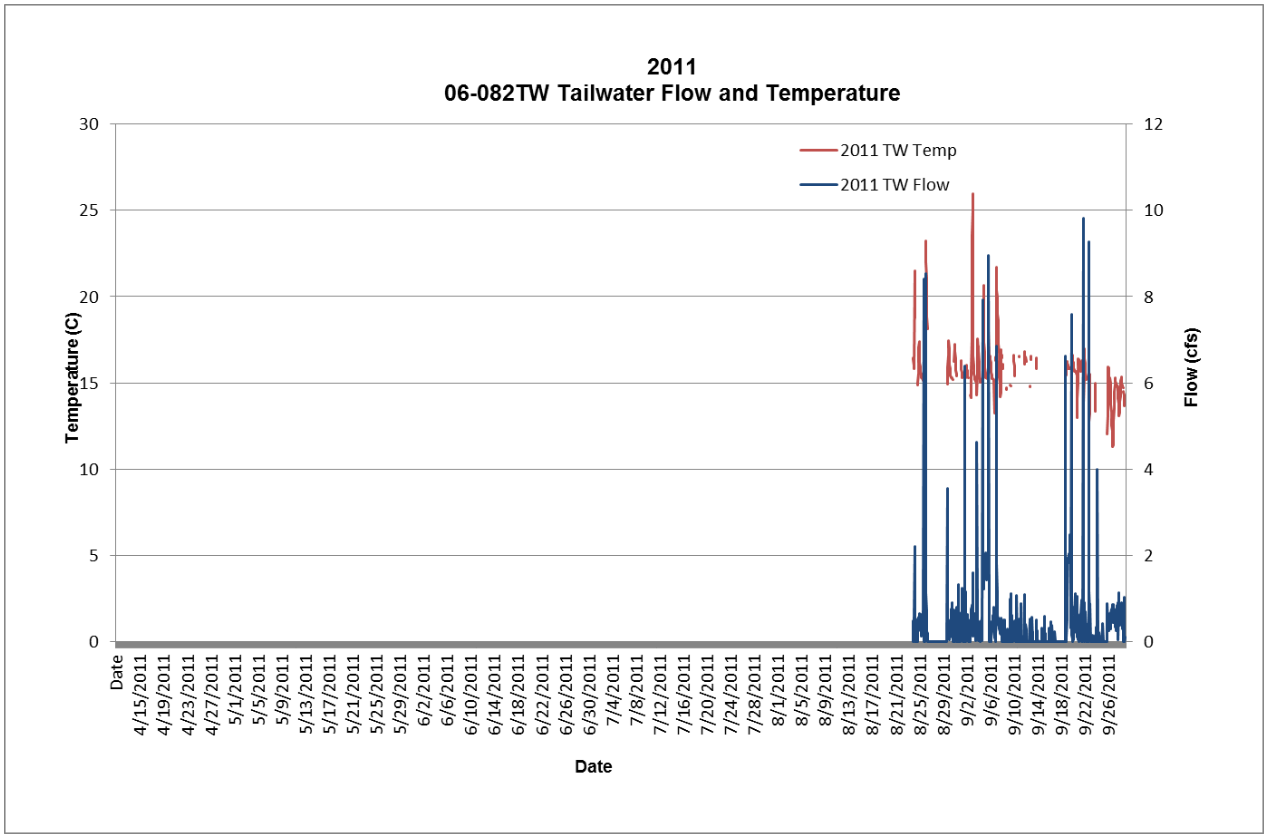
Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR3171TW	2012	*2.206*	*0.07*	*25.4*	*4.29*	*26.34*	*18.77*
105SR3171TW	2011	5.31	0.21	78.46	6.15	28.02	17.05
105SR3171TW	2008	8.48	0.39	144.08	4.61	31.20	18.20

Section 3- Tailwater 2 Project Monitoring Results

Shasta Big Springs Head Gate Structure

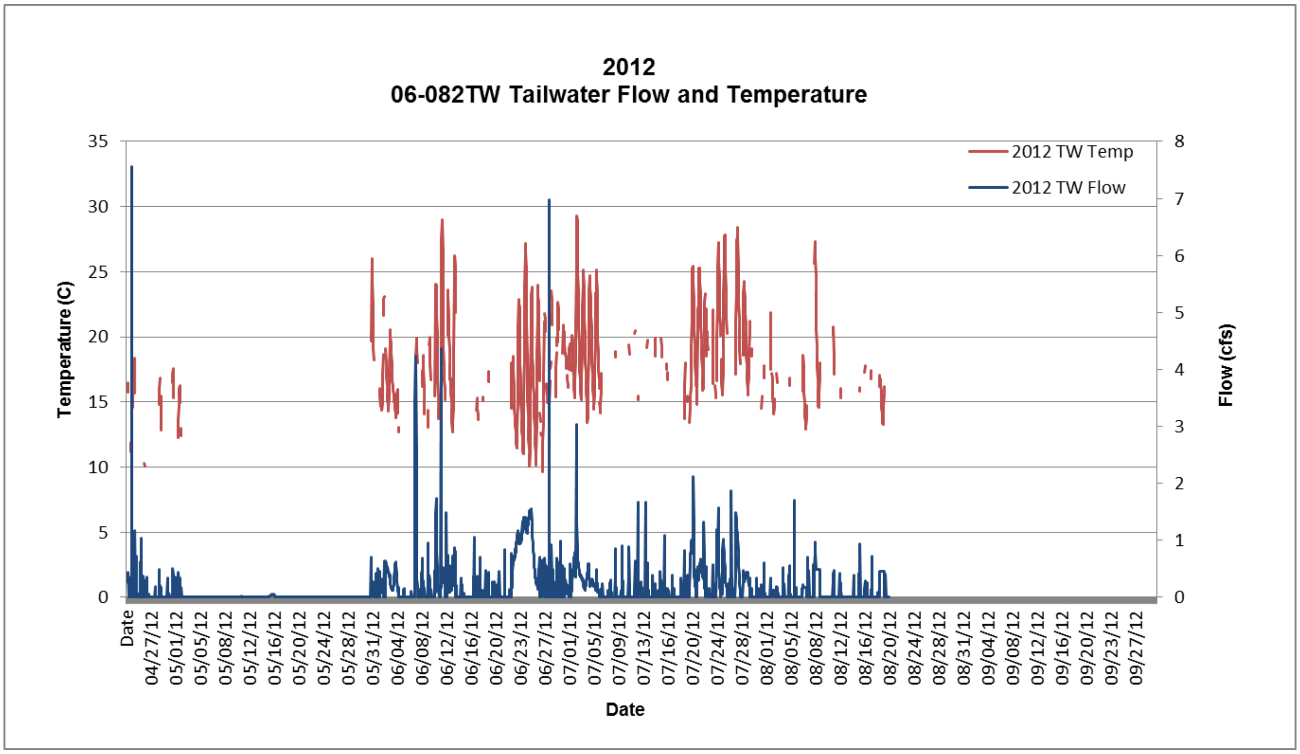
Pre/Post-Project Results of 06-082TW

Site 06-082TW was monitored in 2011 for pre-project conditions, with the new head gate project constructed in early 2012. The site was monitored in 2012 for post-project conditions. The graphs and summarized data is shown below.



Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	Monitoring Year	Tailwater Flow			Tailwater Temps		
		Max	Average	Total Ac-ft	Min	Max	Average
105SR6082TW	2011	9.815	0.405	158.5	11.25	25.96	15.677
105SR6082TW	2012	7.56	0.153	55.46	8.64	29.29	15.79

Though the site is managed by the ranch's irrigator and tailwater is only released when Big Springs Creek will not be negatively impacted, the project has shown to have reduced the amount of tailwater released to the system by almost sixty-percent. Now a dependable amount of irrigation water is delivered to the pastures and reducing the amount of water wasted due to unexpected management changes made by the neighbor.

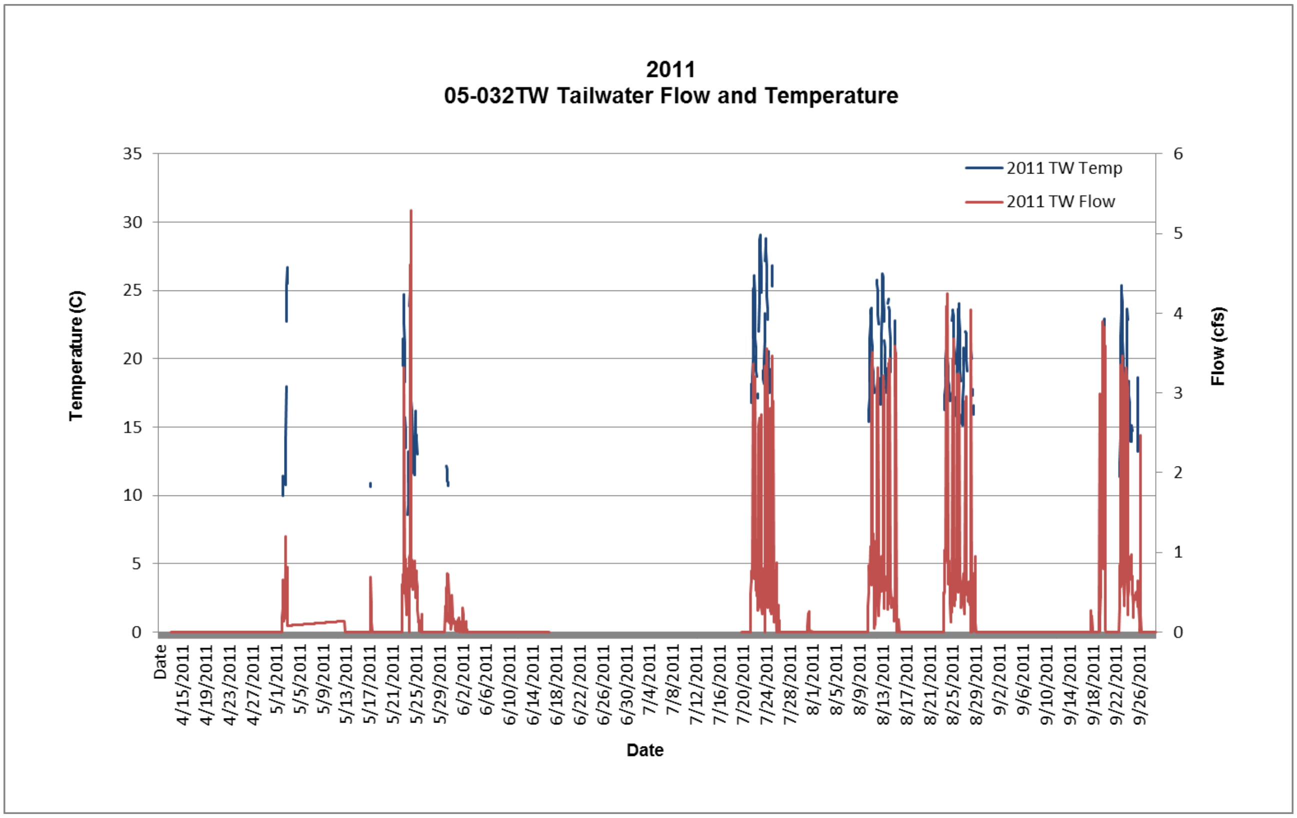


<u>Freeman Efficiency Project</u>

Pre/Post Project 05-032TW

The Freeman Efficiency Project was implemented in winter 2012/13 and pre-project monitoring was completed in 2011 with post-project monitoring completed in 2013. The site graphs and summarized data are shown below. From the summarized results, the tailwater production was reduced by slightly less than half, though the maximum tailwater temperatures are higher. This is likely due to the water being more spread out across pastures as a result of the newly constructed gated- pipe.

Pre/Post Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR5032TW	2011	*5.28*	*0.179*	*65*	*-3.57*	*33.37*	*15.98*
105SR5032TW	2013	*2.847*	*0.095*	*34.74*	*3.248*	*36.2*	*18.89*


2011
05-032TW Tailwater Flow and Temperature
2011 TW Temp
2011 TW Flow
Temperature (C)
Flow (cfs)
Date
35
30
25
20
15
10
5
0
6
5
4
3
2
1
0
Date
4/15/2011
4/19/2011
4/23/2011
4/27/2011
5/1/2011
5/5/2011
5/9/2011
5/13/2011
5/17/2011
5/21/2011
5/25/2011
5/29/2011
6/2/2011
6/6/2011
6/10/2011
6/14/2011
6/18/2011
6/22/2011
6/26/2011
6/30/2011
7/4/2011
7/8/2011
7/12/2011
7/16/2011
7/20/2011
7/24/2011
7/28/2011
8/1/2011
8/5/2011
8/9/2011
8/13/2011
8/17/2011
8/21/2011
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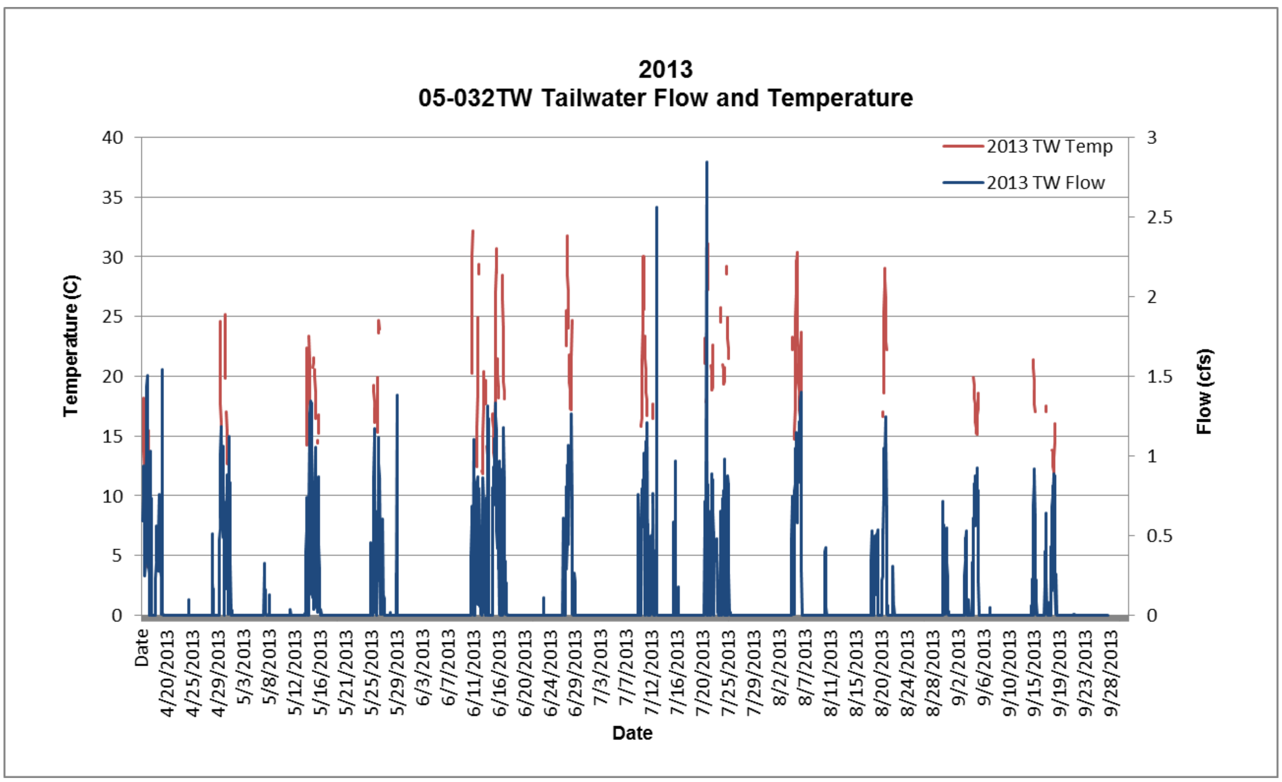
9/14/2011
9/18/2011
9/22/2011
9/26/2011

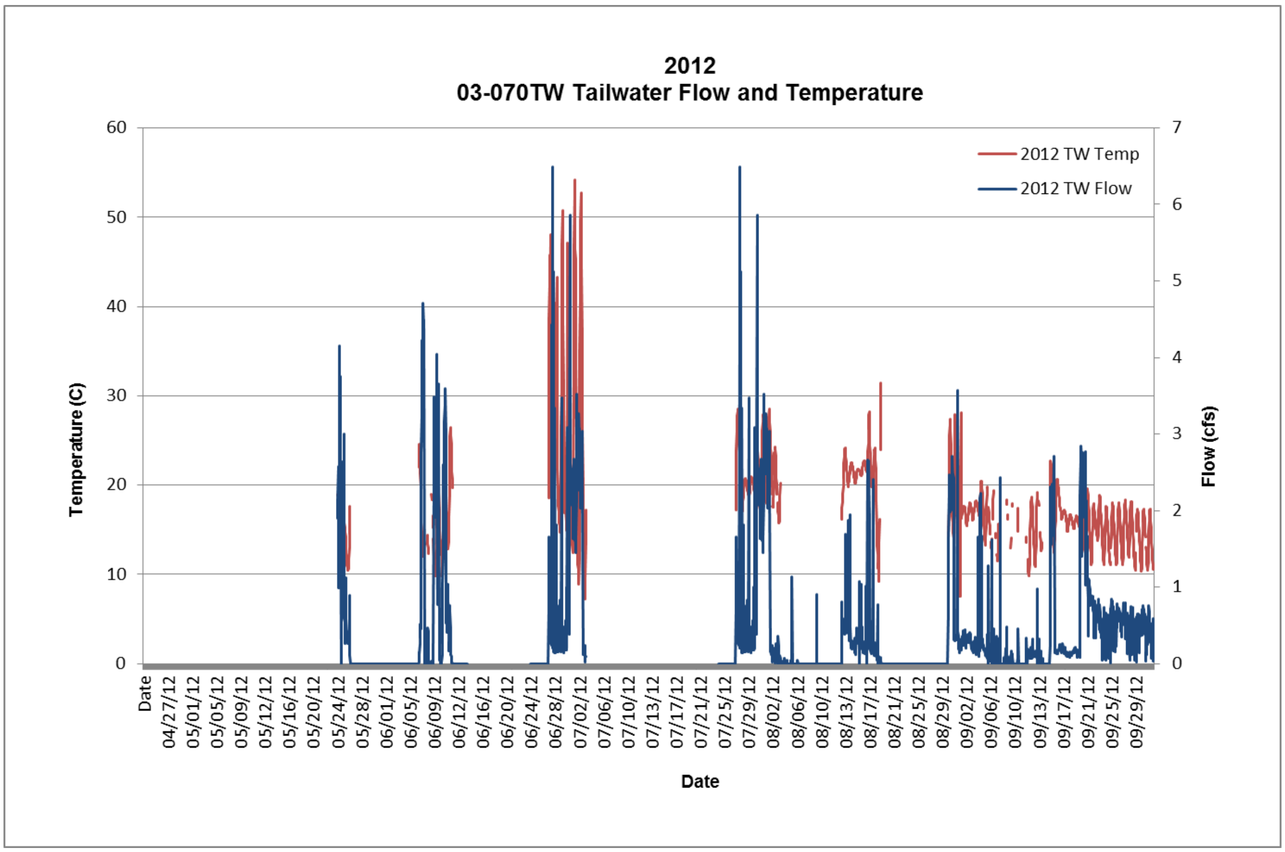

2013
05-032TW Tailwater Flow and Temperature
2013 TW Temp
2013 TW Flow
Temperature (C)
Flow (cfs)
Date
40
35
30
25
20
15
10
5
0
3
2.5
2
1.5
1
0.5
0
Date
4/20/2013
4/25/2013
4/29/2013
5/3/2013
5/8/2013
5/12/2013
5/16/2013
5/21/2013
5/25/2013
5/29/2013
6/3/2013
6/7/2013
6/11/2013
6/16/2013
6/20/2013
6/24/2013
6/29/2013
7/3/2013
7/7/2013
7/12/2013
7/16/2013
7/20/2013
7/25/2013
7/29/2013
8/2/2013
8/7/2013
8/11/2013
8/15/2013
8/20/2013
8/24/2013
8/28/2013
9/2/2013
9/6/2013
9/10/2013
9/15/2013
9/19/2013
9/23/2013
9/28/2013

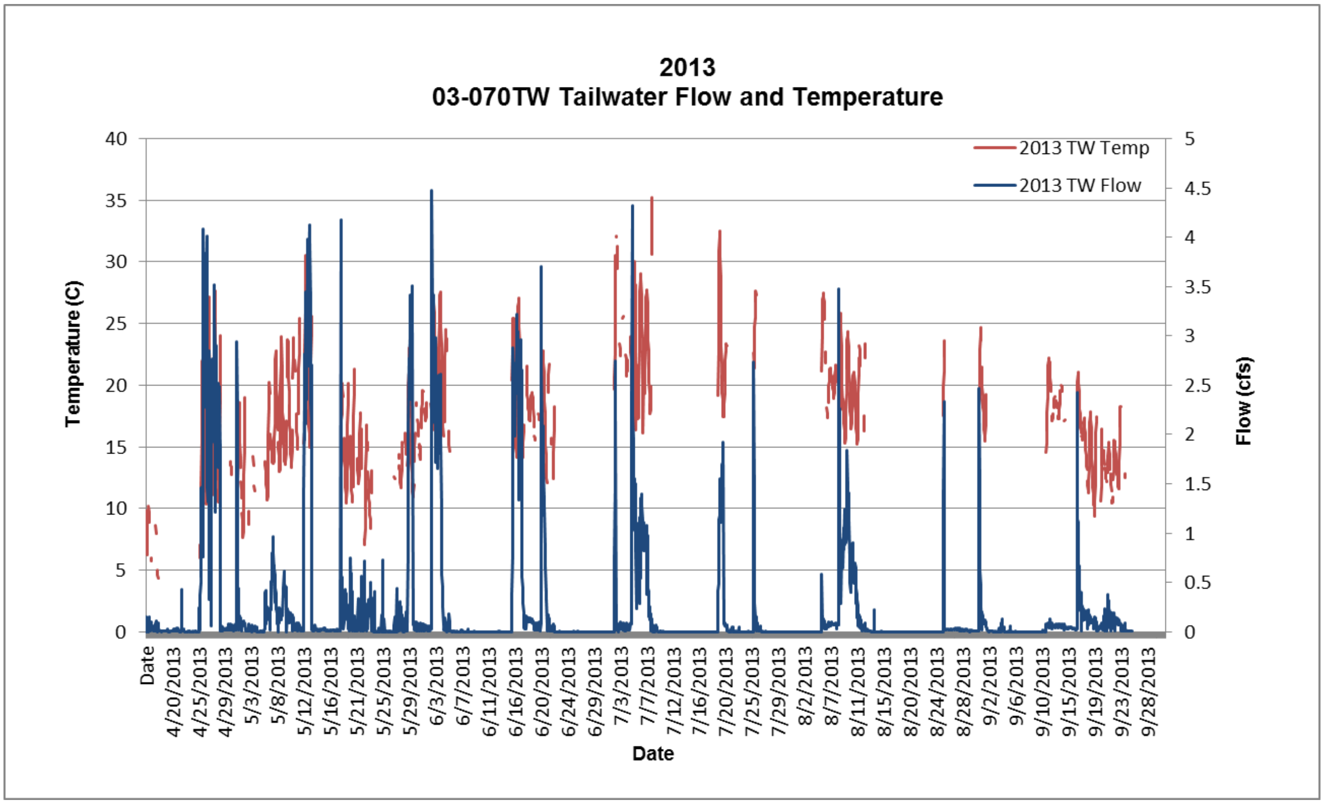
Kuck Ranch Tailwater Re-use Improvement Project

Pre-Project 03-070TW

The following graph and table summarize the data collected pre-project on the Kuck Brother's Ranch prior to the implementation to the Tailwater Re-use Improvement Project. The project is scheduled for construction late fall 2013, just prior to the Tailwater 2 grant termination, so post project data will be collected during a future round of funding.

Pre Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR3070TW	2013	*4.471*	*0.236*	*85.76*	*4.35*	*35.24*	*17.87*
105SR3070TW	2012	*6.48*	*0.44*	*158.5*	*7.22*	*54.15*	*18.28*



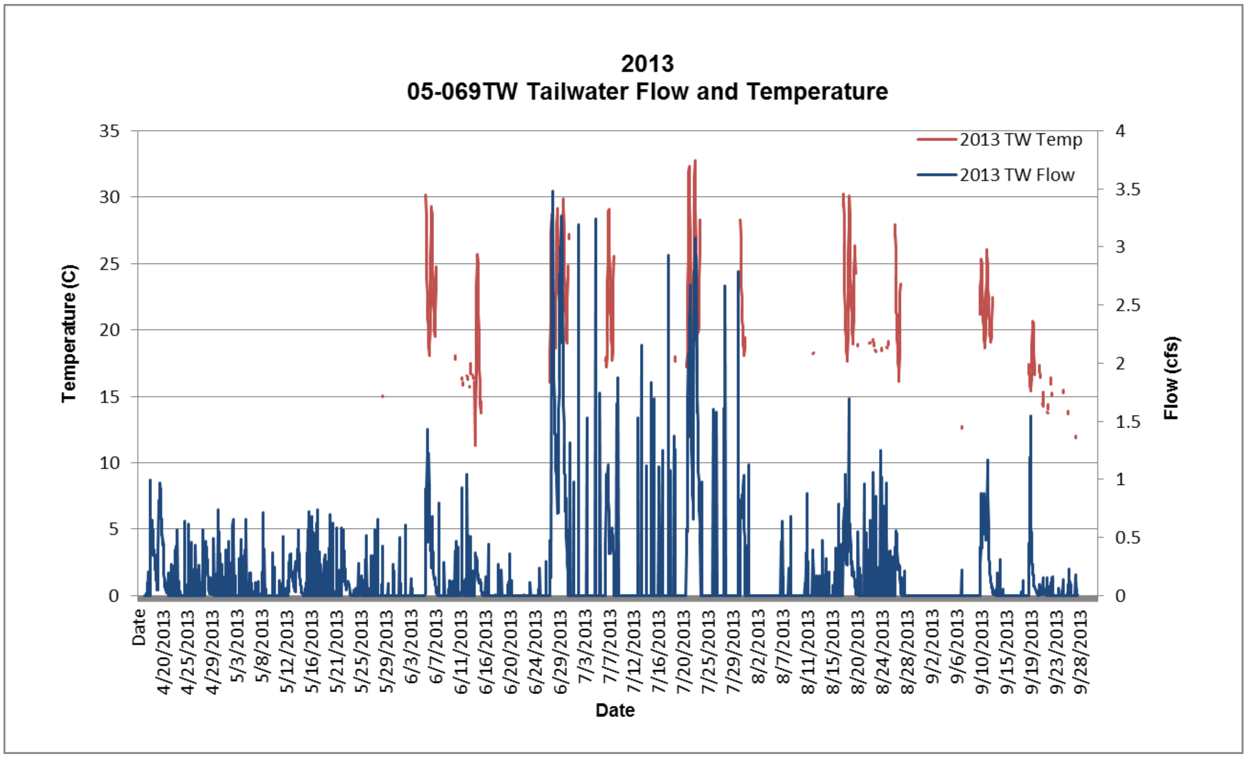


<u>Shasta River Water Association Tailwater Ditch Rehabilitation</u>

Pre-Project 05-069TW and 05-207TW

Site 05-069TW is one of four different drainages associated with this project and was monitored in 2013 prior to the construction of the pick-up ditch. An adjacent site (05_207TW) was monitored in 2009. It can be assumed that all the tailwater from the four neighborhoods will be collected in the constructed ditch and directed into the SWA pump station and be used in-lieu of river water, resulting in a 100-percent reduction in tailwater returning to the Shasta River at this site.

Pre Project Yearly Tailwater Data							
Tailwater Neighborhood ID	***Monitoring Year***	***Tailwater Flow***			***Tailwater Temps***		
		Max	*Average*	*Total Ac-ft*	*Min*	*Max*	*Average*
105SR5069TW	2013	*3.48*	*0.141*	*51.25*	*11.32*	*32.74*	*20.59*
105SR5207TW	2009	*4.45*	*0.065*	*27*	*10.17*	*34.4*	*18.3*



<u>Tailwater Reduction Conclusion</u>

The efforts outlined above have shown a total tailwater return reduction of 589 acre-feet (per season) from re-entering the river. This water did not necessarily show up as increased discharge in the river at any of the weirs, as the watershed is over adjudicated and the water likely went to another user.

It must be noted that an assumption made in these monitoring results is that tailwater would return to the river in the same location post project as pre project. However, it is possible that project activities may have altered the movement of water, thus tailwater may be coming back to the river in a different location or be more readily available for application, and more evaporation and/or transpiration may have resulted.

Section 3- Shasta River Monitoring and Water Quality Improvements

Ambient Air Temperature

Due to the nature and source of tailwater, ambient air temperature is a relatively important aspect of how tailwater may affect river temperatures. The following graph depicts all the years monitored (2008 through 2013) of ambient air temperatures recorded in the Shasta Valley by the RCD. All years were logged using Onset Tidbit Temperature loggers, which were deployed in a shaded area near the river. The 2008 and 2009 stations were located at the Shasta River Water Association pump-station and the 2010 through 2013 station was located at the Montague Bridge.

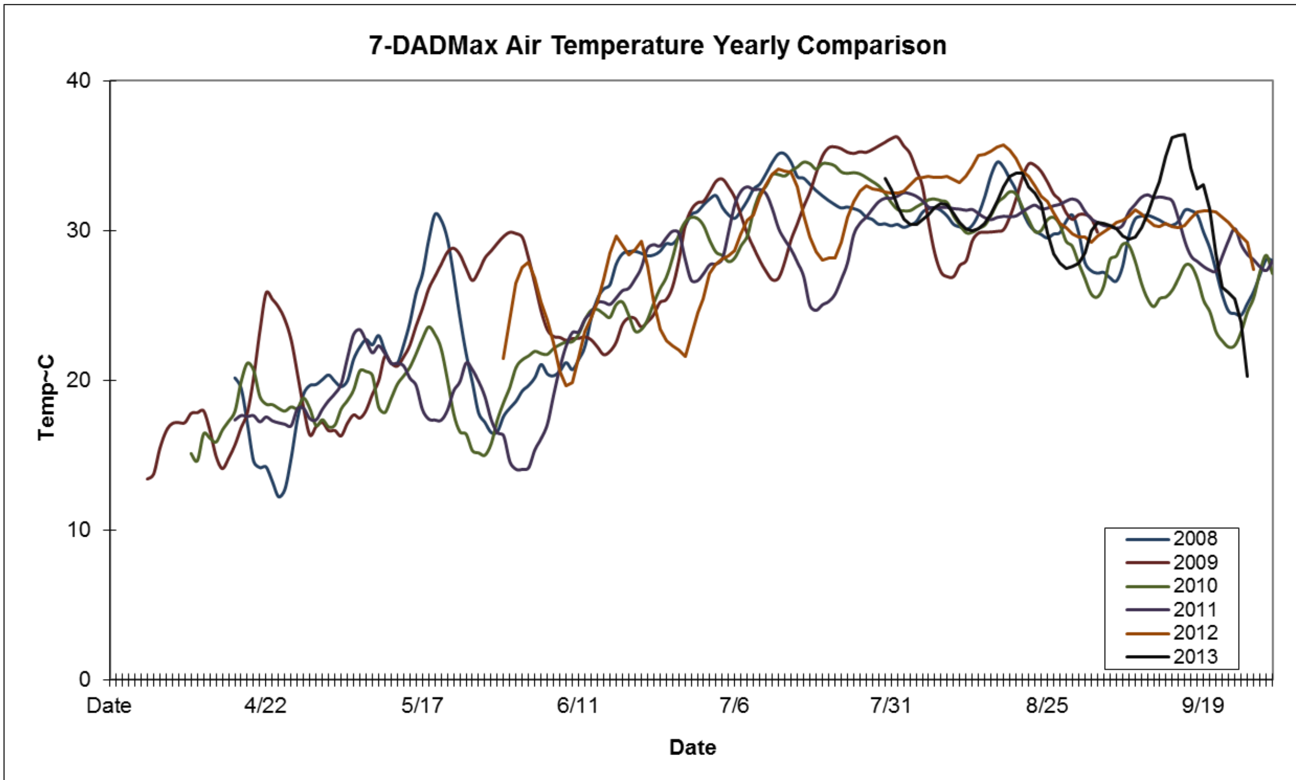


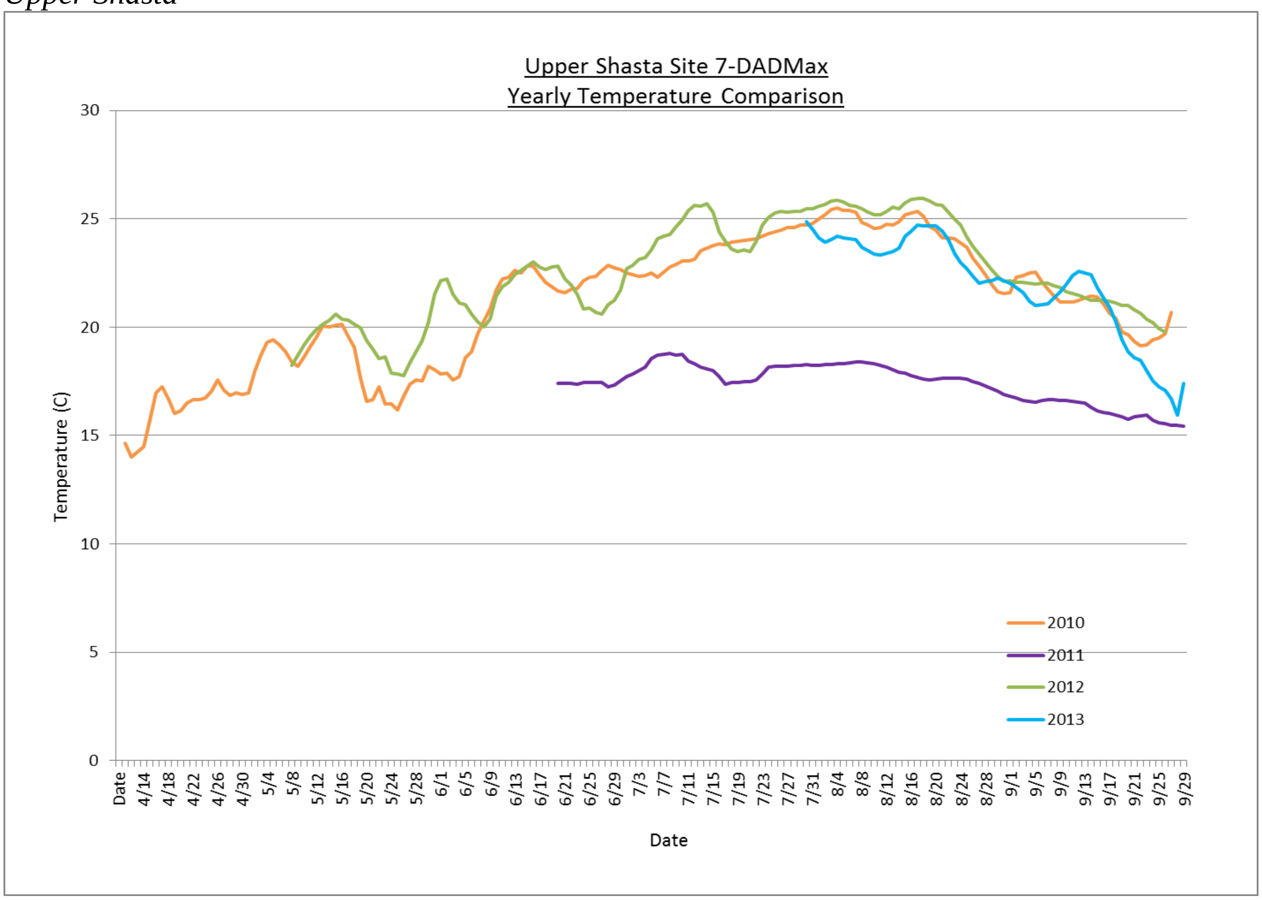
Figure 5- 2008, 2009, 2010, 2011, 2012, 2013 Air Temperature Graph- Comparing 7-Day Running Average Daily Maximum.

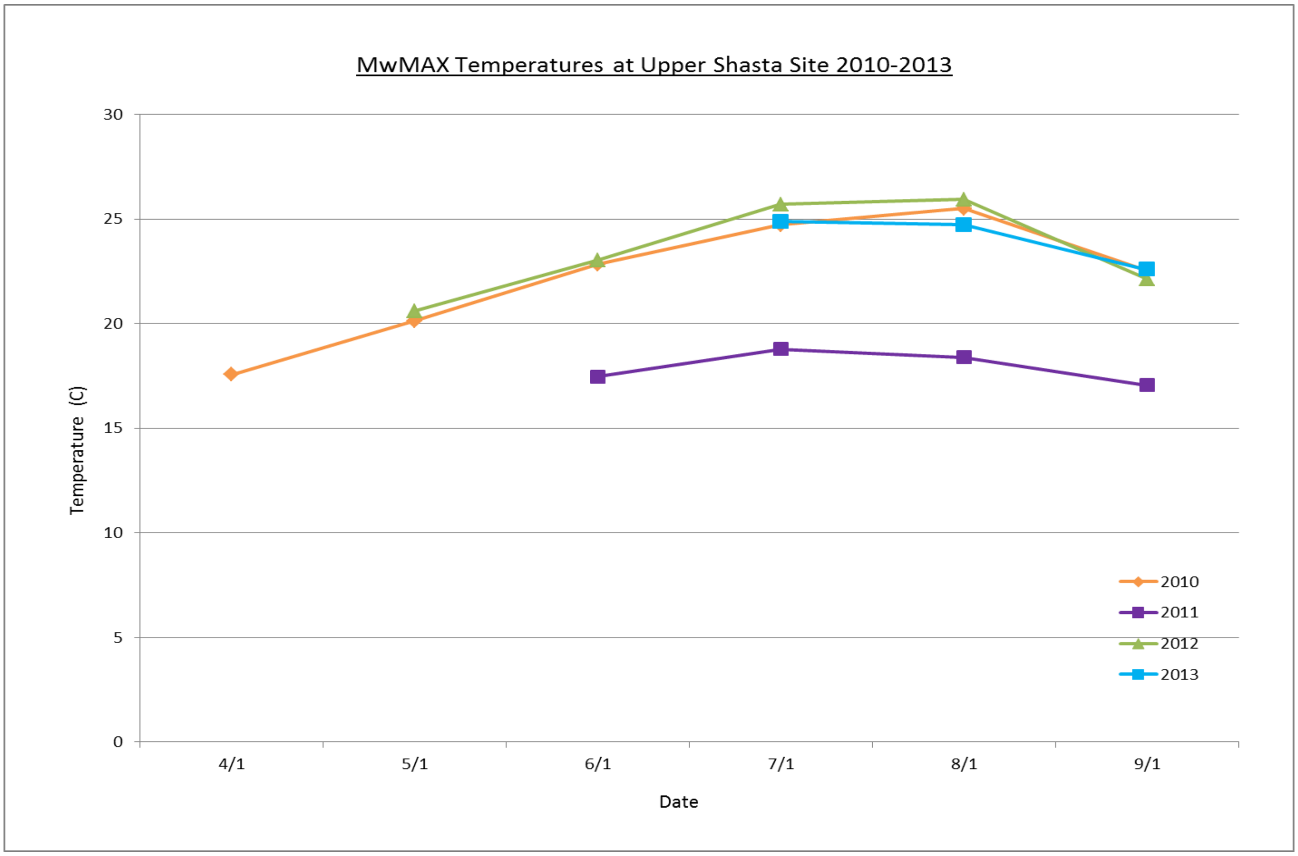
River Temperature Monitoring

Each tailwater monitoring station related to each project also consisted of a river temperature station. It is challenging to evaluate temperature shifts at project locations and know if those changes are related to the project or other watershed factors. Pre and post project river temperature graphs are shown in this section for each dissolved oxygen monitoring site. 2008 (or earliest data set at each site) through 2013 data sets are shown in this report for evaluating watershed improvements that have occurred over the duration of the tailwater project. It should be noted that any improvements or degradation shown in this data are likely not solely due to the tailwater project. Many improvements have occurred in the watershed since the inception of the tailwater project and these other factors also play a large role in overall system conditions.

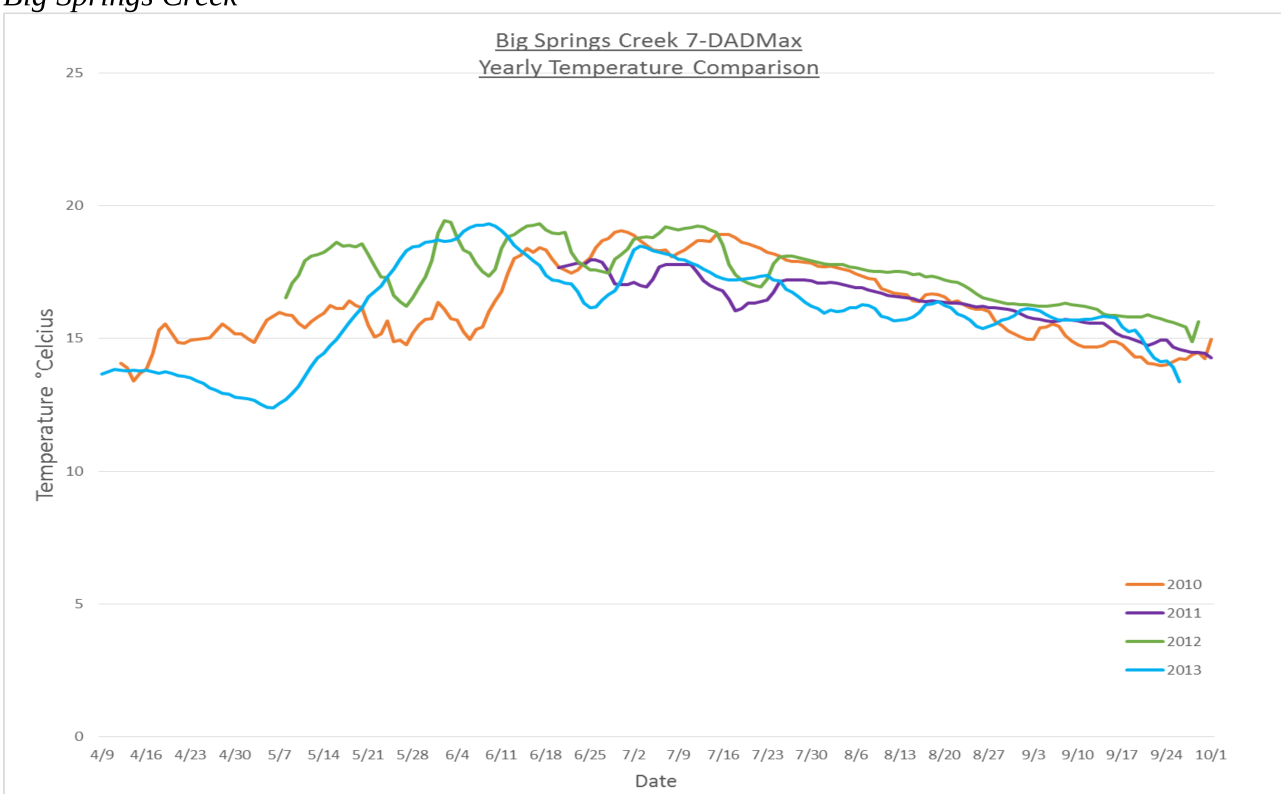
The D-opto loggers record both dissolved oxygen (DO) and temperature on an hourly basis. A total of ten D-opto dissolved oxygen meters were deployed throughout the Shasta Valley, locations shown on Figure 4. The temperature and dissolved oxygen fluctuate daily at each of these locations on a di-urnal basis. The graphs included below illustrates the 7-Day Average Daily Maximum (7-DADMax) Temperatures at each of the DO monitoring locations for each year there is reliable data. The Mean Weekly Maximum Temperatures (MWMT) are found using the 7-DADMax graphs and for some locations MWMT graphs are shown. Using mean seasonal averages can be deceiving, especially if temperatures were abnormally cool in the spring. While not definitive, Welsh et al. (2001) conducted a study that suggests Mean Weekly Maximum Temperatures (MWMT) greater that 18.1° C may completely eliminate the presence of coho in the Mattole River in northern California. (Welsh H. H. Jr., G.R. Hodgson, B.C. Harvey. Distribution of Juvenile Coho Salmon in Relation to Water Temperature in Tributaries of the Mattole River, California.)

Upper Shasta

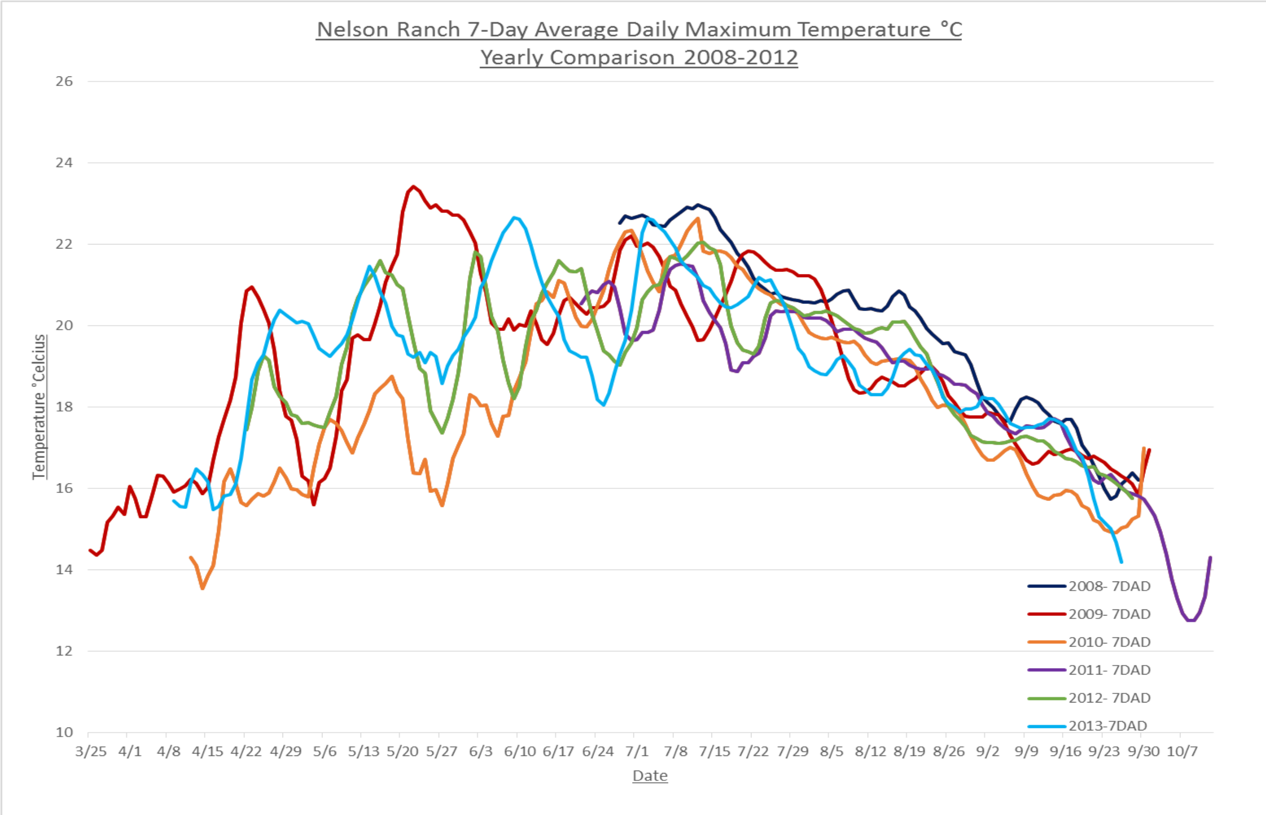




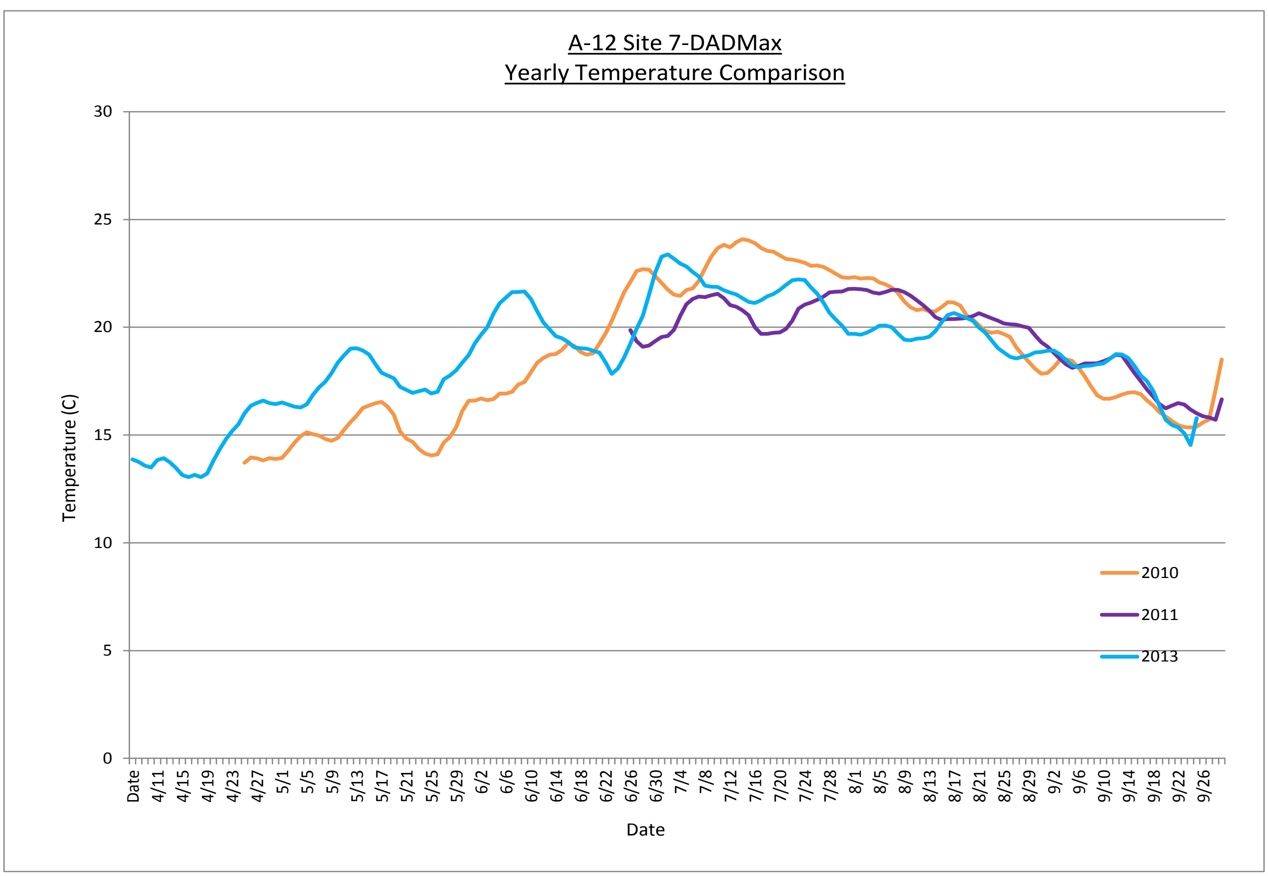
Big Springs Creek



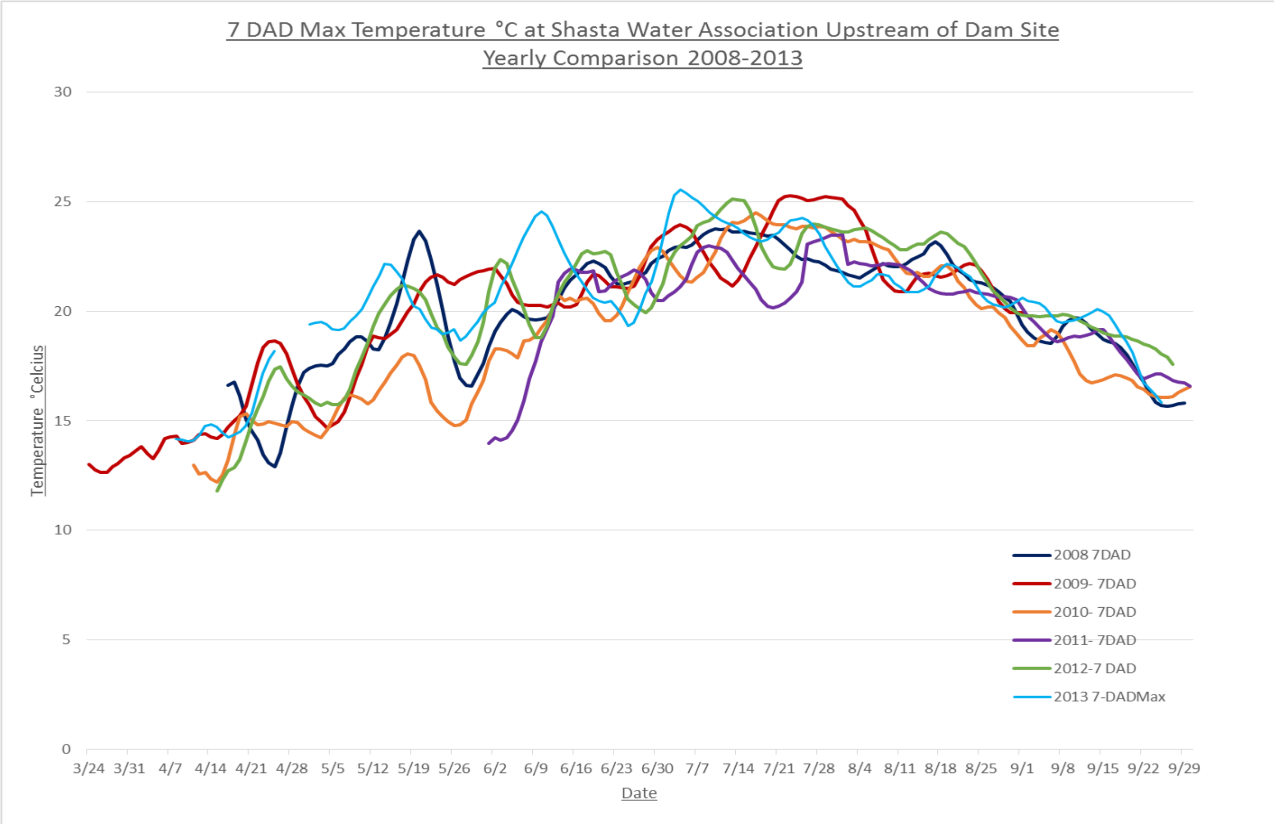
Nelson Ranch

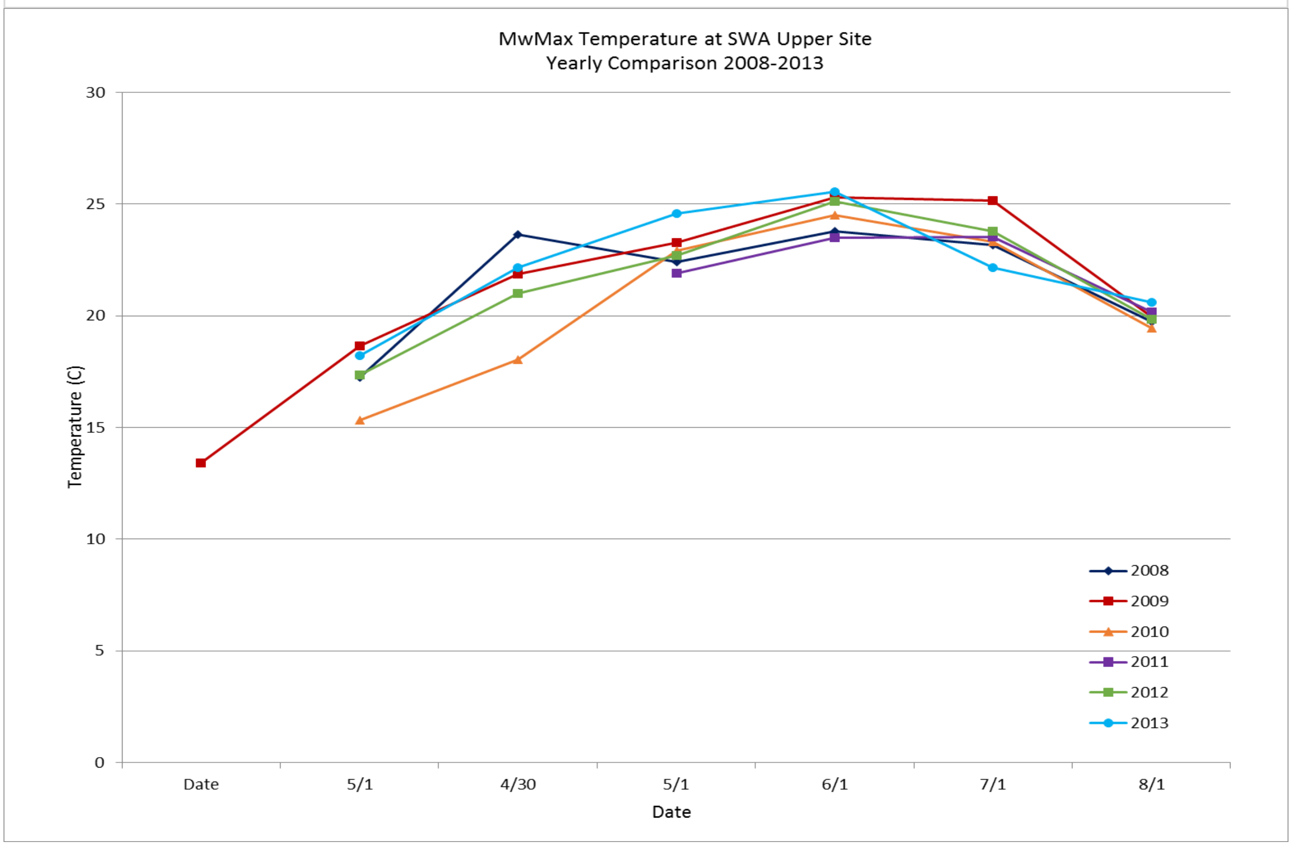


Highway A-12

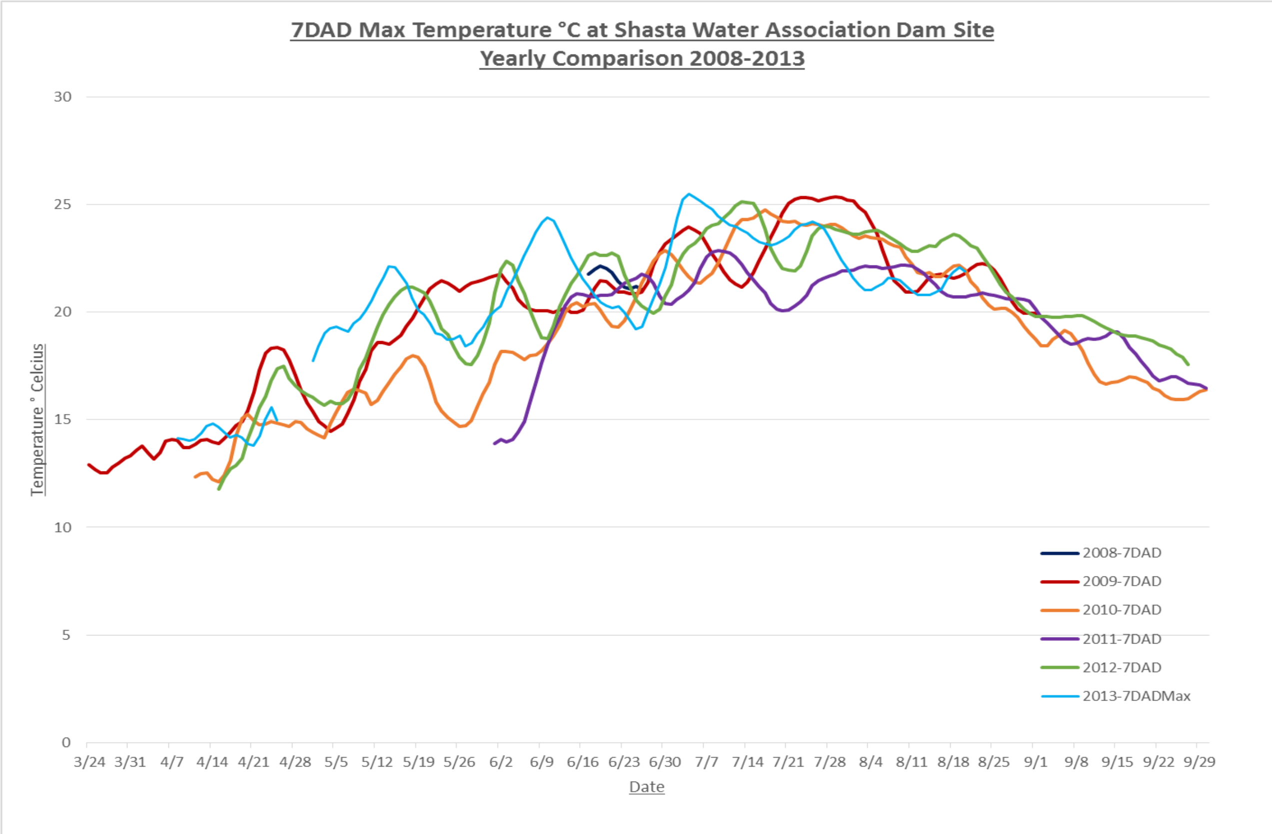


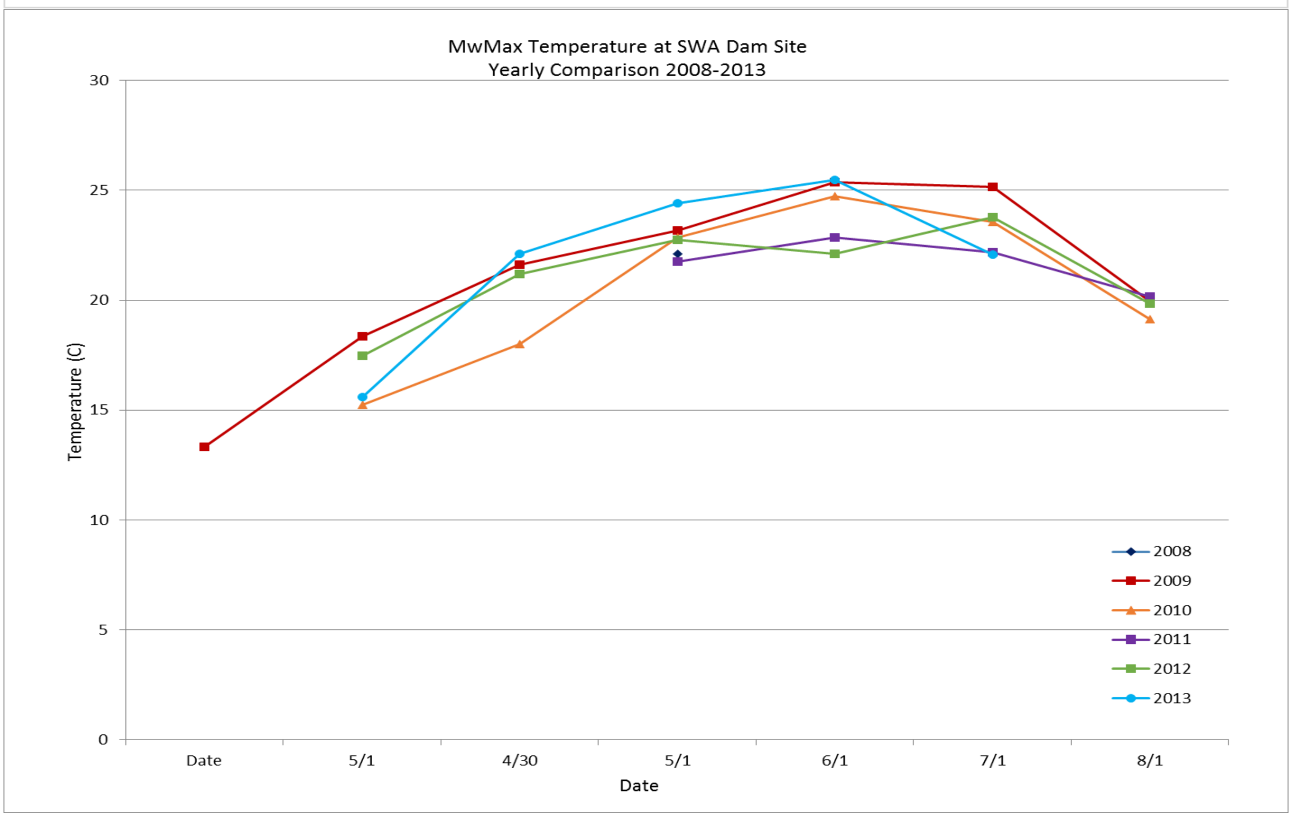
Shasta River Water Association (Upstream)



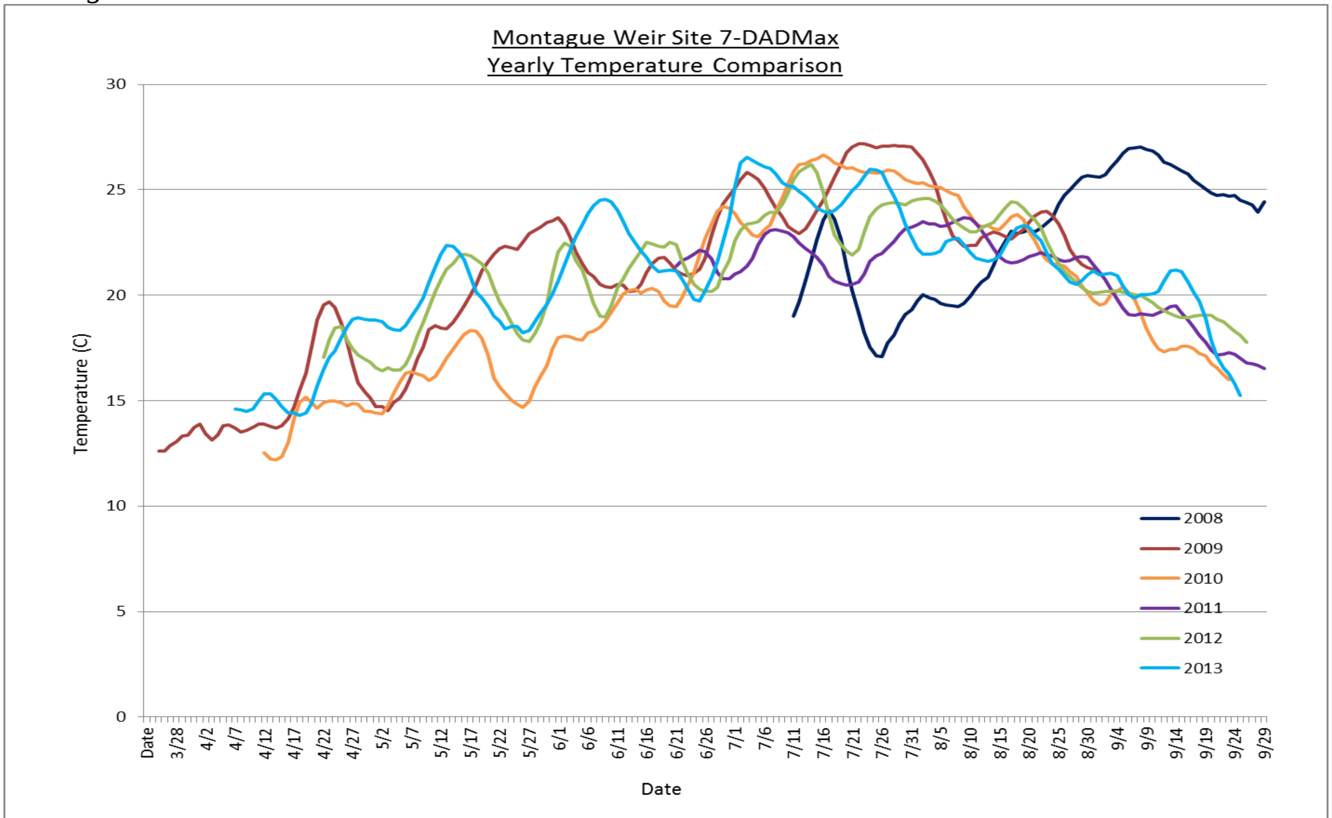


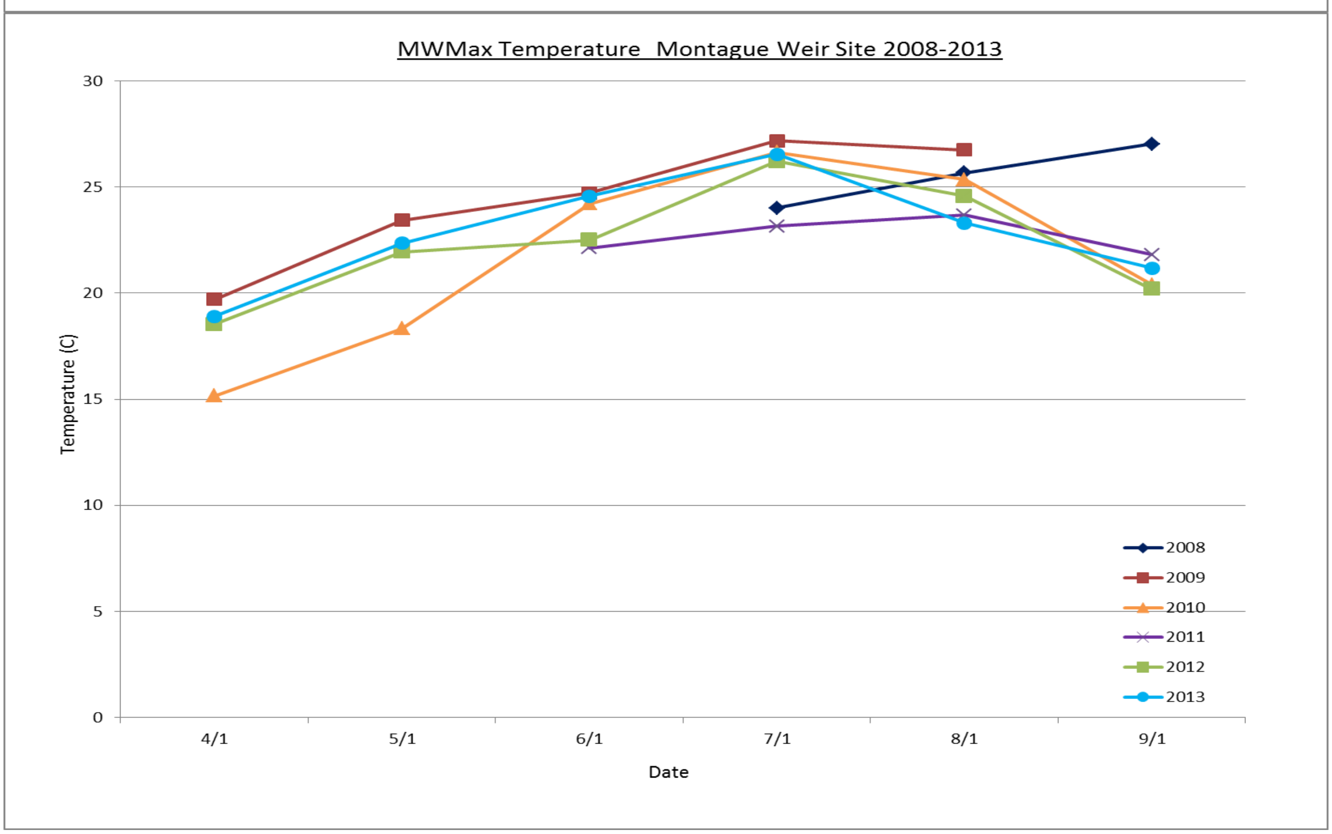
Shasta River Water Association Dam Site



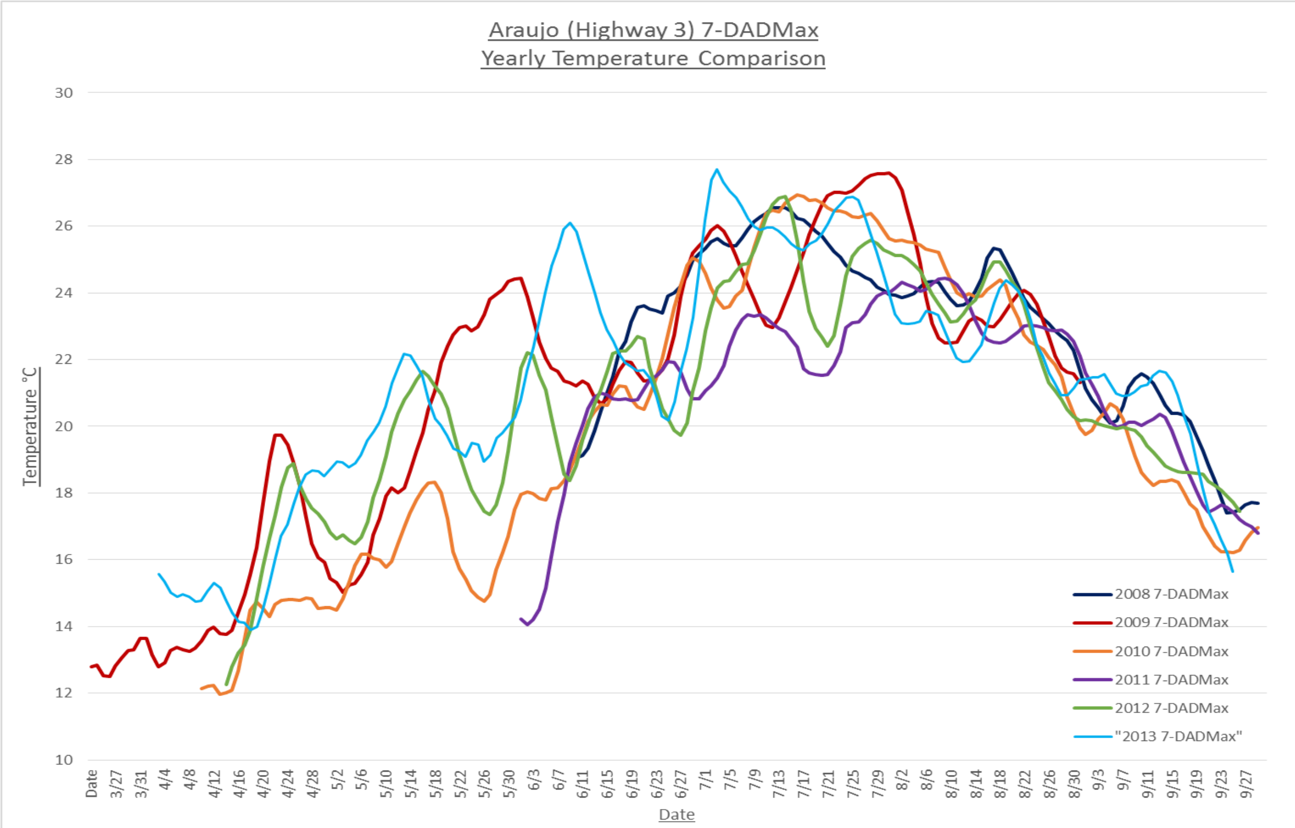


Montague Weir

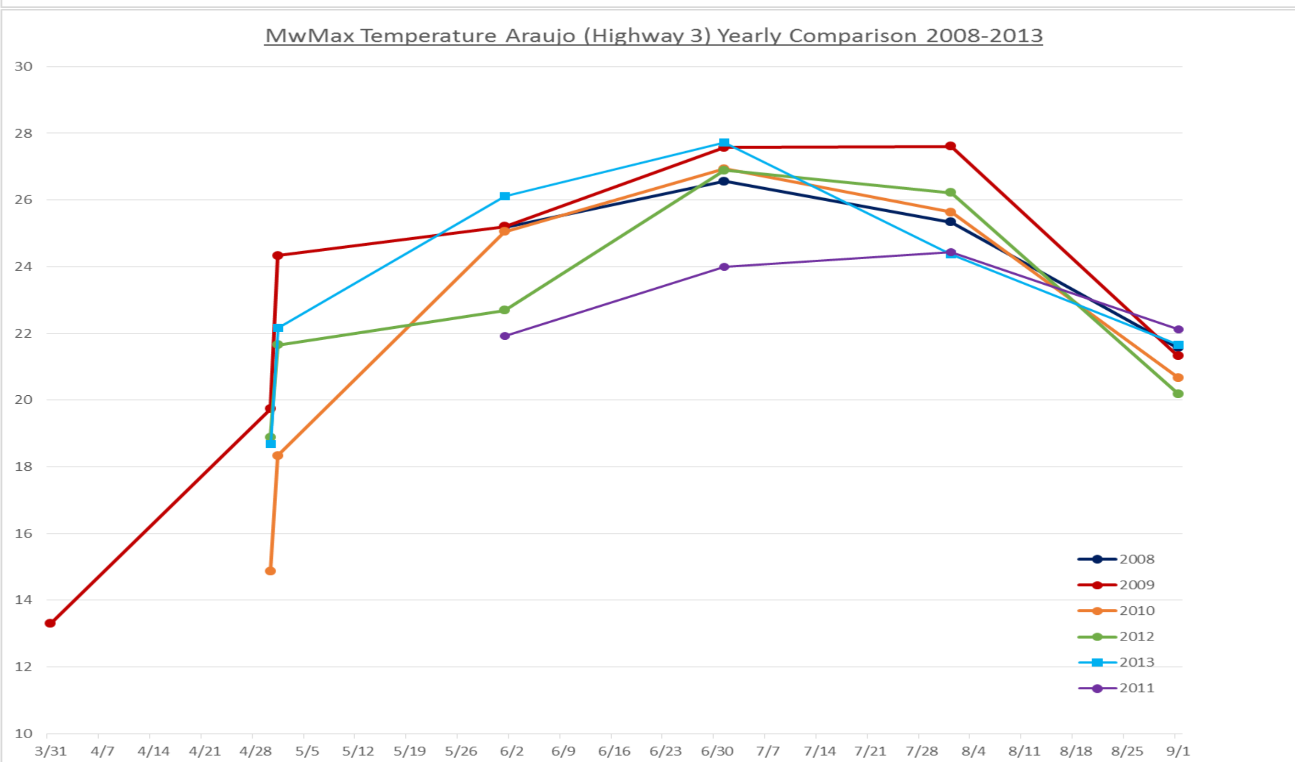




Highway 3

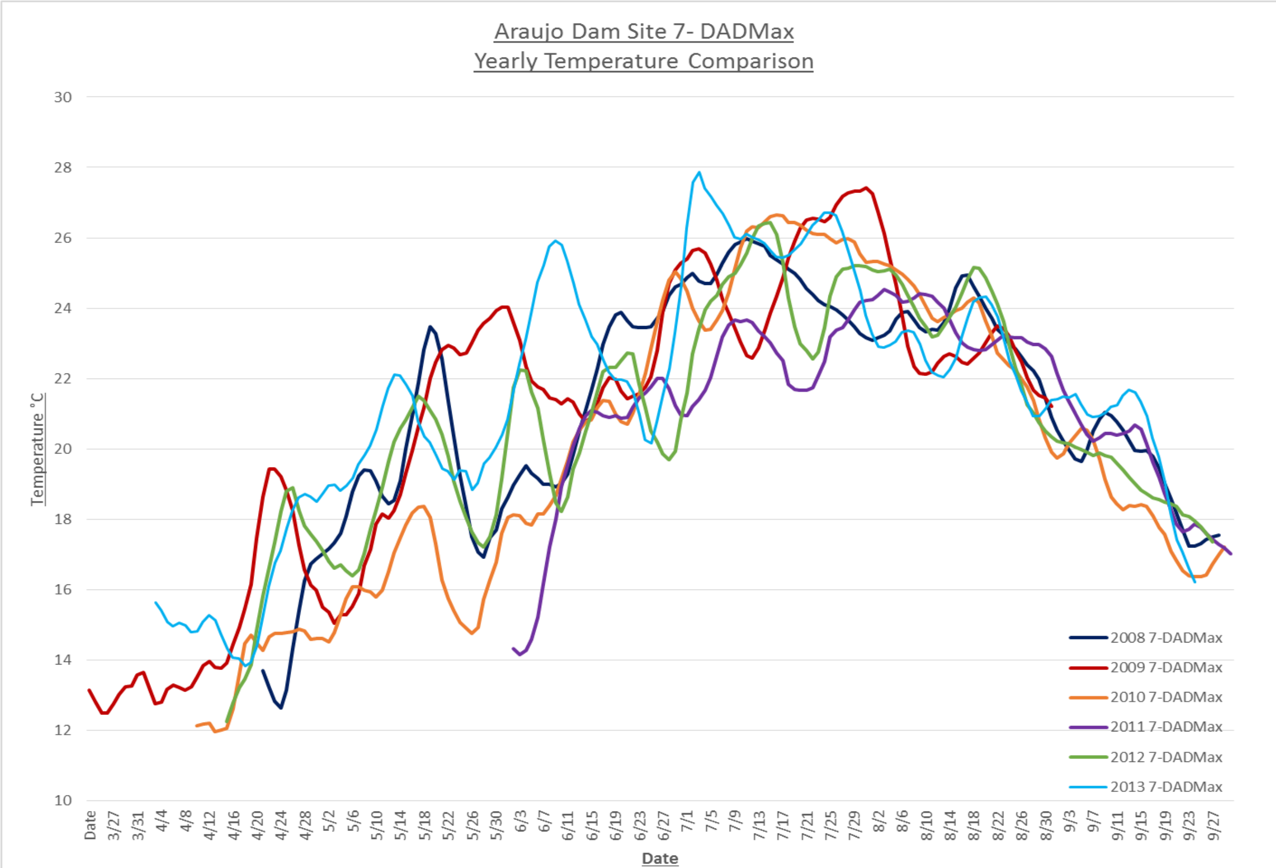


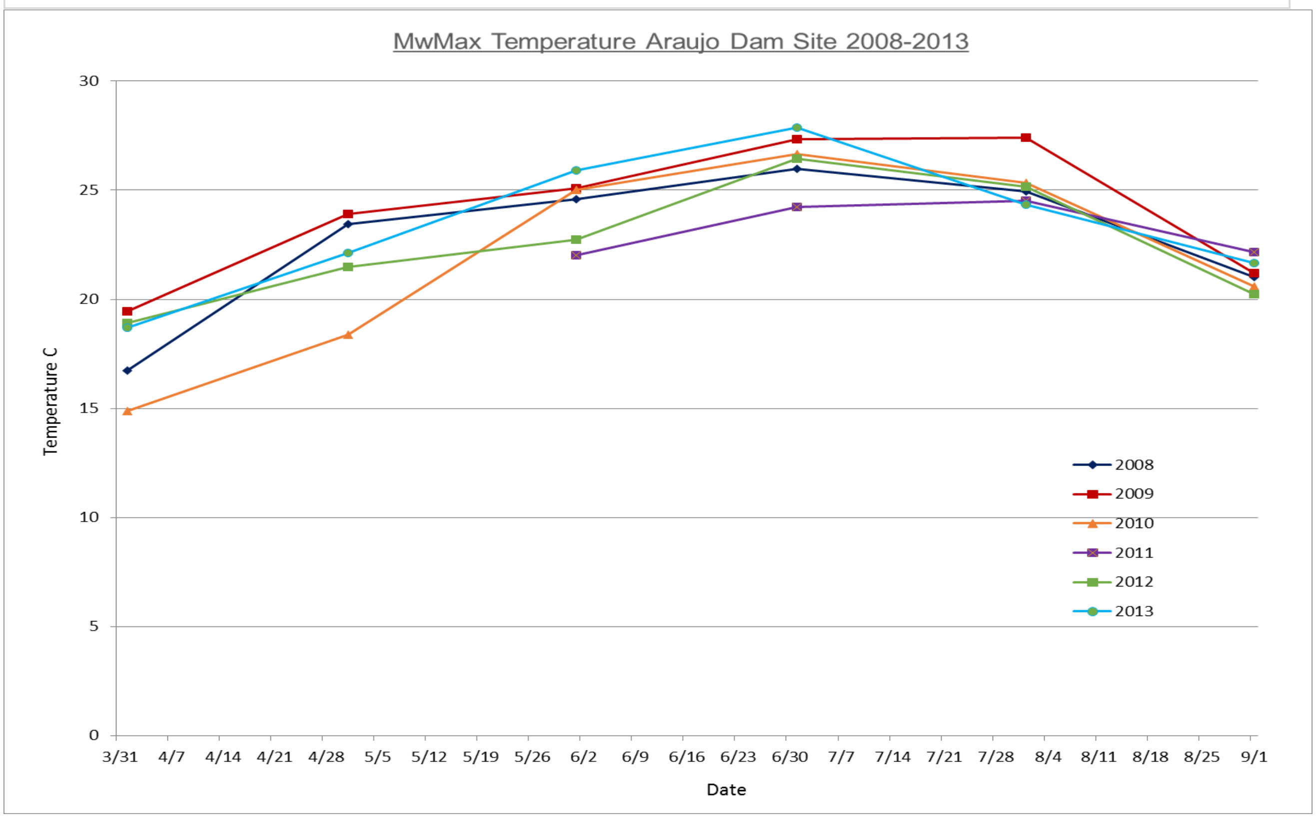
Araujo (Highway 3) 7-DADMax
Yearly Temperature Comparison
Temperature °C
Date
2008 7-DADMax
2009 7-DADMax
2010 7-DADMax
2011 7-DADMax
2012 7-DADMax
"2013 7-DADMax"



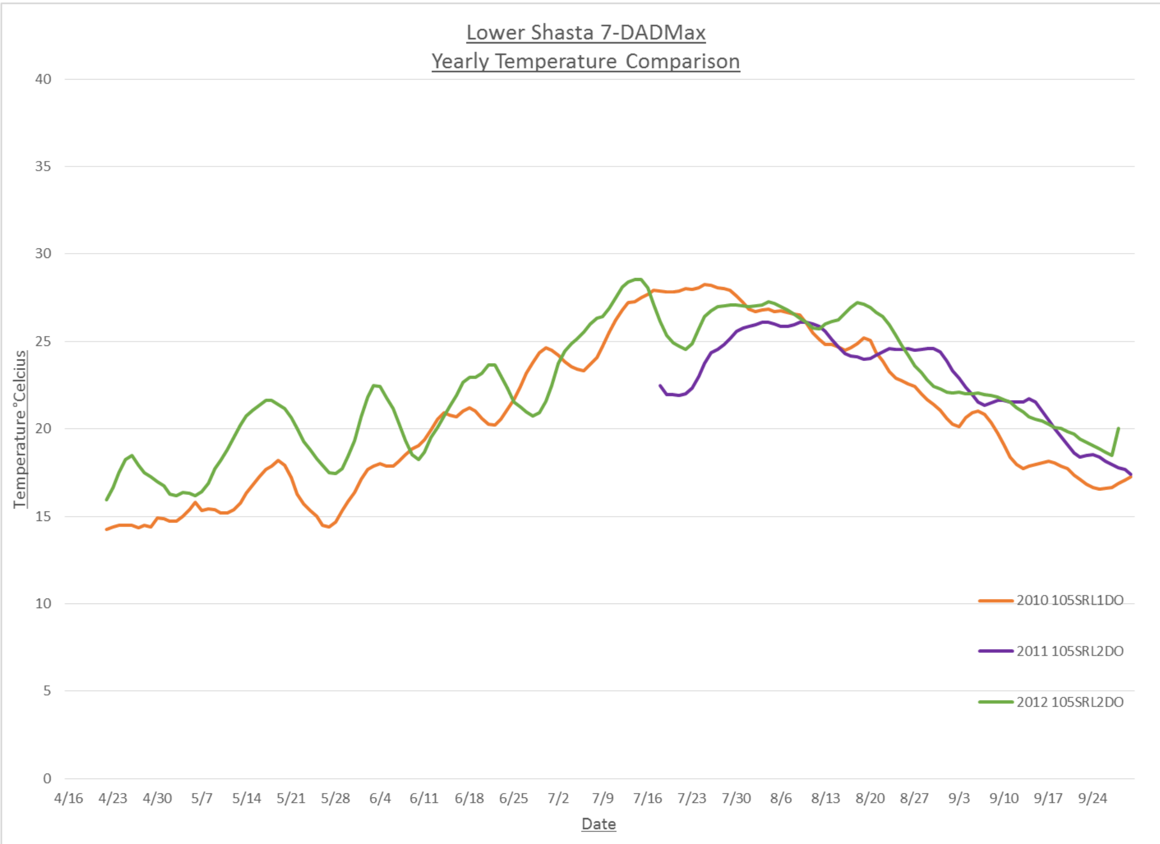
MwMax Temperature Araujo (Highway 3) Yearly Comparison 2008-2013
2008
2009
2010
2012
2013
2011

Araujo Dam Site





Lower Shasta



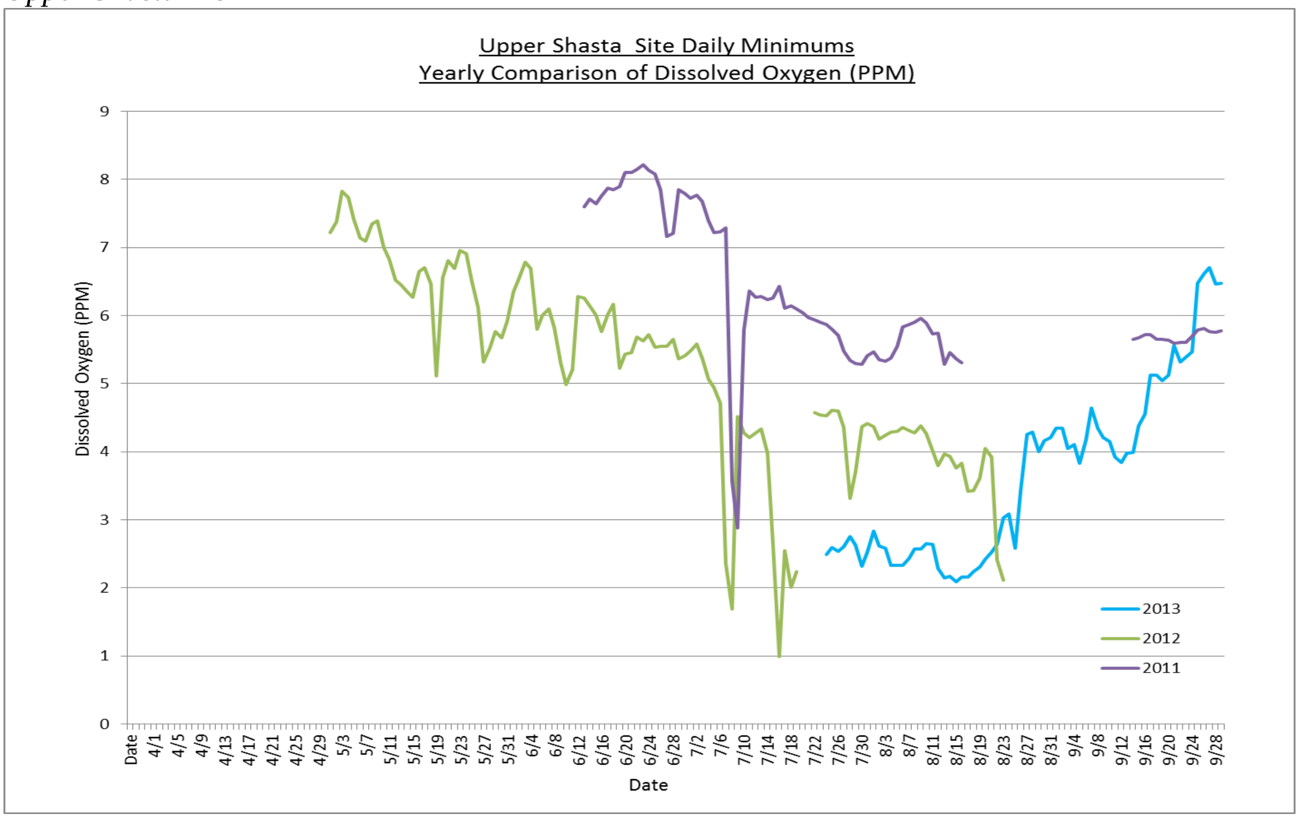
<u>River Temperature Monitoring Conclusions</u>

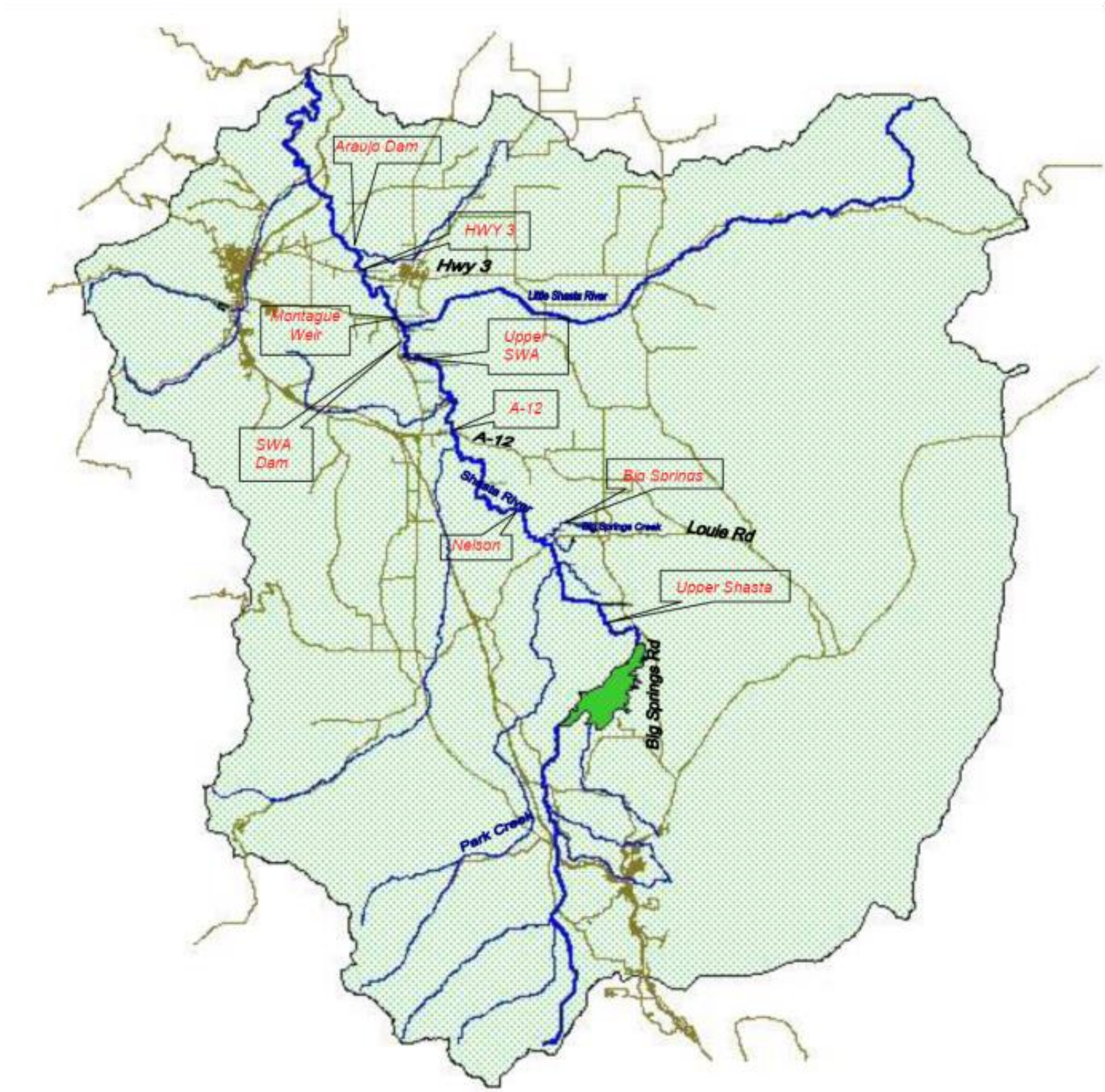
After reviewing the temperature data and the river discharge data from the previous six years, a few trends have been observed. The storage records for Dwinnell and discharge records at the Montague Weir (see following section) show that 2008, 2009, 2013 irrigation seasons all had similar water year records, or what could be considered below average. 2010 and 2012 were similar to each other, and could be considered average water years, and 2011 was an above average year. For all stations in 2011 the lowest 7-DADMax temperatures throughout the season were recorded, there was ample water in the system and ambient air temperature were also considered below average. Comparing the below average years of 2008, 2009 and 2013, from Big Springs Creek to A-12, temperatures in 2013 are considerably lower than 2008/2009 even though the water year/discharge is comparable. Downstream of A-12, the 7-DADMax Temperatures are similar for the three below average water years, with 2013 being the highest at some stations for the majority of the season. In August 2013 the temperatures dropped to 2011 levels at some stations, likely due to air quality conditions (smoke cover). Air quality would reduce solar gain on tailwater returning to the river, thus reducing river temperatures.

Dissolved Oxygen Monitoring

Dissolved Oxygen (DO) was also recorded at all ten stations referred to in the above section. Figure 4 highlights the locations where dissolved oxygen and river temperature was monitored. They all recorded the standard diurnal dissolved oxygen fluctuation, where the lowest concentrations of DO are between 23:00 and 11:00 when respiration occurs. In all locations the water temperatures peak from mid-afternoon to late evening, and are then followed by the lowest DO concentrations. The following graphs illustrate the Daily Minimum DO levels in parts per million (ppm) at each of the monitoring locations for the term of this grant, as well as the previous tailwater grant.

Upper Shasta DO

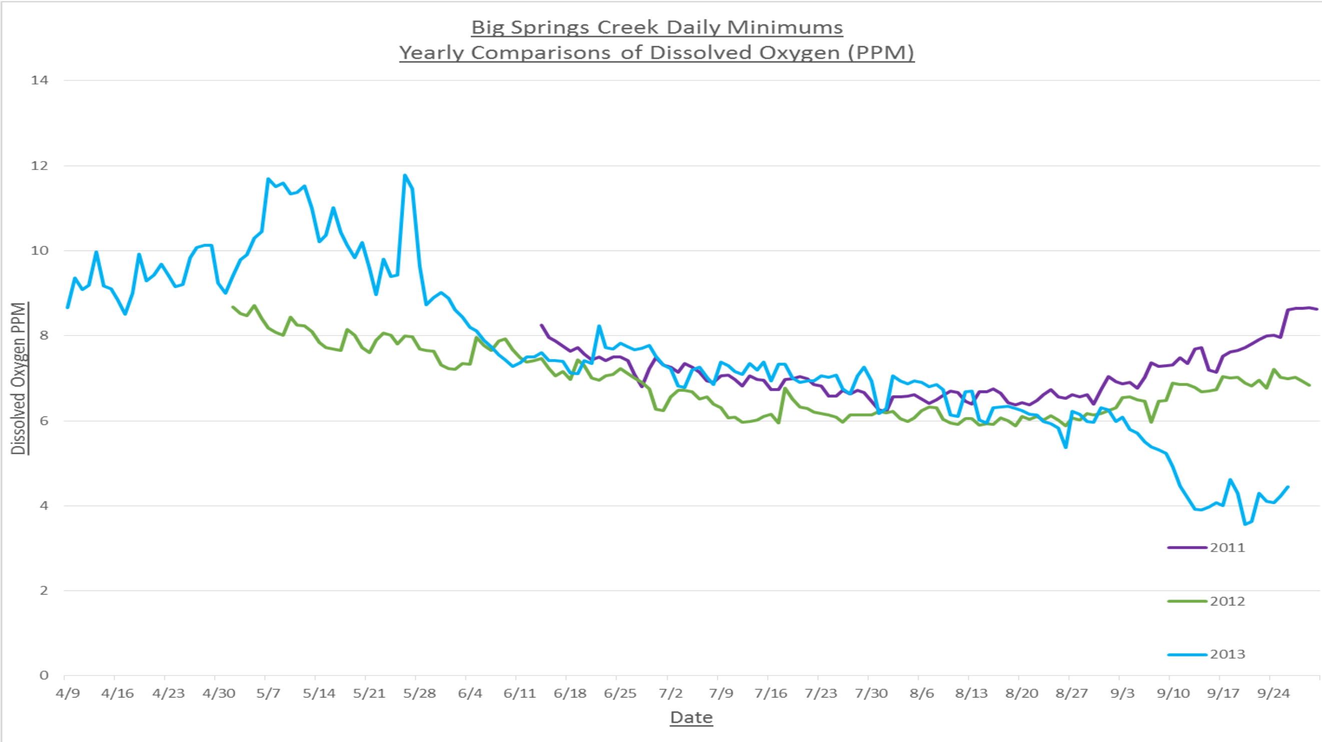


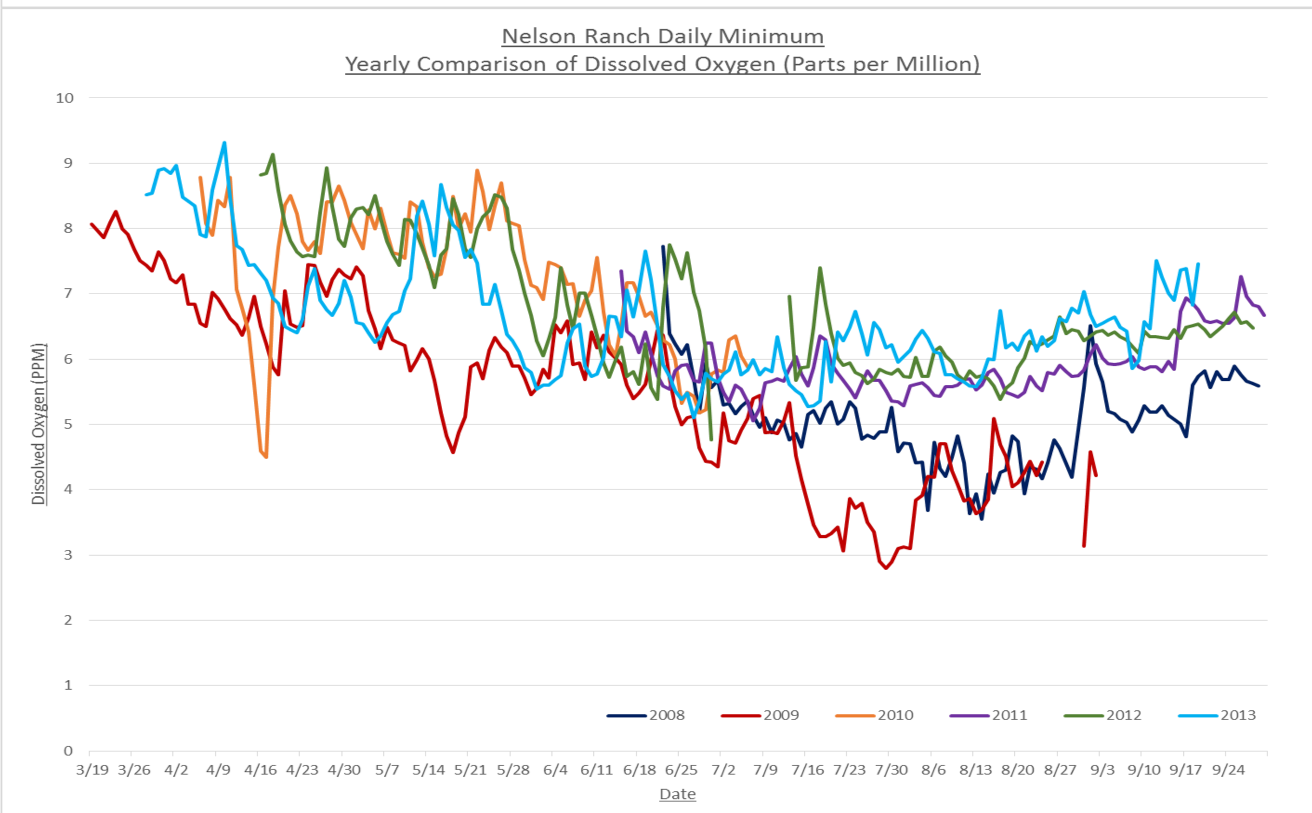


AquaTerra CONSULTING

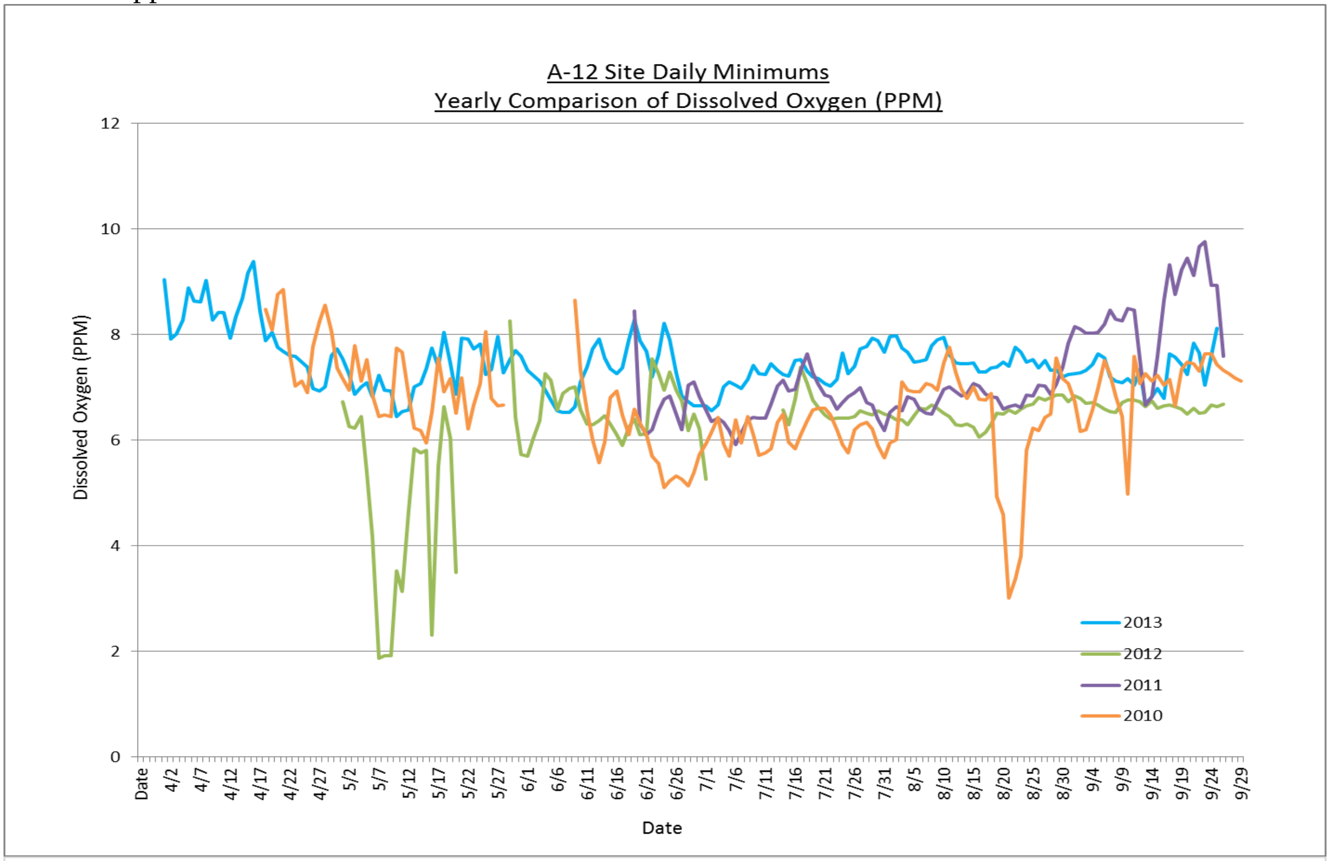
Shasta Valley RCD- Tailwater Reduction Project
Figure 4
Dissolved Oxygen Monitoring Location Map

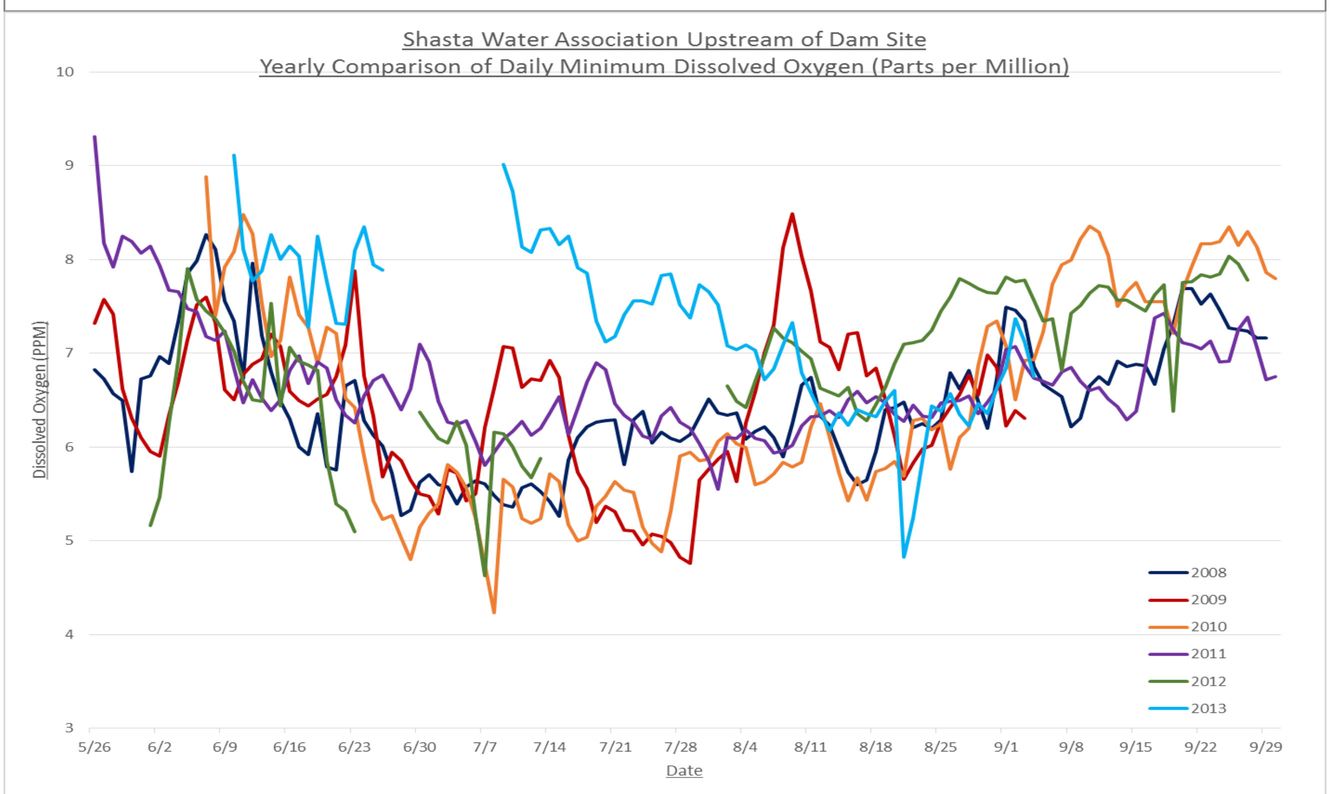
Big Springs Creek & Nelson Ranch DO



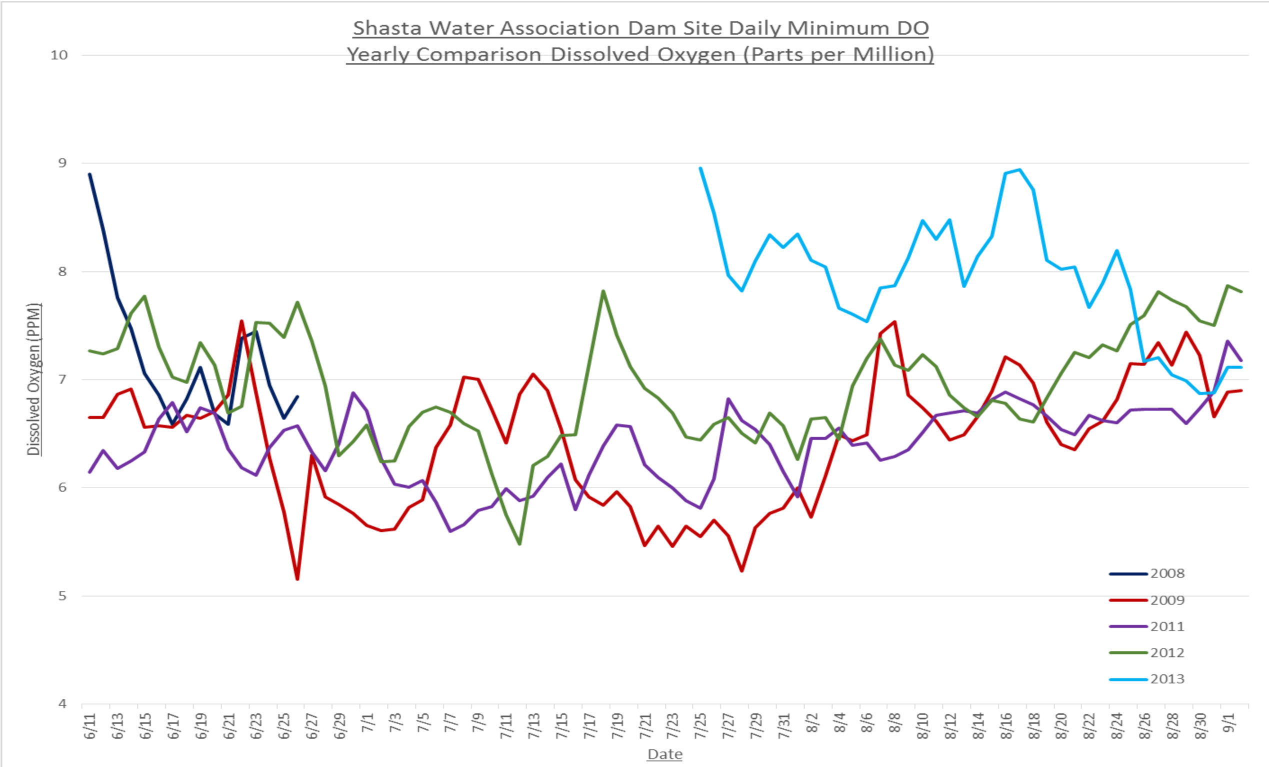


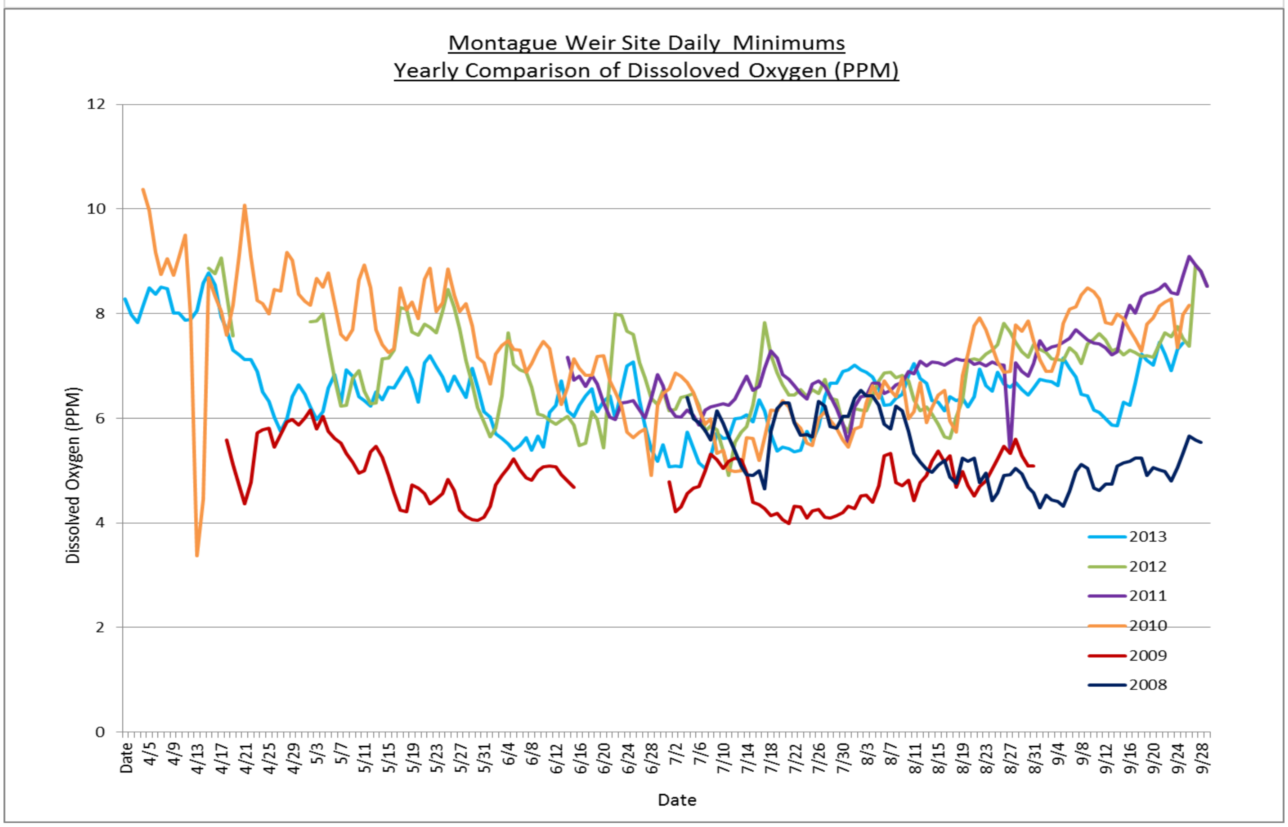
A-12 & Upper SWA



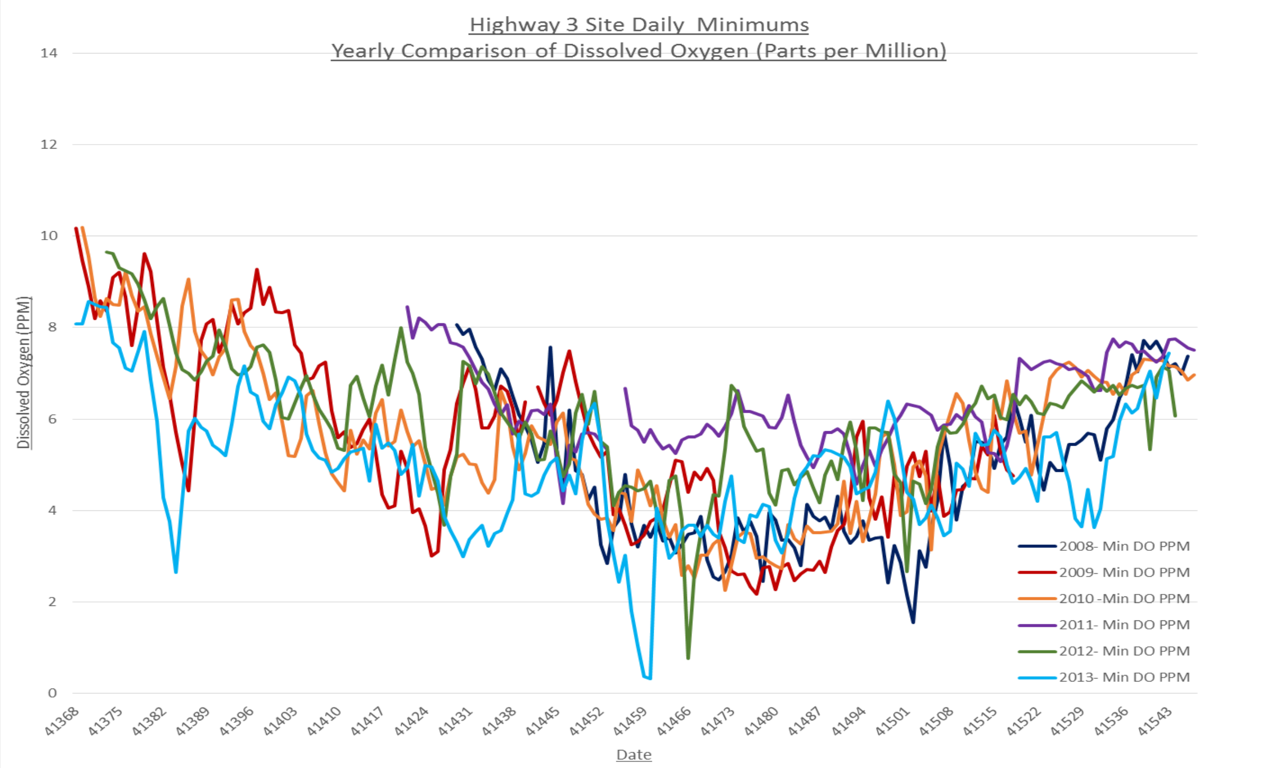


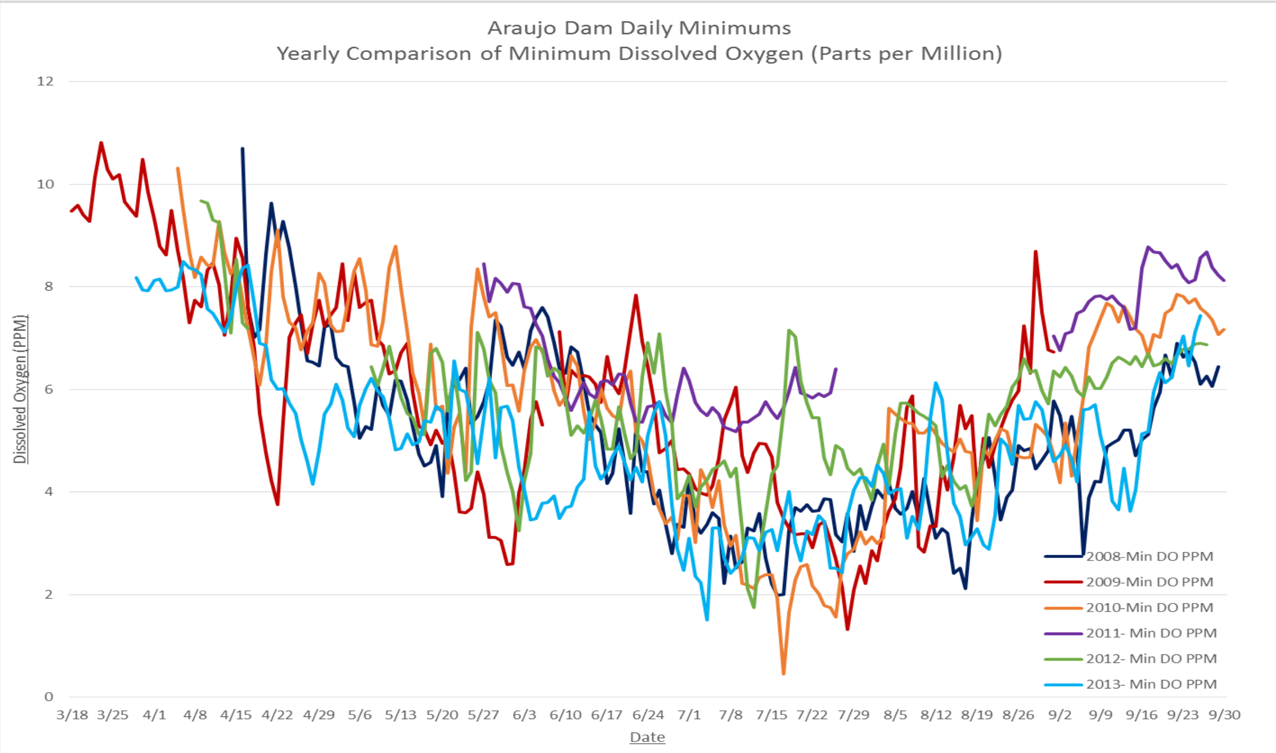
SWA Dam Site & Montague Weir DO



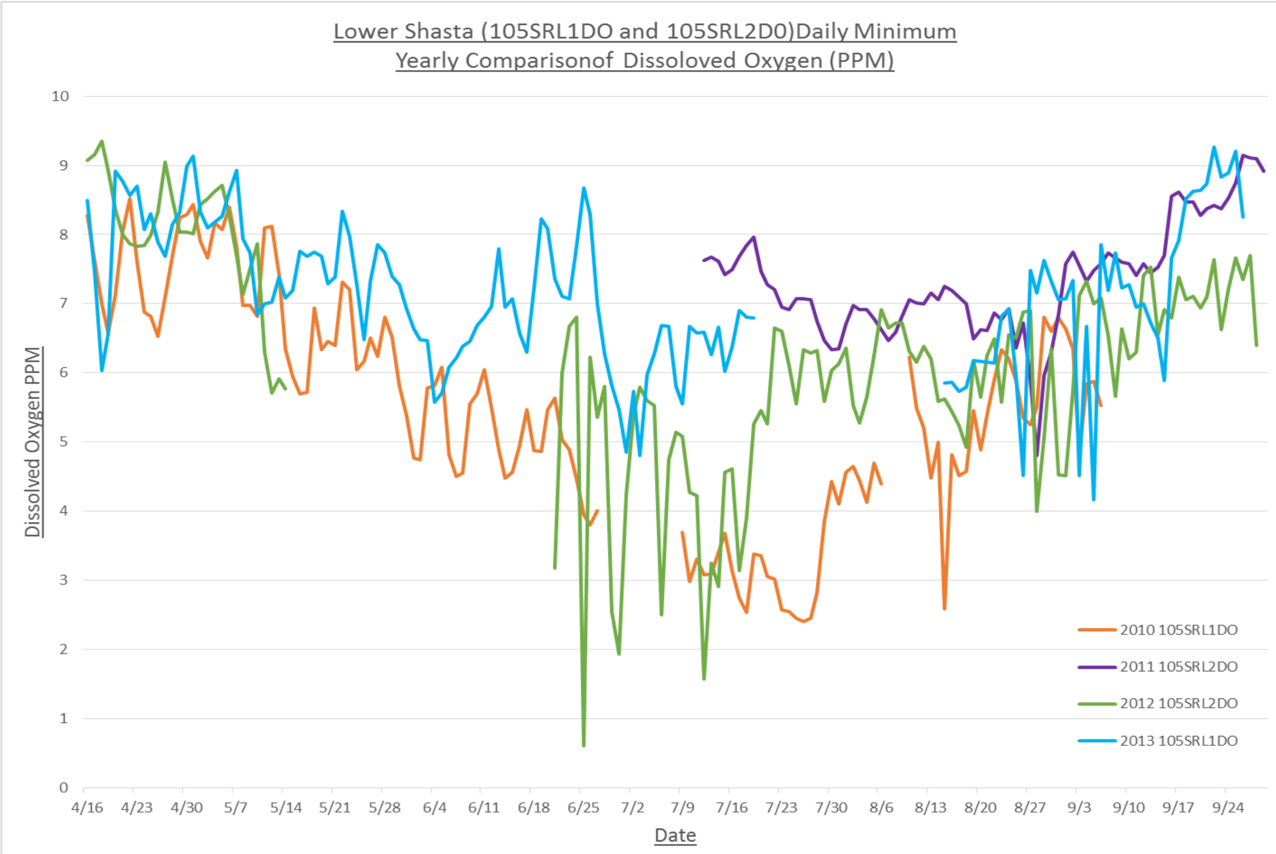


Highway 3 and Araujo Dam Site DO





Lower Shasta DO



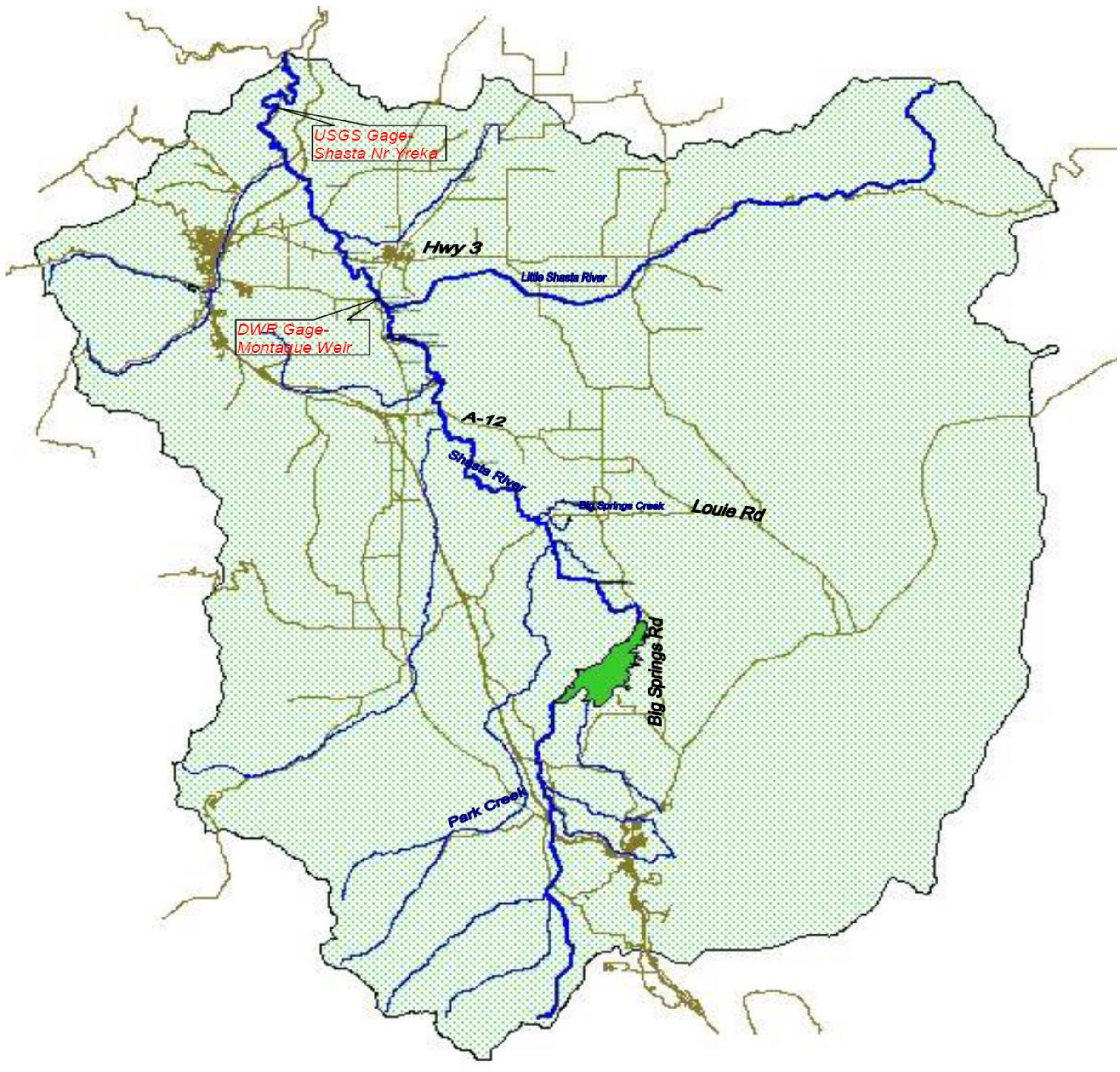
Dissolved Oxygen Monitoring Conclusion

When reviewing the above Dissolve Oxygen Data results, it could be inferred that conditions in the Shasta River are improving, when comparing 2013 data against the other years. From Big Springs Creek to Shasta Water Association Dam site the daily minimum Dissolved Oxygen levels for 2013are higher than 2011 levels and rarely drop below 6 ppm, even though 2013 would be considered a below average water year and 2011 is above average. At the Montague Weir site daily minimum Dissolved Oxygen levels for 2013 are comparable to 2010/2012 levels and not dropping below 5 ppm. At Highway 3 and down through the Araujo Dam site daily minimum dissolved oxygen levels in 2013 are comparable to other below-average water year (2008/2009) levels. The lower Shasta site is back up to DO levels comparable to average water years (2010/2012), not dropping lower than 5 ppm for the most part with some late season levels close to 4. So the conclusion is that water quality (DO and Temperature) are improving, especially upstream of A-12. This is likely due to management changes at Shasta Big Spring Ranch, but also the tailwater reductions due to the tailwater project's activities in the high priority area of the watershed.

River Discharge

Discharge is an important aspect of measuring the impact any given tailwater input could have on water quality. Included in this report is data from the USGS gages at the Montague-Grenada

Bridge (MG Rd-11517000). See Figure 5- River Gage Location Map for general location of all gages. Reviewing storage in Dwinnell illustrates the difference in water years. 2011 could be considered an above average water year, there was ample water in storage. 2013, 2009 and 2008 were all comparable water years, where 2010 and 2012 were similar.



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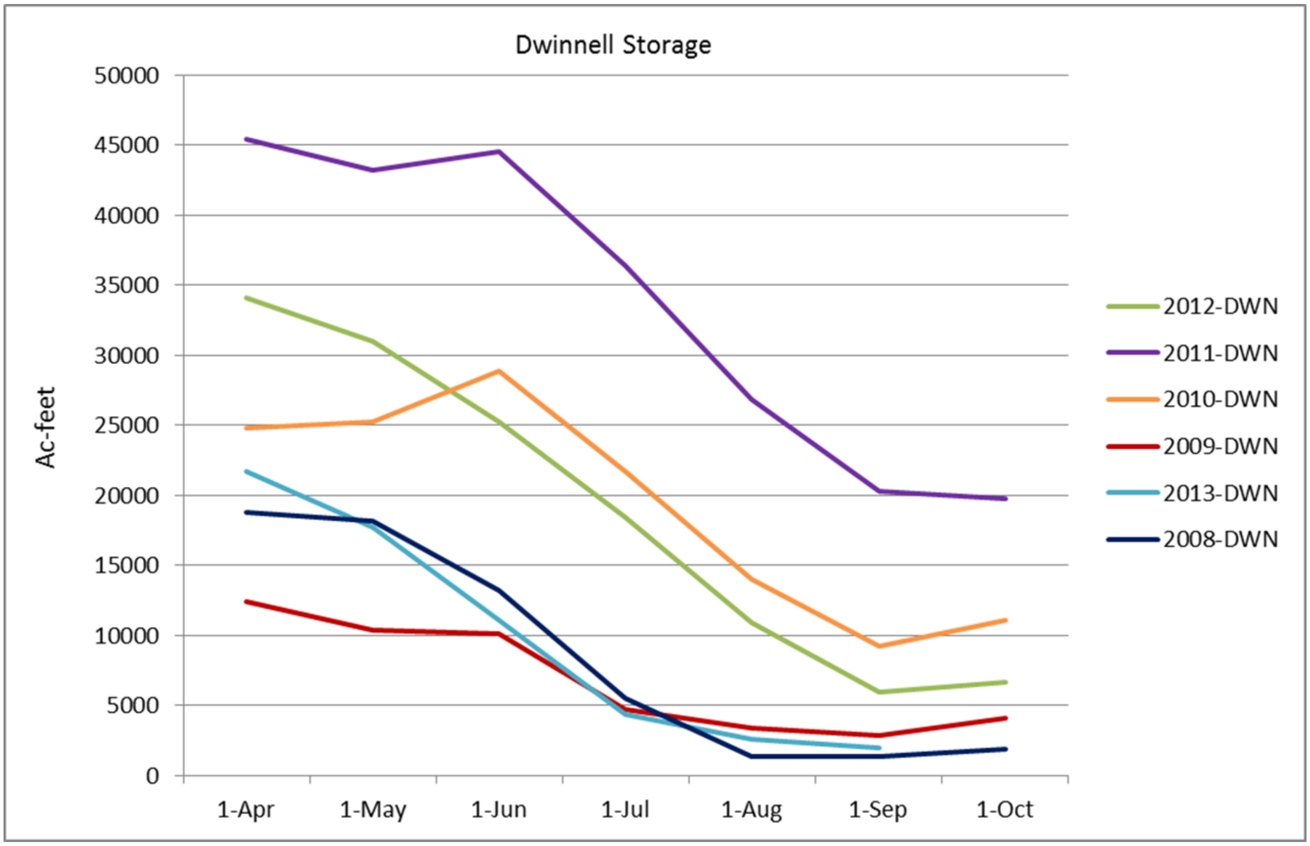
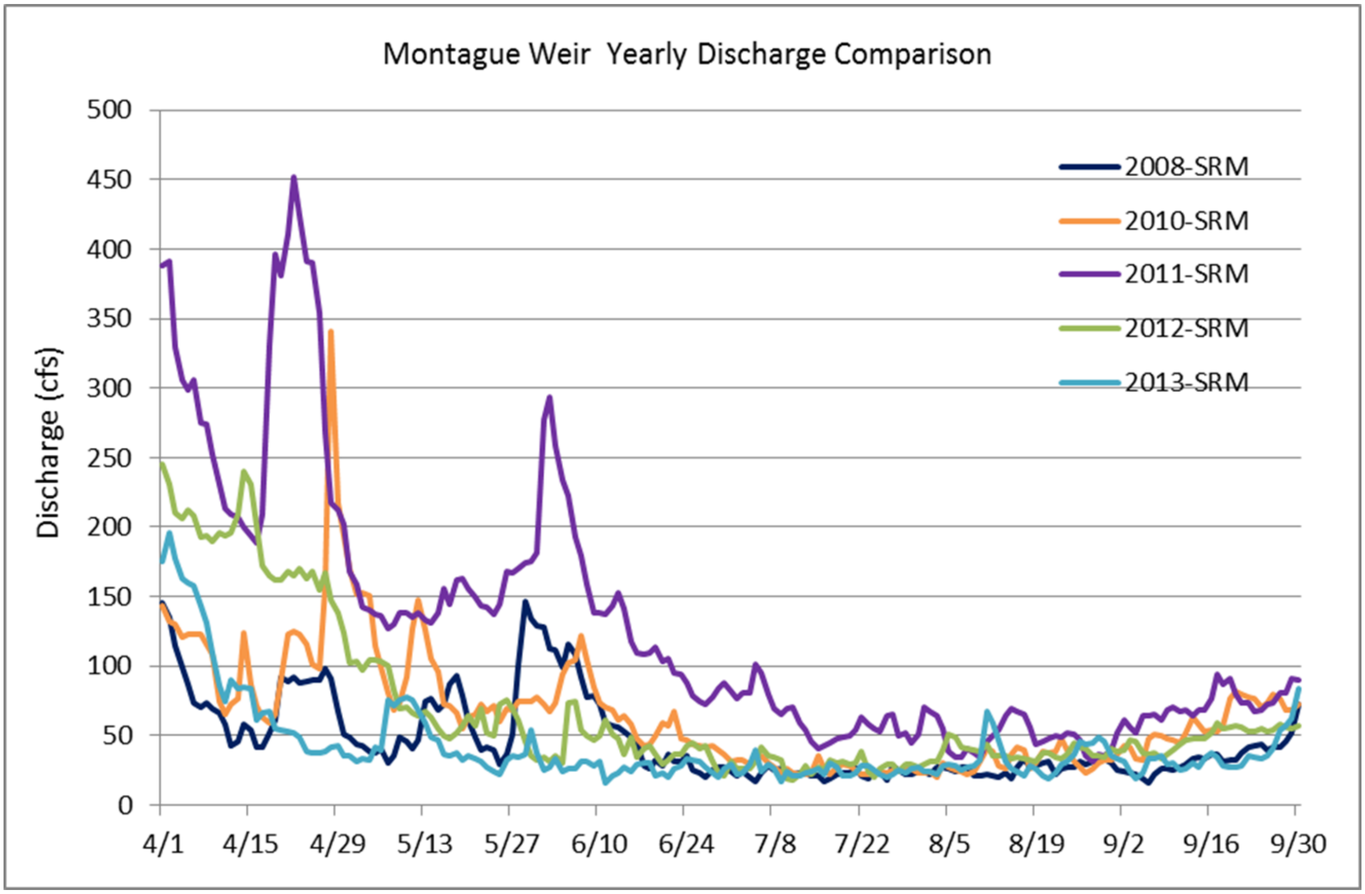
Shasta Valley RCD- Tailwater Reduction Project
Figure 5
Established Gage Location Map



Montague Weir Gage

The following graph illustrates the average daily discharge at the Montague Weir five irrigation seasons (April 1 through October 1), based on data from the USGS website. In 2011 the highest average daily discharge recorded at this gage was 452 cfs on April 22nd and the lowest average daily flow was 32 cfs on August 28th. In comparing the irrigation season flow records at this location; the 2011 season water year observation noted above was recoded throughout the system. The comparison of 2008/2013 and 2010/2012, is also evident at this gage.


Montague Weir Yearly Discharge Comparison
Discharge (cfs)
500
450
400
350
300
250
200
150
100
50
0
4/1
4/15
4/29
5/13
5/27
6/10
6/24
7/8
7/22
8/5
8/19
9/2
9/16
9/30
2008-SRM
2010-SRM
2011-SRM
2012-SRM
2013-SRM