Jesse Kruthaupt
Upper Gunnison Project Specialist

October 7, 2019

Craig Godbout
Colorado Water Conservation Board
1313 Sherman St.
Denver, CO 80203

Re: Final Report Tomichi Water Conservation Program.

Dear Mr. Godbout,

The Tomichi Water Conservation Program was completed on August 28, 2019. Under this program, TU compensated six water users on lower Tomichi Creek near Gunnison, Colorado in exchange for their cessation of irrigation diversions, with expected flow benefits accruing to the Tomichi State Wildlife Area. The program was designed to be implemented during either 2018, 2019, or 2020 based on water supply conditions. The water supply threshold was meet in the spring of 2018, and therefore the program was implemented during that year.

Trout Unlimited (TU) would like to thank all participating landowners and funding partners for their support of the Tomichi Water Conservation Program. The following report provides details on each project task and summarizes the data collected during the execution of this project.

Task 1: Enroll Participants and Implement the Conservation Program

In the spring of 2018, TU successfully enrolled 6 properties totaling 1003 acres of irrigated land in the Tomichi Water Conservation Program.

Participation agreements and field summaries were completed for each participating property. Each agreement specified the water conservation actions, and the field summaries specified the estimated consumptive use reduction and payment amounts for each property owner. Participants were paid $20 per acre of irrigated land they chose to enroll in the program for the three-year period and $180 per estimated acre foot conserved. A sample agreement is included in Appendix A.

At the beginning of May 2018, TU consulted with participants to review the NRCS May 1st Water Supply Outlook Report for Tomichi Creek. The report forecasted water supply for Tomichi Creek at Gunnison to be 19% of average. This forecast fell within the range that TU and the participants had established as the trigger for implementing water conservation actions. Once it was decided that 2018 would be the implementation year, participants were paid for 50% of the estimated conserved water payment prior to the agreed upon shut off date of July 1, 2018.

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The six participants successfully completed the proposed conservation actions during the July, August and September of 2018 and were compensated for the remaining amount due in October of 2018.

Task 2: Estimate and Verify CU and Impacts

Pre-Project Modeling:

In March of 2018, TU contracted Hydros Consulting to model how the conservation actions would affect streamflow at three locations: the lower terminus of the project reach (Tomichi at I-Bar Ranch), Tomichi at Gunnison USGS Gage, and the Gunnison River above Blue Mesa Reservoir. Four water management scenarios were modeled using StateMod. Scenario 1 depicted historic stream flows using recorded diversions from 1998 to 2013. Scenario 2 modeled flows as if irrigation was shut off on July 1 without shepherding. Scenario 3 modeled flows if irrigation was shut off and conserved water was shepherded to Blue Mesa. Scenario 4 modeled the extent conserved water from these ditches could be used to offset a Gunnison Tunnel call in 2002 or 2003. The pre-project Hydros model report is included as Appendix B.

The pre-project modeling estimated an average of 1,392 acre-feet of consumptive use savings would result from cessation of irrigation from July 1- October 1 for participating ditches. This estimate was more than the estimated conserved consumptive use TU used to compensate participants for the following reasons: (1) Irrigated acreage assigned to the participating ditches in model inputs is more than the actual total of participating acreage; (2) Two participants chose to include the option of a 10-day irrigation in August which essentially eliminated the CU reduction for the month of August for approximately 280 acres; and (3) One ditch (irrigating 95 acres) included in the pre-project model run opted not to participate. Although acreage was not accurate in the pre-project run, per-acre CU values provided some guidance as to what changes could be expected prior to implementation of the project.

Figure 1. shows the pre-project modeling results for stream flow impacts based on averaged stream flow and diversion data from 1999-2013. Each bar shows acre feet of modeled stream flow increase at the sites described above from July 1 to October 31. Again, these results are assumed to be overstated due to the acreage discrepancies in the initial model run. However, it is worth noting very little difference between shepherded and none-shepherded was predicted during average year types.

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Figure 1.

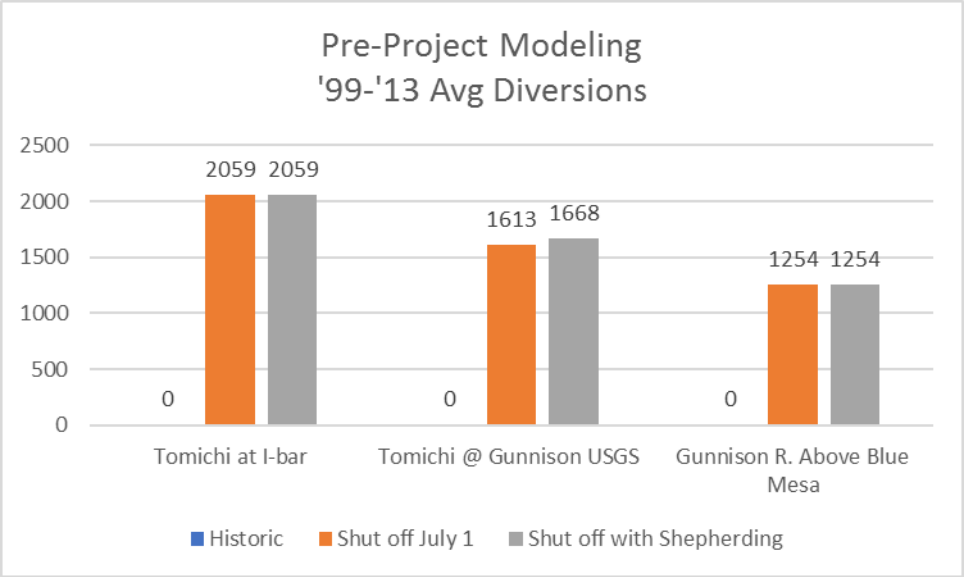
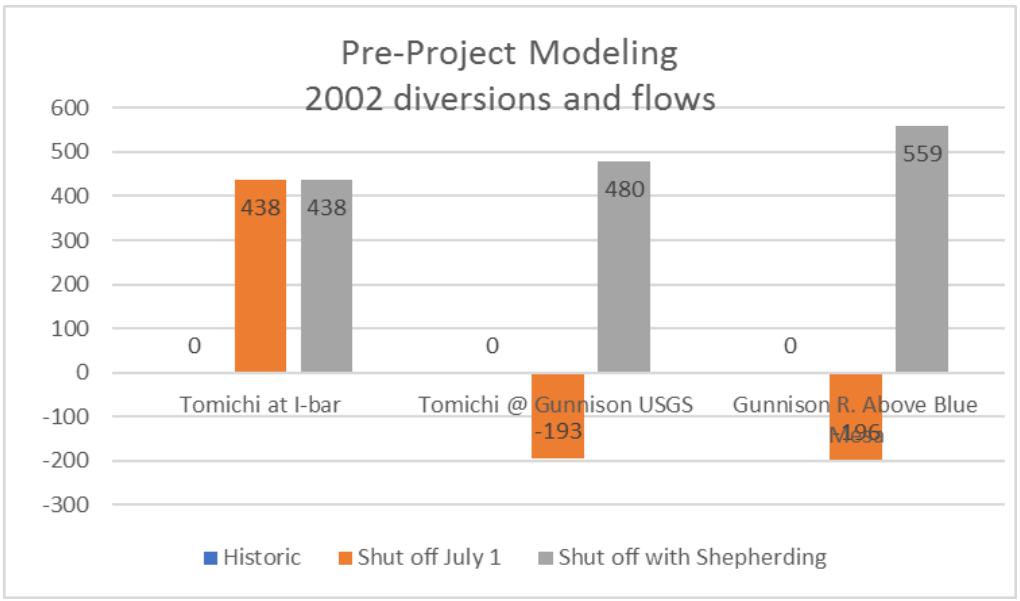


Figure 2. Shows the pre-project model results if this program was run in 2002. Notice the negative values at two sites in the none shepherding scenarios. Many of the participating diversions "called" in 2002, thereby reducing diversions and CU upstream. Without a call or shepherding the model is showing less water available through this reach during very dry years. This also may be due to return flows. For example, if water was diverted, a portion is assumed to come back below the downstream diversions. If not diverted or shepherded, the model shows downstream diversions using the new water available.

Figure 2.



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The modeling analysis showed that conserved water from these ditches would have had little effect on mitigating the Gunnison Tunnel call during 2002 or 2003.

Stream Flow Monitoring

TU installed 2 temporary flow gages on Tomichi Creek. The I-Bar gage was located below the project reach and the Cold Harbor gage was located upstream of the project reach. Manual flow measurements were taken at each site on a weekly basis. A rating curve was developed based on the relationship between stage height and measured flow. The stage height was recorded at 15-minute intervals with a pressure transducer. This data provided discharge values from May to October of 2018. Unfortunately, the temporary gauge recording stage height at the Cold Harbor gage became submerged when a beaver dam was constructed downstream sometime between 7/10 and 7/12. On 7/20 the Cold Harbor gauge was moved to another location, and a new rating curve was started. USGS recorded a measurement on Tomichi below the confluence with the Cochetopa on 7/19 of 12 cfs which helped fill in the gap.

Figure 3. depicts the I-Bar and Cold Harbor gages, and Figure 4 compares the I-Bar gage with USGS gages on Tomichi in Sargents and near Gunnison.

Figure 3.

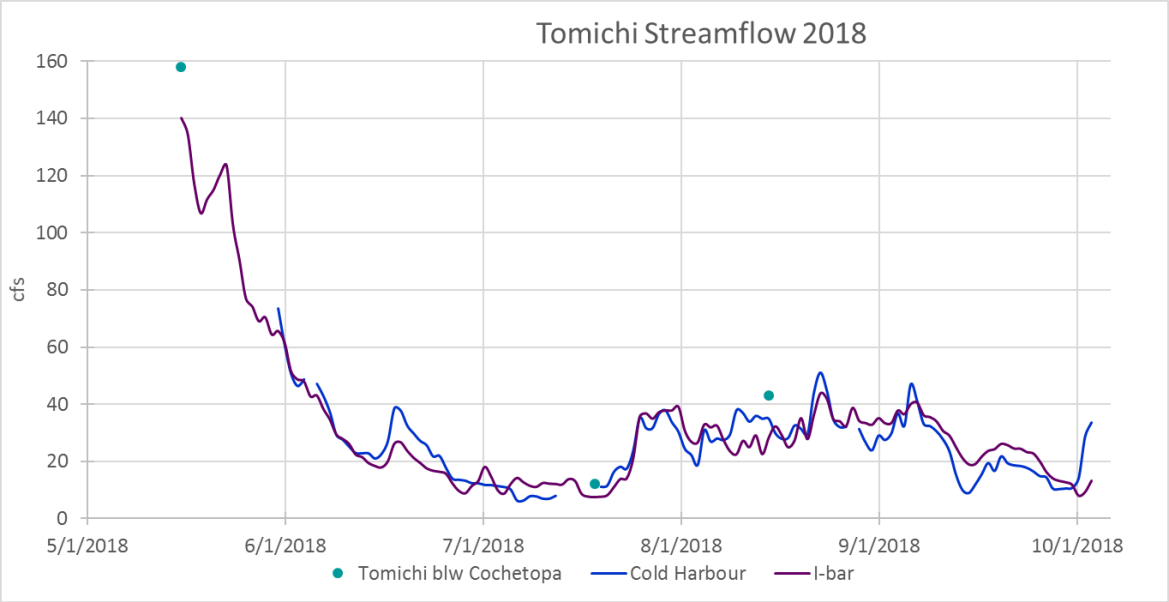

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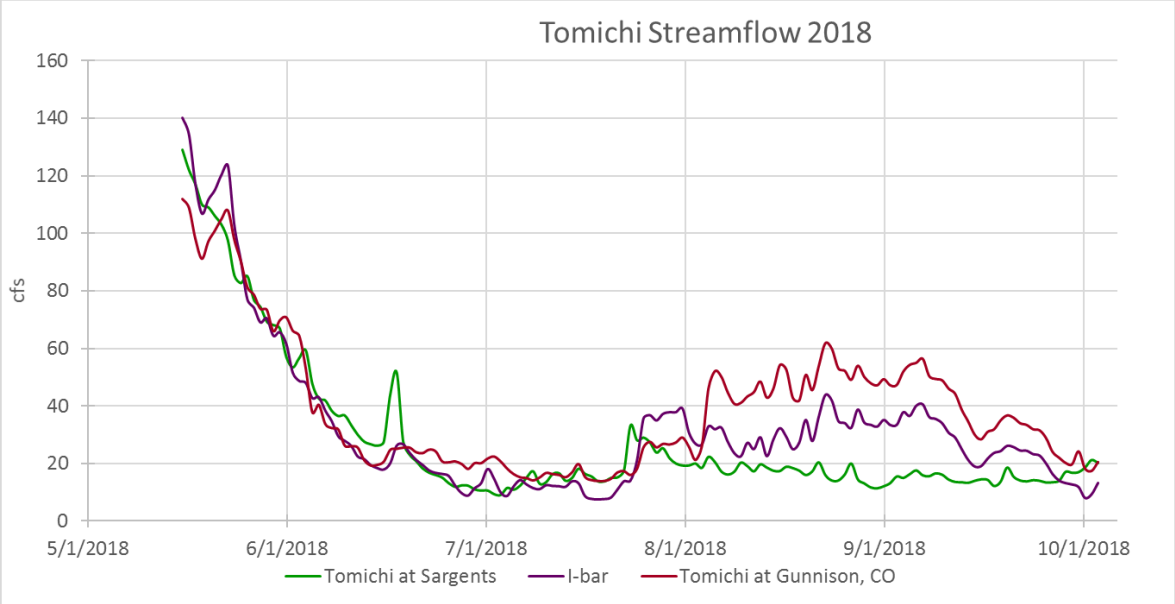
Figure 4



Seven of the 8 ditches in the program shut off on July 1st. One ditch was shut off on June 29th. At the I-Bar gage, there was an increase in streamflow beginning on June 29th from 6.5 cfs to a peak of 18.5 cfs on July 3rd, followed by a decrease to 10 cfs on July 5th. Flows at the Cold Harbor gage and Sargents gage upstream of the project area continued to decline during the first week of July. Figure 5. shows a noticeable increase in flow at the USGS Tomichi near Gunnison gage beginning on June 29th lasting until July 3rd. This indicates the surge from the irrigation shut off made it past 4 intervening diversions between the end of the project reach and the USGS gage. Beginning on July 14th, a small increase in flows can also be seen at both the I-Bar and USGS gage showing a linear relationship between those two gages.

Trends from the flow monitoring data suggest a peak increase of 10 cfs for a duration of two days on July 1-3, as surface return flows came back to the stream. After that initial surge, the comparison between the Cold Harbor gage and the I-Bar gage showed a 2-3 cfs increase of streamflow at the I-Bar gage into the second week of July. Streamflow improvements below each diversion were more significant as the creek was completely dewatered below most of the participating diversions at the end of June.

The Gunnison Tomichi Valley ditch and other diversions from the Gunnison River add water to lower Tomichi, above the USGS Tomichi Creek gage. Therefore, flows at the USGS gage are generally more than at the I-Bar gage.

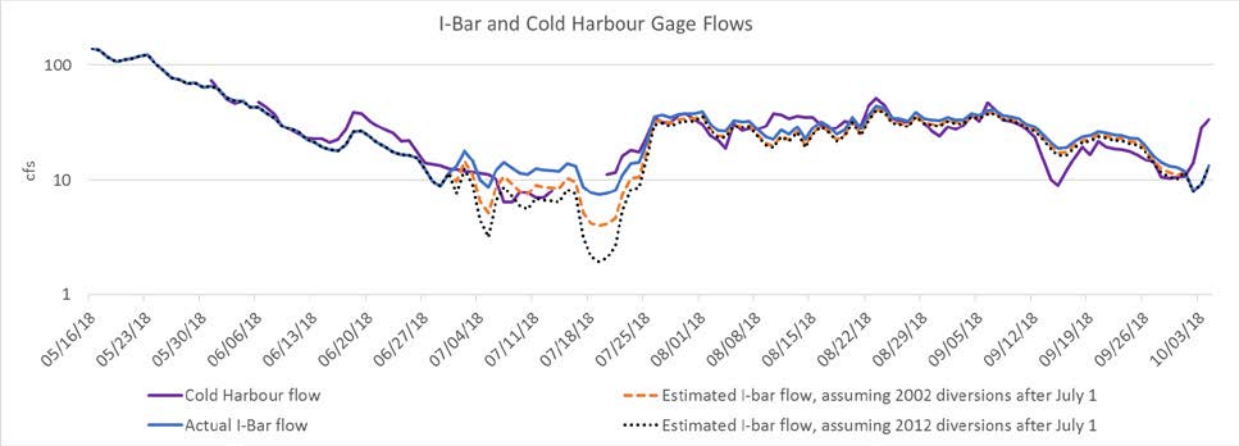
Post-Project Modeling

TU contracted Hydros Consulting to analyze the stream flow monitoring data to determine what stream flow benefits resulted from the conservation program. The modeled flows assume that

water users would have used similar irrigation practices in 2018 as they did during 2002 or 2012, similar drought years in recent history. Using this assumption, the foregone diversions and resulting consumptive use savings were calculated with 2002 and 2012 diversion records for the participating ditches, 2018 stream data, and 2018 climate data from the Gunnison CoAgMet station (attached in Appendix C), and Colorado's CU model, StateCU (which uses the Blanney-Criddle method for estimating reference crop ET). The total conserved consumptive use modeled using diversions from 2012 was 703-acre feet. Using 2002 diversions showed 487-acre feet of conserve water.

If the 2002 total of 487-acre ft was distributed over the three-month period the daily average flow increase would be 3.5 cfs in July, 2.8cfs in August, and 1.7cfs in September. The orange dashed line in Figure 5. depicts modeled flows at I-Bar had the conservation program not been activated using 2002 diversions. The black dot line shows modeled flow using 2012 diversions. The Hydos Flow Analysis Modeling report can be found in Appendix C.

Figure 5



Aerial imagery ET monitoring

In addition to the stream flow monitoring and modeling, TU analyzed Landsat images taken on July 4, July 29, August 14, and September 15th. These images also helped estimate the reduction of ET resulting from the conservation program. Figure 7 below shows a four-panel progression of ET imagery of the project area. The field with diagonal lines was not a participating field and irrigation continued into July. This field was used as a control. These images are most useful to show the influence of precipitation, residual soil moisture, and influence from ground water. For example, .22'' of precipitation was recorded on July 28th. The July 29th image reflects this precipitation and shows ET on non-irrigated uplands as well as substantial ET on irrigated areas in the meadows. Interestingly, the area to the far northeast was hayed around July 15th the adjacent land that had not been cut shows a higher ET rate with the same irrigation practices. We attribute this to the taller grass has more surface area for the atmosphere to pull water

from. Influence from ground water is apparent in slough areas and in the northwestern portion of the project area where influence from the Gunnison Tomichi Valley ditch sustained ET.

Figure 6

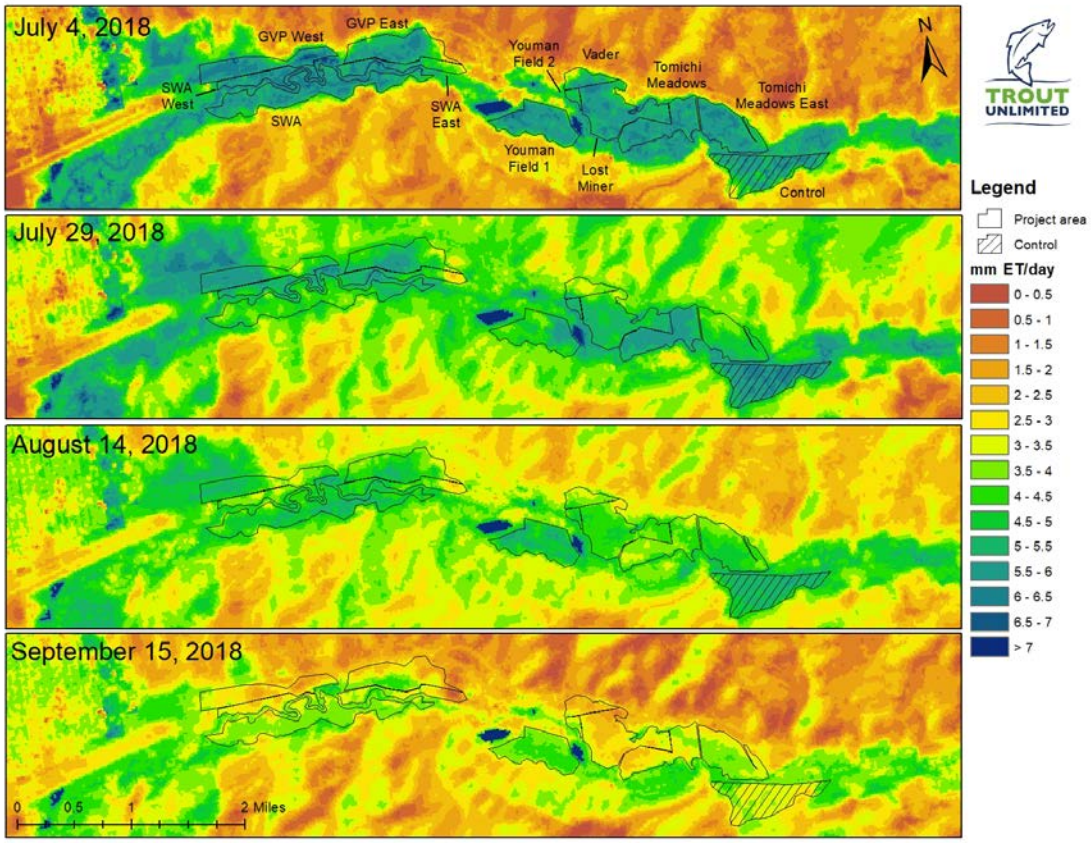


Figure 7. is a line graph showing how ET rates on five participating fields compared to each other, to the control, and to reference ET from the Gunnison CoAgMet. Each ET data set is associated with a monitoring window (e.g., July 4 image covers July 1 – July 16; July 29 image covers July 17 – Aug 8, etc.). Landsat images for other dates during 2018 irrigation season were "lined" (poor resolution) or were obscured by clouds.

This analysis was done by TU in-house to explore aerial imagery as a tool to verify conserved water. There may be minor errors in the methodology and the table below should only be used for comparative purposes. With that said, these images provided some interesting outcomes. For example, comparing the light blue and dark blue lines helps show the ET difference between fields not cut prior to the July 29th and fields that had been cut prior to that date. Also, the fields that received a 10-day irrigation in August showed 1mm/day of ET more on September 15th than the fields across the creek that received no irrigation after July 1, (gray line vs. light blue line below). Interestingly, the field with an August irrigation surpassed the ET rate of the control field in August (gray line compared to the green line). The largest difference estimated between

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the control and a participating field was 2.5mm/day (.1inch/day) seen on July 30. This was a field farther away from the creek on higher ground.

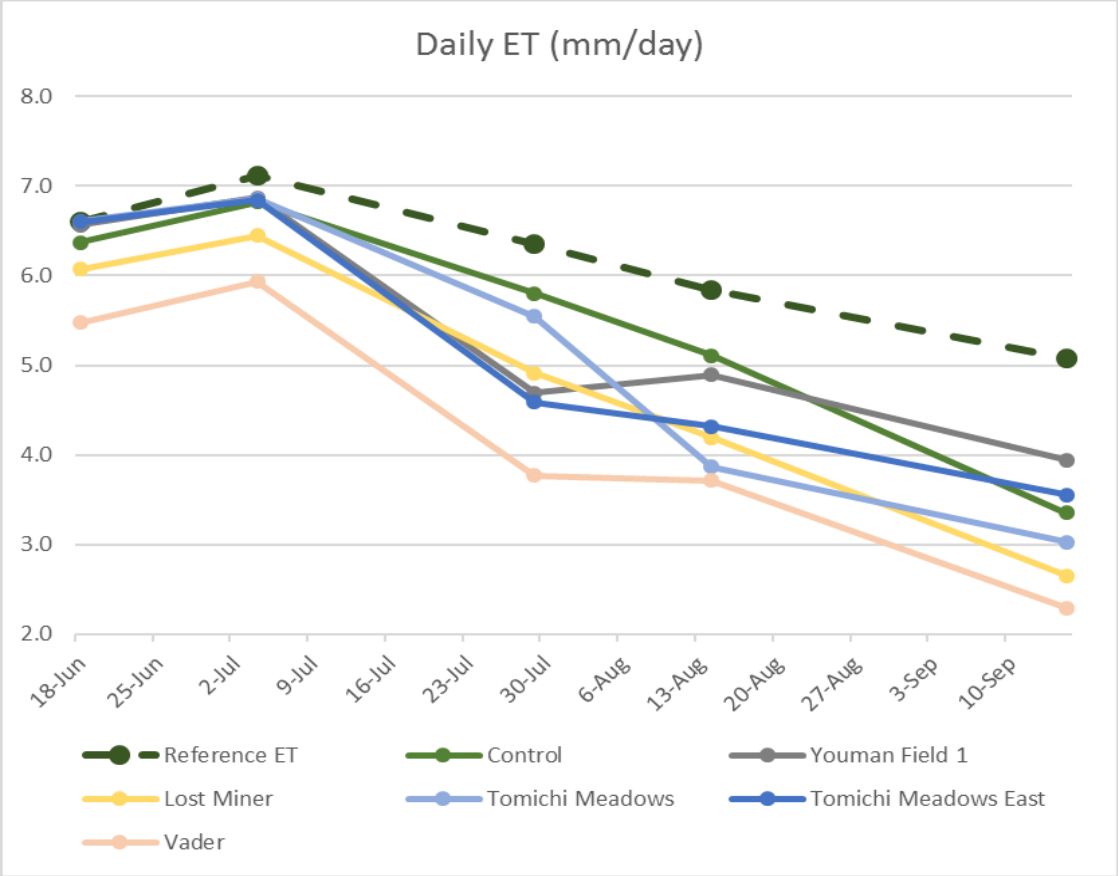

Figure 8

Based on this Landsat imagery analysis we estimate the total difference in consumptive use between the control field and the participating fields was 350-450 acre feet. This would translate to a 2-3 cfs average daily flow increase from July 1 to October 1 at the I-Bar gage.

Soil moisture and ET using eRams

Another tool used to estimate ET and soil moisture retention is eRams irrigation scheduler. This online program allows water users to plan irrigations based on soil type, crop type while incorporating ET and climate data from the nearest CoAgMet station (located 5 miles north). Water delivered to the crop has to be manually entered and the program charts water use and soil moisture deficit. Soil types present in the project area show soil moisture providing for about 13 days of ET before Management Allowable Depletion (MAD) is reached.

Seasonal water use estimates can also be estimated using eRams. Three scenarios were run using eRams: July 1 shut off for the season; July 1 shut off with a 10-day August irrigation; and

July 1 shut off but resuming full supply on August 1 for the remainder of the season. The difference between the three scenarios demonstrates a reduced CU value similar to StateMod estimates for July, August, and September. Using eRams the total avoided ET for the 1003 (723 acres implementing a July to October shutoff and 280 with July 1 shut off and a 10-day irrigation August 1-10) is 678 Acre feet.

Summary Table of CU and Flow Modeling

	Estimated CCU (Acre Feet)	Estimated Stream Flow increase at I-Bar (AF)	Estimated Stream Flow increase at USGS Tomichi (AF)	Estimated Stream Flow increase at USGS Gunnison(AF)
Pre-Project State Mod '99-'13 Average	1284	2059	1613	1254
Post Project State Mod w/ 2002 diversions	487	487	487	*
Post Project State Mod w/ 2012 diversions	703	703	703	*
Aerial Imagery	350-450	350-450	350-450	*
eRams	678	678	n/a	*

* Recorded flows in the Gunnison fluctuate more daily than what was contributed from this project, so it was difficult to see any clear trend at the gage. It's worth noting that there are no diversions below the USGS gage on Tomichi.

Ground Water Monitoring

Four ground water monitoring wells were installed on the Tomichi SWA to monitor the effect of irrigation shut off and ground water recharge and release. Wells 1 and 2 were installed on the south side of Tomichi creek and 3, 4 were installed on the north side of creek. Please see Figures 8-11 below. Map of the sites is included in the Appendix D. Timing of irrigations can clearly been seen in well 1 and 2. This area is irrigated by the Southside Ditch and looks to have benefited from a surge of water as upstream diversions began to shut off on June 29-July 1. The 10-day irrigation in August is also apparent at these two wells. Wells 1, 3 and 4 showed a gradual draining trend of about 3 weeks, while Well 2 drained in about 1 week. Well 4 was damaged by cattle, and the transducer may have been displaced slightly which may have influenced the data.

Figures 9-12

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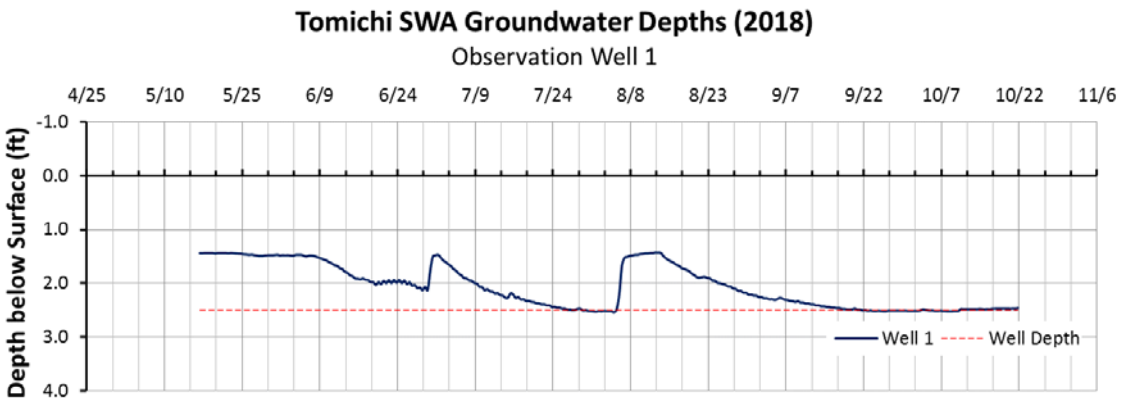

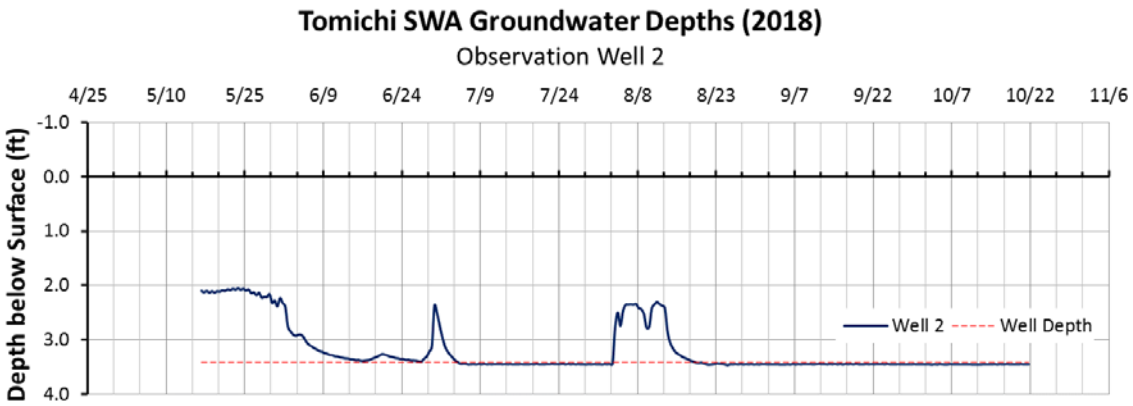

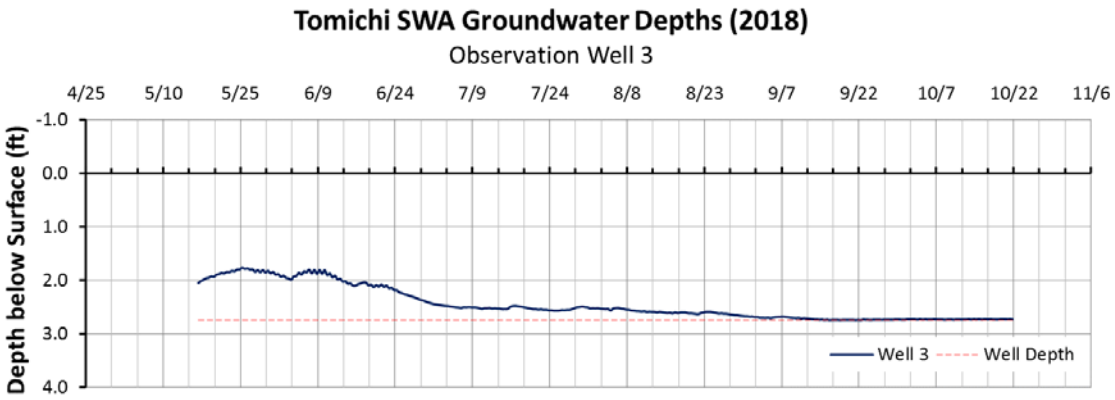

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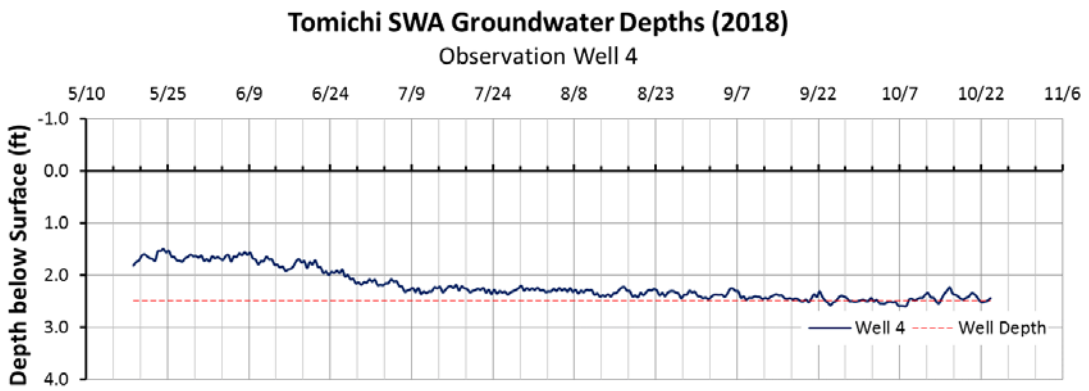

The drainage trend recorded at each well is similar to the return flow timing estimate used in the pre-project model scenarios. Those values are described in Figure 12.

Figure 12

Return Flow %		
Same month	75.6%	
next month	11.3%	
3	3.2%	
4	2.2%	
5	1.6%	
6	1.2%	
7	0.8%	
8	0.6%	
9	0.5%	
	97.0%	(3% incidental loss)

Task 3: Water Rights Protection

On May 3, 2018, TU applied to the Colorado River Water Conservation District (CRD) to request the Tomichi Water Conservation Program be recognized as a sponsored water conservation program. The CRD approved our request and notified TU with an approval letter on June 20, 2018. The CRD approval letter is attached as Appendix E. Each of the participating water rights were included in the approval letter.

Task 4: Evaluate opportunities to bank conserved water in Aspinall.

TU and The Nature Conservancy (TNC) held two meetings to discuss this project with the Bureau of Reclamation (BOR). The first meeting was held during the summer of 2018 to provide an overview of the project and request input on monitoring and legal questions related to storing water in the Aspinall Unit. The second meeting was held on August 28, 2019 to follow up on project findings and review a more in-depth legal analysis completed by TNC. The meeting

summary from the second meeting and legal analysis is included in the Appendix F of this report.

Due to developments with the Drought Contingency Plan (DCP) in early 2019, the follow-up meeting was postponed allowing appropriate personnel from the state and BOR to attend. Representatives from the UGRWCD, CWCB, DWR, and the State of Colorado Attorney General's office attended the meeting either in person or by phone.

Representatives from the BOR were pleased with the amount of analysis completed with this project and said they are committed working with the State of Colorado and other partners if a future demand management program is developed. However, it was stated multiple times that any decision making or interpretation was limited on their end as they do not want to get ahead of the upper basin states in any demand management conversations.

It was suggested that the monitoring and CU analysis completed as part of this project will be helpful to inform the CWCB's demand management working group process. As a result of that suggestion, TU presented on this project to the CWCB's Demand Management Monitoring and Verification Working Group on September 10, 2019.

Conclusions and Lessons Learned

2018 was one of the driest years on record for Tomichi Creek. This added challenges for TU and participants enrolled in the program. Drought years typically increase the value of hay and pasture and result in higher demand for productive pastures. This may have limited the financial benefits for participants because the value of forgone production was greater in 2018 than it would have been during an average year type. Also, the volume of conserved water the participants were compensated for was not as large as it would have been on an average year. Diversions were limited prior to July 1st due to water supply. Several of the participating water rights owners could have called prior to the shut off date, as they did in 2002, but there was not a call on Tomichi in 2018.

Even with the regionally coordinated approach amongst the six participating water users, one non-participating water right owner had difficulty delivering water to a lined pond because the delivery ditch typically relies on historic irrigation patterns on neighboring properties to "carry" the water down. Because the ranchers were not irrigating, the smaller water right used to fill the pond did not make it down the ditch until irrigation was turned back on after October 1st. This property chose not to participate because little conserved consumptive use would have resulted, and it was not worth the trouble to enroll in the program. This confirms that regionally coordinating any future conservation actions would be desirable.

The resulting flow benefits that accrued through the Tomichi SWA in early July had positive impacts for the fishery. Preliminary fish survey results show the mortality during the summer of 2018 was less than what occurred in 2012.

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Seeing some increase in flows at both the I-Bar and the USGS gage suggests that the conserved water would have made it to the Gunnison River and Blue Mesa. There are no diversions on the Tomichi below the Gunnison USGS gage. There are diversions from the Gunnison below the confluence with Tomichi Creek. However, those rights are generally not sweeping the stream or water short.

Updates to the irrigated acreage in the CDSS have been completed through the Upper Gunnison Watershed Management planning process. These updates will improve future modeling accuracy for future conservation projects.

I would like to thank the Colorado Water Conservation Board for their support of this project. Please let me know if you have any questions about the Tomichi Water Conservation Program. I would be happy to present to the board on this project.

Sincerely,
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