FINAL REPORT

COLORADO HEALTHY RIVER FUND

Lower Gunnison River Basin

Selenium and Salinity Water-Quality Monitoring

Project Sponsor: Colorado River Water Conservation District
Purchase Order #: OE PDA 10000000073
Performance Period: December 23, 2009 – June 30, 2011

Colorado River District
75 Years
Protecting Western Colorado Water

INTRODUCTION

Water-quality information is the foundation for important decision making. *The Lower Gunnison Basin Selenium and Salinity Water-Quality Monitoring* project expanded upon and optimized the existing water-quality monitoring network in the Lower Gunnison River Basin by adding a real-time specific conductance monitor in one of five strategic locations in the lower Gunnison River Basin at a key U.S. Geological Survey (USGS) real-time stream flow station. The goal of the project was to gather selenium and salinity water-quality data so that remediation could be better targeted for the purposes of meeting State of Colorado water quality standards and Endangered Species Act requirements for the protection of endangered river fishes.

This project helped to achieve this key goal by: 1) gathering selenium data necessary for TMDL development and/or refinement, 2) providing data to help refine existing modeling tools (e.g. USGS's Upper Colorado Detailed Salt Model (UCDSM) and Spatially Referenced Regression on Watershed Attributes for Selenium and Salinity (SPARROW)), 3) furthering our knowledge of water-quality impacts due to changes in land and water use, and 4) demonstrating measurable results of implemented remediation projects.

BACKGROUND

Mancos shale soils are common in the Lower Gunnison Basin and Grand Valley areas of western Colorado. Selenium and associated salts naturally occur in high concentrations in these soils. In these areas, the application of water to the soil (e.g., via irrigation water, leaking canals, seepage from ponds and septic leaching systems) can mobilize selenium and salts and create hydraulic gradients that can result in the discharge of non-point source surface and groundwater pollution into irrigation drains and local waterways. The majority of waters within the lower Gunnison River Basin are classified for aquatic life, recreation, and agricultural uses and related water-quality standards. The State of Colorado has a 4.6 ppb chronic water-quality standard to protect aquatic life uses. In many places in the lower Gunnison River Basin this standard is exceeded.

High selenium concentrations have been shown to cause reproductive failure and deformities in sensitive aquatic birds and fish. The lower Gunnison River from the confluence of the Uncompahgre River downstream serves as designated critical habitat to four listed endangered fish species (Razorback sucker, Humpback chub, Bonytail chub, and Colorado pikeminnow).

In addition, salinity is also a major concern for the State of Colorado and other Colorado River Basin States. The salinity contributions from natural, agricultural, industrial, and municipal sources can affect the water quality of receiving streams which in turn can cause adverse impacts to downstream users. Selenium and salinity are commonly found together in Mancos Shale soils in the Lower Gunnison Basin.

Agricultural Non Point Source (NPS) pollution of surface water and ground water is a priority in the State of Colorado's NPS Management Program. Section 303(d) of the Clean Water Act (CWA) requires that states submit to the EPA a list of those waters for which technology-based effluent limitations and other required controls are not strict enough to implement water-quality standards. According to the State of Colorado Integrated Water Quality Monitoring Assessment

Report, of those river segments placed on Colorado's 303(d) List of Impaired Waters, the leading cause of impairment statewide is selenium (Colorado Department of Public Health and Environment (CDPHE), 2010). Such impairments require that a Total Maximum Daily Load (TMDL) assessment be completed. In 2011, a TMDL for dissolved selenium was completed for the Uncompahgre and Lower Gunnison Rivers and their tributaries in Montrose, Delta and Mesa Counties (CDPHE, 2011). The completion and publication of the TMDL removed applicable selenium impaired segments from the 303(d) list while continuing to monitor them under CWA Section 305(b).

In order to reduce or prevent selenium and salinity loading to local water ways, millions of dollars are being expended on water-quality improvements and Best Management Practices (BMPs) in the Lower Gunnison River Basin. Salinity control projects such as off-farm piping and lining of irrigation delivery systems, the elimination of winter water in the Uncompahgre Project canals, and on-farm BMPs under the Environmental Quality Incentives Program (EQIP) have been successful in reducing selenium and salinity loads in the Lower Gunnison Basin.

In addition, the U.S. Fish and Wildlife Service (FWS) issued a Programmatic Biological Opinion (PBO) for the Gunnison Basin for the reoperation of flow releases from the Aspinall Unit for the benefit of endangered river fish (U.S. Fish and Wildlife Service, 2009). The PBO called for the development of a Selenium Management Program (SMP) as a conservation measure necessary for the recovery of endangered fish. After years of effort and significant coordinated planning on the part of Gunnison Basin stakeholders in conjunction with the Gunnison Basin & Grand Valley Selenium Task Forces, the SMP Formulation Document (PFD) was completed with specific guidelines and submitted to the FWS (U.S. Bureau of Reclamation, 2011).

The PFD calls for a comprehensive Lower Gunnison Basin Water-Quality Monitoring Program in order to document changes in selenium loading associated with selenium and salinity reduction activities and/or changing land use. Therefore, in cooperation with partners such as the Gunnison Basin & Grand Valley Selenium Task Force (STF), USGS, U.S. Bureau of Reclamation (USBR), Colorado River Water Conservation District (CRWCD), WQCD, and the CHRF, a robust water-quality monitoring program has been put into place.

APPROACH

This project worked within the existing CRWCD cooperative water monitoring program with the USGS to add an additional important real-time water-quality monitor in one of five identified strategic locations to capture up-gradient or baseline, water-quality information. The data from the monitor enhance the monitoring network of down-gradient sites by providing real-time water-quality background conditions so that temporal changes in concentrations and loads can be detected. The water-quality monitor provides long-term data critical to the documentation of selenium load reduction analyses in the basin.

OBJECTIVES/TASKS/PRODUCTS/COSTS/SCHEDULE/MILESTONES

Objective 1: Install a real-time specific conductance monitor at the USGS gauging station at Colona to gather necessary data for selenium and salinity water-quality analyses.

Task 1: Purchase and install a real-time specific conductance monitor
Product: Monitor installed in existing gauge
Milestone/Schedule: Monitor purchased and installed

Proposed Budget	**Final Budget**
CHR Funding: $7,800	$7,800
In-kind match: $0	$0
Cash: $0	$0

Task 2: Annual operation and maintenance
Product: Real-time data archived on NWIS.
Milestone/Schedule: Real-time data from monitor on NWIS

Proposed Budget	**Final Budget**
CHR Funding: $4,550	$4,550
In-kind match: $8,774	$9,259
Cash: $9,036	$9,538

Task 3: Selenium sampling and analysis
Product: Results of 6 sampling events and analysis
Milestone/Schedule: Summary Report as part of final report

Proposed Budget	**Final Budget**
CHR Funding: $3,650	$3,650
In-kind match: $6,716	$8,317
Cash: $3,479	$3,671

Task 4: Public involvement
Product: Documentation of public involvement (sign-in sheets, watershed plan, newsletter updates, web links to NWIS for real-time monitor results, web link to STF water quality monitoring program description)
Milestone/Schedule: Completion of 5 public involvement tasks

Proposed Budget	**Final Budget**
CHR Funding: $0	$0
In-kind match: $1,000	$1,030
Cash: $0	$0

Task 5: Grant accountability and project management
Product: Documentation of expenditures, in-kind match, cash match, and final report
Milestone/Schedule: Final Report

Proposed Budget	**Final Budget**
CHR Funding: $0	$0
In-kind match: $1,500	$8,408
Cash: $0	$0

RESULTS

The results from the monitor and field sampling events are summarized in Table 1 below.

Table 1 shows summary results for discharge (ft^3/sec), temperature (degrees C), total dissolved selenium (µg/L), selenium load (lbs/day), total dissolved solids (µg/L) and salt load (tons/day).

Table 1. Summary Data for the Uncompahgre River at Colona, Colorado, stream gauge site.

Date	Water Temp (deg C)	Discharge (ft3/sec)	Specific Conductance (µg/L)	Total Dissolved Se (µg/L)	TDS (µg/L)	Selenium Load (lbs/day)	Salinity Load (tons/day)
01/29/10	4.1	56	600	1.1	405	0.33	61.2
04/21/10	9.4	498	447	0.88	289	2.36	388.6
06/15/10	11.3	700	467	0.7	302	2.64	570.8
07/08/10	12.2	323	427	0.51	273	0.89	238.1
09/07/10	15.3	244	436	0.44	276	0.58	181.8
11/30/10	3.7	60	621	0.91	412	0.29	66.7
12/14/10	4.6	63*	610	1.2	405	0.41	68.9
02/03/11	0.1	70	601	0.9	411	0.34	77.7
03/29/11	9	212	610	0.8	412	0.91	235.8
05/17/11	7.2	528	437	0.72	273	2.05	389.2
08/29/11	15.5	405	373	0.423	231	0.92	253

*Data from rating curve.

Figure 1 is a graphical representation of selenium and salinity loading results (lbs/day and tons/day, respectively) from January 2010 to August 2011 which covers the grant performance period of December 23, 2009 to June 30, 2011.

Figure 1. Selenium and Salinity Load in the Uncompahgre River at Colona, CO.

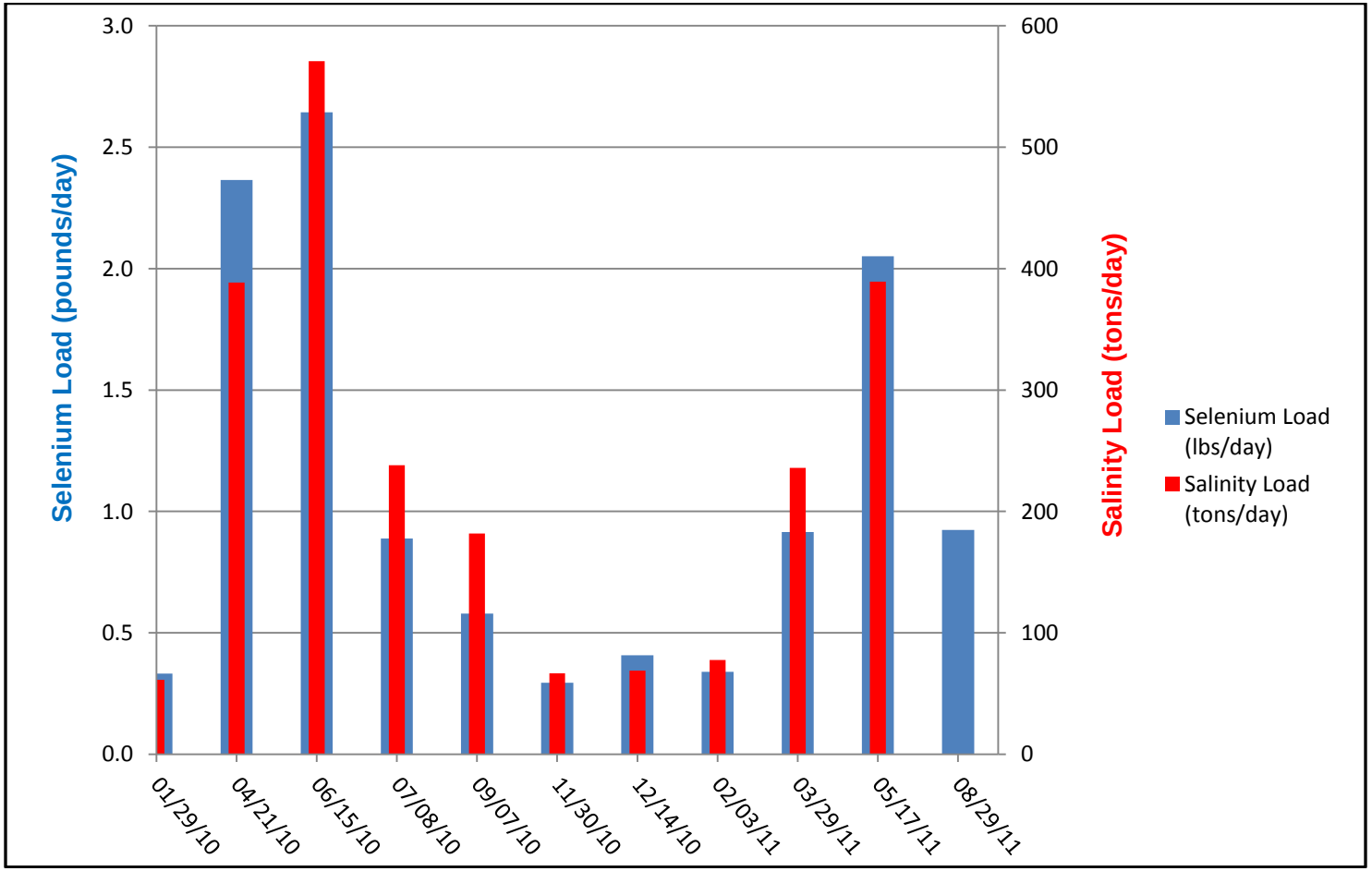


Figure 2. Daily discharge Uncompahgre River at Colona, CO.

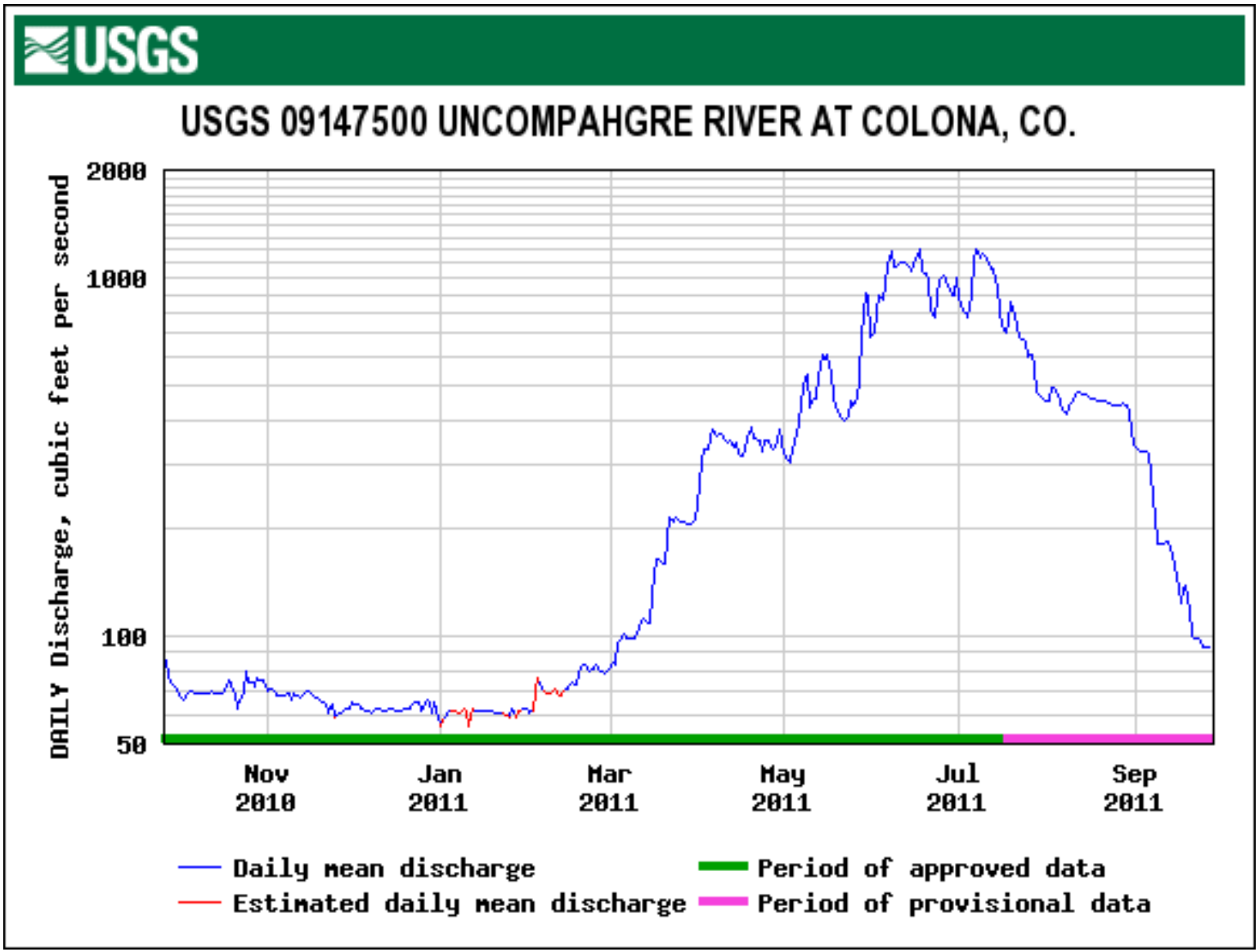


Figure 3. Daily specific conductance Uncompahgre River at Colona, CO.

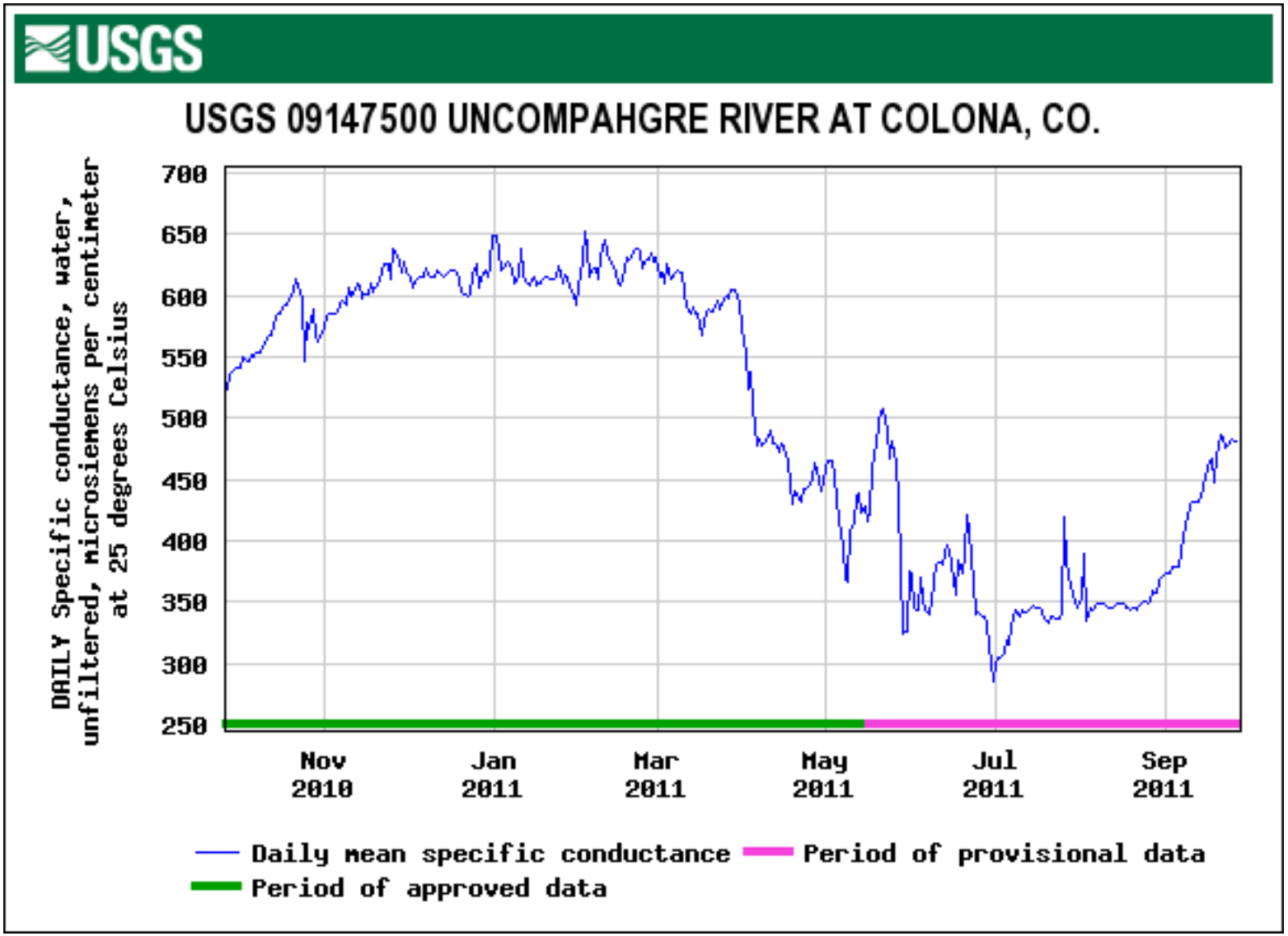


Figure 4. Daily temperature Uncompahgre River at Colona, CO

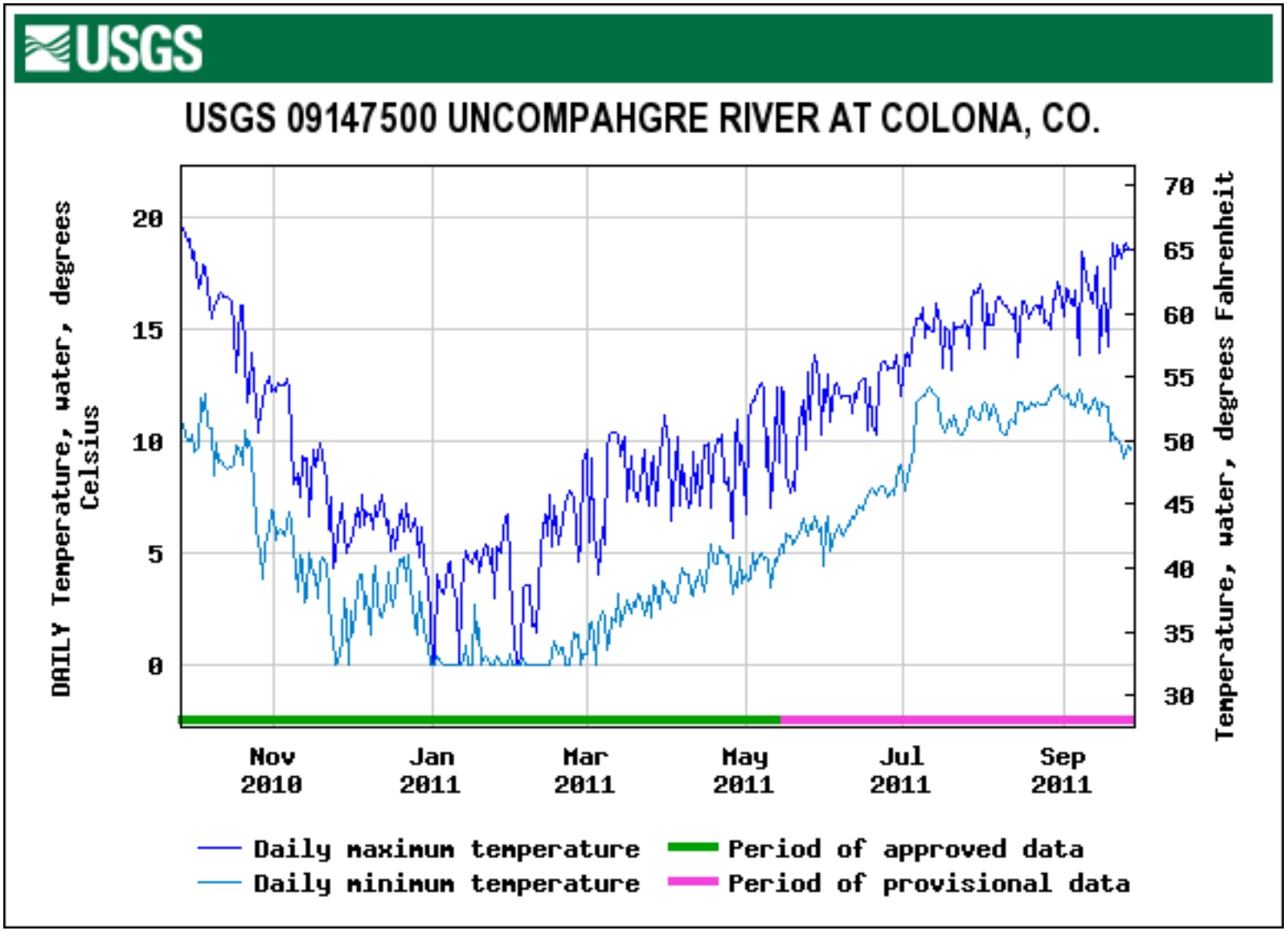
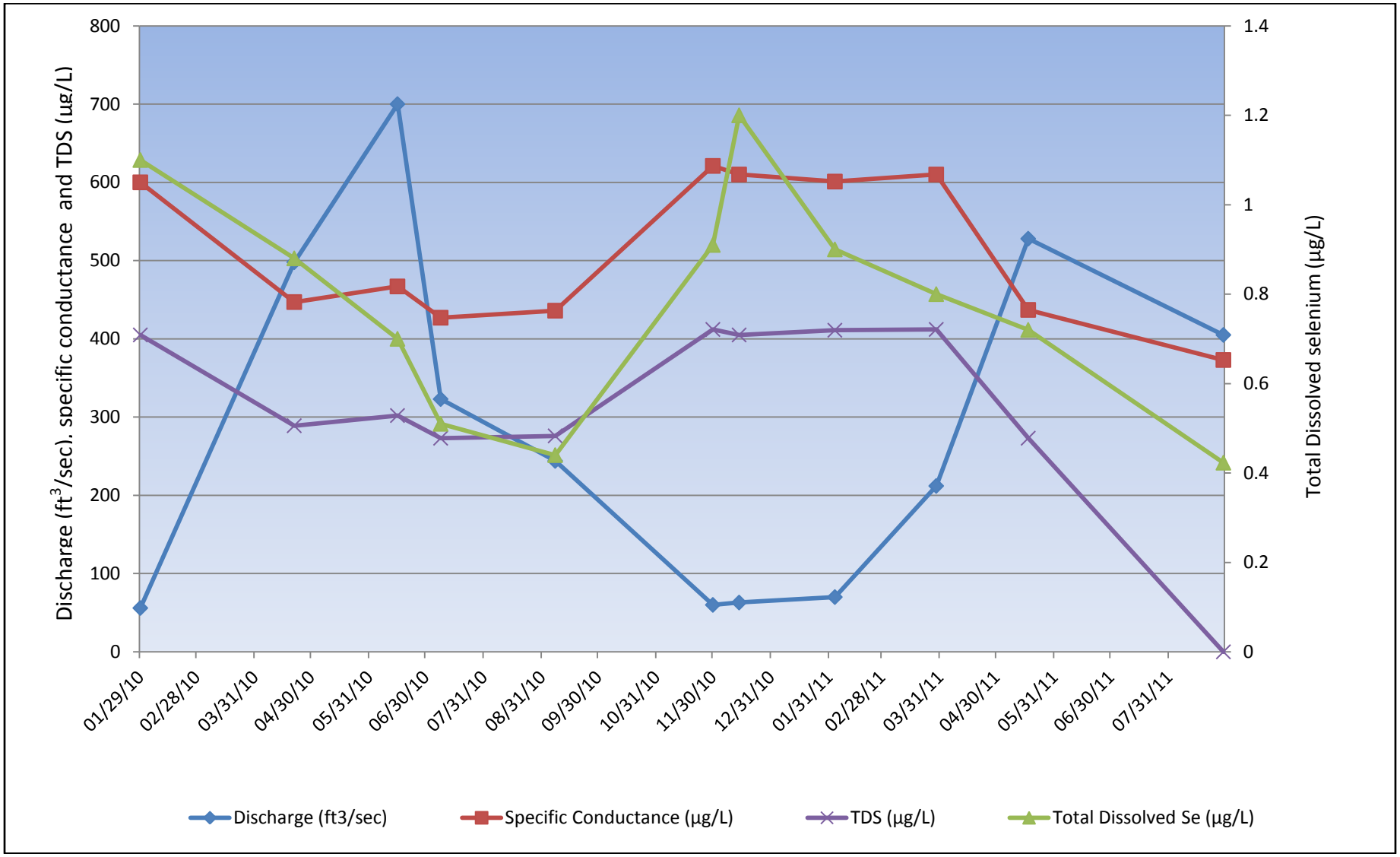


Figure 5 is a graphical representation of the concentration of selenium, salinity, and total dissolved solids with varying discharge at the Uncompahgre River at Colona, Colorado.



DISCUSSION

The addition of the real time water quality monitor provides a large quantity of data points very cheaply (data is collected and recorded every 15 minutes). These data can be correlated to discrete samples that are typically collected between 6 and 9 times a year (Table 1 shows that 11 samples were collected in the study period) for validation and to enable the calculation of selenium concentrations based upon the value of specific conductance (SC). If the correlation is statistically valid, the SC data from the monitor can thereby act as a 'surrogate' for dissolved selenium concentrations. In essence, this approach 'leverages' or extends the manually collected data.

In general, selenium, salinity (TDS) and SC tend to follow the same general trend. Increasing flows have a dilution effect and cause a decrease in selenium and salinity concentrations. Typically, as flows increase in spring with snow melt, the SC decreases and concentrations of TDS and selenium also decrease. Later in the season, as flows decrease (e.g., late July), concentrations tend to increase as dilution effects become negligible. This can be seen in Figure 5. The water quality monitor also provides valuable information regarding water temperatures both throughout the day as well as seasonally. Temporal changes in ambient temperature and seasonal flow conditions can cause water temperatures to rise and fall dramatically. Understanding the nature of such changes is essential not only for water quality concerns (e.g., SC and Dissolved Oxygen) but understanding temperature variations help understand potential impacts to in-stream aquatic species and habitats. Seasonal changes are easily observable in Figure 4 as temperatures decrease from October to January and increase from January through September.

Preliminary data indicates that there are measureable selenium and salinity loads at Colona, above the federal Uncompahgre Project area. This suggests that there may be additional non point sources of salt and selenium upstream. Additional remedial activity related to potential non-point sources upstream of the UVWUA area may be warranted.

CONCLUSIONS

Overall, this project was very successful. By assisting in the installation and operation/maintenance of the continuous water-quality monitor, the CHRF has significantly enhanced the database of water quality upstream of the federal Uncompahgre Project irrigation area.

This project provided essential information and filled an important data gap related to upstream water-quality conditions. Together with downstream data collection points, the new real time monitor at Colona, located near the southern end of the selenium planning boundary, effectively brackets irrigation district and primary selenium and salinity loading areas. Now with this important data gap filled, the database is more complete and can more easily be queried and analyzed to more accurately detect differential changes in salinity and selenium concentrations and loading. Any such detected changes can then be better linked to changes in land use, weather events, and/or remediation projects (e.g., piping / lining of water conveyance systems and/or

conversion to more efficient surface irrigation practices). This approach helps quantify changes and can provide 'measureable results' for different remediation techniques.

Specifically, in the future, when sufficient specific conductivity and temperature data from the monitor are collected, the continuous record can be used to estimate daily, seasonal and annual selenium and salinity loads at this background site. Additionally, the continuous water-quality record can be used to perform differential loading analysis to evaluate downstream irrigation activities by comparing against existing down gradient measurement locations that also have continuous water-quality records. This will enable scientists and managers to better understand the magnitude and variability of selenium and salinity loads in the Uncompahgre River and Lower Gunnison River basins and to potentially target remedial activities for salinity and selenium control.

It is anticipated that this monitor will continue to be funded through the Selenium Management Program and will continue to provide a critically important continuous water quality record to further the state of water-quality science in the Lower Gunnison Basin.

LITERATURE CITED

U.S. Fish and Wildlife Service. 2009. Final Gunnison River Basin Programmatic Biological Opinion. Grand Junction. [Cited 2012, August]. Available from: http://www.usbr.gov/uc/wcao/rm/aspeis/pdfs/aspinallpbo_final.pdf

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Colorado Department of Public Health and Environment, Water Quality Control Division. 2011. "Gunnison and Lower Dolores River Basins – Completed TMDL's". [Cited 2012, August] Available from: http://www.cdphe.state.co.us/wq/Assessment/TMDL/gunnison.html

PROJECT BUDGET SUMMARY (See also attachment A)

Grant Expenditures:	$16,000
In-Kind Match:	$27,014
Cash Match:	$13,209
Project Total:	$56,223

***$13,536 paid to date by CHRF (15% withheld until grant completion)*

Balance due: $2,464

CHRF Match and Expenditures Summary

Grant Performance Period 12-09 to 06-11

Attachment A

	Budget Revised	Dec 09	Jan - June 2010	July - Dec 2010						Jan - June 2011						Total
				July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	
Task 1: Purchase & Install																
USGS (Cash)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -
River District (In-kind)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -
CHRF	$7,800	$7,800	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ 7,800
Task 2: O & M																
USGS (Cash)	$9,036	$502	$3,012	$502	$502	$502	$502	$502	$502	$502	$502	$502	$502	$502	$502	$ 9,538
River District (In-kind)	$8,774	$487	$2,925	$487	$487	$487	$487	$487	$487	$487	$487	$487	$487	$487	$487	$ 9,259
CHRF	$4,550	$253	$1,517	$253	$253	$253	$253	$253	$253	$253	$253	$253	$253	$252	$0	$ 4,550
Task 3: Se sampling and analysis																
USGS (Cash)	$3,479	$193	$1,160	$193	$193	$193	$193	$193	$193	$193	$193	$193	$193	$193	$193	$ 3,671
River District (In-kind)	$6,716	$373	$2,239	$373	$506	$706	$464	$494	$388	$495	$505	$505	$523	$373	$373	$ 8,317
CHRF	$3,650	$203	$2,196	$531	$531	$189	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ 3,650
Task 4: Public involvement																
USGS (Cash)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -
River District (In-kind)	$1,000	$0	$1,030	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ 1,030
CHRF	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -
Task 5: Accountability																
USGS (Cash)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -
River District (In-kind)	$1,500	$0	$105	$852	$1,020	$621	$600	$600	$600	$989	$600	$600	$611	$600	$611	$ 8,408
CHRF	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -
TOTAL	**$46,505**	**$9,811**	**$14,182**	**$3,192**	**$3,492**	**$2,951**	**$2,500**	**$2,530**	**$2,424**	**$2,919**	**$2,540**	**$2,540**	**$2,569**	**$2,407**	**$2,166**	**$ 56,222**