Section 319 Nonpoint Source Pollution Control Program
Information/Education/Training/Demonstration Project

Final Report

Onion Creek Streambank Stability Demonstration

By

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7/1/08

This project was conducted in cooperation with the State of Utah and the United States Environmental Protection Agency, Region 8.

Grant # 998187050

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Executive Summary:

Project Title: Onion Creek Streambank Stability Demonstration

Project Start Date: 6/1/04 Project Completion Date: 7/1/08

Funding:	Total Budget	___$213,800____
	Total EPA Grant	_____$123,250__
	Total Expenditures of EPA Funds	_____$123,250__
	Total Section 319 Match Accrued	____$100,550____
	Budget Revisions	_____
	Total Expenditures	____$213,800____

Summary Accomplishments:

Onion Creek is a perennial stream about 20 miles northeast of Moab in Grand County, Utah. A County Class B dirt road travels adjacent to Onion Creek for about 8 miles with 24 stream crossings.

In 1998, the State of Utah listed Onion Creek as "impaired" due to water quality concerns. A Total Maximum Daily Load (TMDL) report was completed as required by the EPA, http://www.waterquality.utah.gov/TMDL/Onion_Creek_TMDL.pdf.

The goals of this project were to decrease sediment loads and improve stream water temperatures to meet state water quality standards (27° C). To assist in obtaining these goals objectives were determined including reducing sediment from eroding and flooded streams banks and improving vegetative growth.

This project was started in 2004 and finished in 2007. It was originally funded with an EPA grant of $30,000 and matching county funds of $20,000. An amendment was added to include additional work. The amendment included an EPA grant of $93,250 with in-kind match of $70,550. The total project cost was $213,800.

Tasks to assist in this objective included limiting or excluding ATV and other vehicle traffic from riparian areas through signage, increased BLM patrols, fencing and other methods. Signs were placed at a number of stream crossings, rocks were placed at various locations to limit access and the BLM patrols the area to enforce regulations. The Moab Jeep Safari organizers have agreed to change a route that previously traveled through the stream in the Onion Creek Narrows and now takes a different route.

Another task was to directly establish vegetation along the stream through planting of appropriate vegetation. In 2004 a pilot project was undertaken with the involvement of the Grand County Road Department, BLM, Utah State University Extension/Grand County, Corps of Engineers, Utah Division of Water Quality and others to plan and then plant a stretch along Onion Creek with willows and cottonwoods. This was done to study their ability to survive along the lower stretch of Onion Creek and provide source material for future plantings or natural spreading.

The last and most critical task involved road work at sites that during pervious flood events had been inundated by flood waters with sediments being washed into the stream. When this happened major road repairs were required. Sites requiring stabilization were determined in conjunction with the Utah Dept of Water Quality, the Corps of Engineers and the County Road Department. Of eight sites determined to require work 5 sites were included in this project and have been completed (sites 1 to 5, see attached map). At all sites the road was built up to the high water mark and channel barbs were installed. At sites 1 and 2 gabions were installed, at sites 3 and 5 rip rap walls were built and also at site 5 a French drain was installed to move water from a spring under where the road was placed and at site 4 only barbs were installed.

Trees and willows planted along Onion Creek continue to survive and where gabions, rip rap walls and barbs were placed road damage and stream bank erosion has been limited. Other native plants have started growing along sediment deposits between the barbs and in front of the gabions and rip-rap walls including Rabbit Brush and an assortment of grasses.

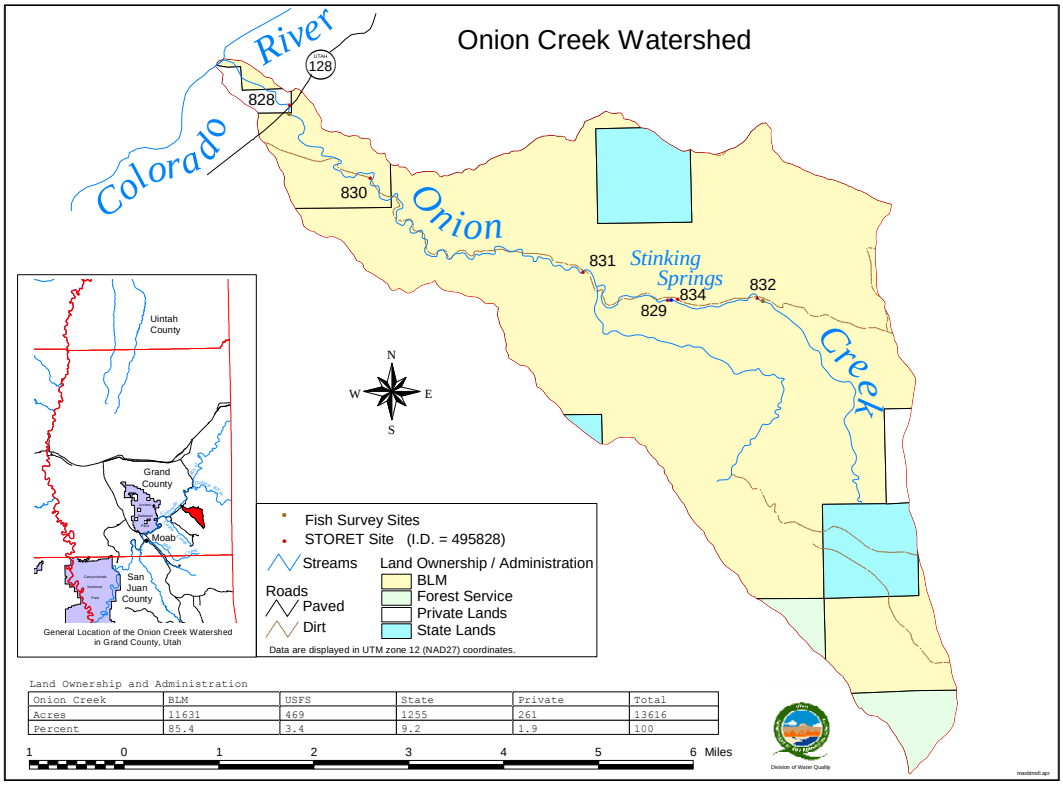
This project as had a number of groups tour including a Take Pride in Utah Day event in April of 2004 which included local State Representatives, the U.S. Secretary of the Interior, County Council representatives, BLM personnel and local citizens and news media. This was in response to the plantings that had been undertaken along with signage and other efforts. In fall of 2007, the Utah Watershed Council met and toured the area and in March of 2008 met and received a presentation on the project.

Introduction:

Onion Creek is a tributary (perennial stream) to the Colorado River. The Onion Creek drainage is located in Grand County approximately 20 miles upstream from where highway 128 turns off of highway 191 near the bridge over the Colorado River by Moab. The watershed encompasses 13,616 acres including 11,631 acres of BLM land, 469 acres of USFS land, 1,255 acres of state land and 261 acres of private land. Onion Creek and tributaries total 14 miles of stream.

Table 4 – Onion Creek Physical Description	
Watercourse – Tributary to Colorado River	Stream length – 14 miles
Waterbody ID – UT14030005-010	Watershed Area ($mi.^2$) – 21.27
Quad Maps – Fisher Towers & Fisher Valley	Drainage Density – 0.66 $miles/mile^2$
Watershed Management Unit – Southeast Colorado	Highest Elevation – 5,260 ft.

A Grand County Class B dirt road travels adjacent to Onion Creek for about 8 miles with 24 stream crossings.



In 1998, the State of Utah listed Onion Creek as "impaired" due to water quality concerns. A Total Maximum Daily Load (TMDL) report was completed as required by the EPA, http://www.waterquality.utah.gov/TMDL/Onion_Creek_TMDL.pdf. Based on historical water quality data, water quality of Onion Creek does not meet the standards set by the State of Utah for its 3B & 4 designated use classifications. It was originally listed on the 1998 303d list. The pollutants of concern include; total dissolved solids (TDS), and temperature. One of the main TMDL recommendations was to stabilize the road, to reduce impacts to the stream during and after flooding and subsequent road repairs. A more stable stream channel would minimize erosion and contribute to a healthier stream system.

Tables 1-3 show the TMDL status, pollutants of concern and the beneficial use classification of Onion Creek.

Table 1 – from Utah's 2002 List of Stream and River Waterbodies Needing TMDL Analyses.

Water Quality Management Unit	Waterbody Name	HUC	Waterbody Size (Miles)	Beneficial Use Impaired	Pollutant or Stressor Of Concern	Priority For TMDL	Targeted For TMDL 2000-2002
Southeast Colorado	Onion Creek	14030005	6.79	3B	Temperature	Low	No
Southeast Colorado	Onion Creek	14030005	6.79	4	Total Dissolved Solids	Low	No

Table 2 – Beneficial use class and pollutants causing impairment		
Waterbody	**Beneficial Use Classes** (Impaired class shown in **bold**)	**Impairment**
Onion Creek	1C, 2B, **3B**, **4**	Total Dissolved Solids Temperature

Table 3 – Explanation of beneficial use classifications for Onion Creek
Class 1 - Protected for use as a raw water source for domestic water systems
Class 1C - Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.
Class 2 - Protected for recreational use and aesthetics.
Class 2B - Protected for secondary contact recreation such as boating, wading, or similar uses.
Class 3 - Protected for use by aquatic wildlife.
Class 3B - Protected for warm-water species of game fish and other warm-water aquatic life, including the necessary aquatic organisms in their food chain.
Class 4 - Protected for agricultural uses including irrigation of crops and stockwatering.

The temperature impairment in Onion Creek during the 1997-1998 intensive monitoring cycle is depicted in Figure 2. Only the July 30th and August 28th samples exceeded the state standard of 27 degrees Celsius for Class 3B waters. Peak recreational impacts occur during the growing season. The effects are noticeable during summer low flow when climatic factors increase water temperature.

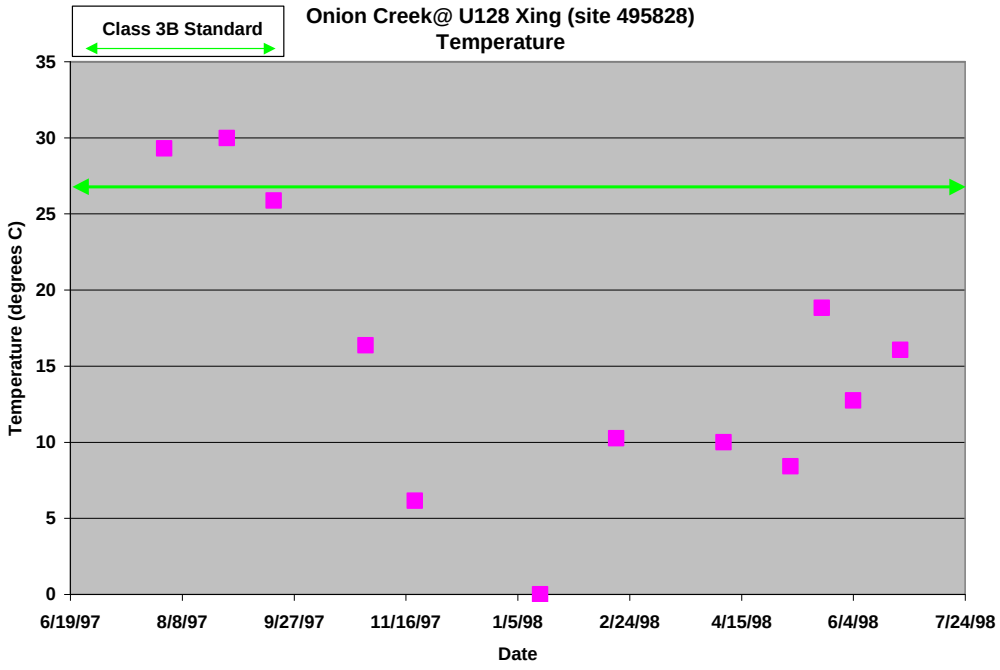
Significant Sources

Factors contributing to the impairment:

1. ATV and 4x4 vehicle instream use
2. Stream morphology
3. Lack of riparian habitat & canopy cover
4. Stream crossings
5. Improper stream alterations associated with road work

There are 23 road crossings that occur between the highway and Stinking Springs (see Figure 3). Above Stinking Springs there is only one crossing. These crossings tend to create a wider, shallower channel at the point of the crossing thus increasing the potential for thermal input from solar radiation. A more substantial source of temperature increase occurs as a result of ATV's and 4X4 vehicles driving up and down the stream channel. Between Stinking Springs and the confluence with the Colorado River the recreational use of the channel as a trail for ATV's and 4X4 vehicles is evidenced by the track marks left in the channel. In addition to causing impairment through a loss of vegetative cover off-road vehicles also contribute to streambank erosion and increase sediment. Frequent stream alterations in the past by County road crews have caused additional riparian problems and eliminated riparian cover.

Figure 2 - Onion Creek temperature data



Project Goals and Objectives:

The desired goal is to meet state water quality standards for the designated and beneficial uses of the waterbody. Based on this the following TMDLs will be established to assist in this effort.

The data indicates TDS in Onion Creek comes from a natural source. Groundwater transmission through a gypsum substrate leeches water with a high concentration of dissolved solids into the stream. The only viable solution is to develop site-specific criteria for TDS on the basis of the data. Current data will be used to petition the Utah Water Quality Board to adopt a new standard not to exceed 3000 mg/l in Onion Creek.

Table 7 – TMDL for Onion Creek		
TMDL		
Waterbody	**Total Dissolved Solids**	**Temperature**
Onion Creek & tributaries from confluence with Colorado River to USFS boundary	Site Specific Standard (two segments) not to exceed 3000 mg/l developed by October 1, 2002	≤ 27 degrees Celsius associated with assessment criteria

Although natural conditions create large thermal inputs to the system, unauthorized access to the stream channel by off road vehicles is a contributor to temperature impairment. To attain a temperature reduction in Onion Creek this TMDL recommends off road vehicles be limited or excluded from the stream channel and that channel alteration permits be examined carefully to minimize adverse impacts.

By restricting off road vehicles and heavy equipment from the stream channel and facilitating improvements to the riparian condition, it is expected that:

- Solar radiation reaching the stream can be reduced by at least 15 percent,
- River water washed off of hot engines will be eliminated,
- Spraying of water onto hot adjacent surfaces and exposure to high ambient temperatures will be eliminated,
- Destruction of riparian habitat will be reduced.

In addition to shading from riparian habitat, the morphology of the stream should become deeper and narrow thus reducing exposure area to sunlight. This estimate is based upon best professional judgment as to potential improvement to riparian communities. Appropriate planting of native species in the riparian corridor will supplement and enhance the recovery of the canopy cover. These BMP's will allow the river to meet temperature standards.

Recommended BMP's to achieve riparian corridor restoration may include:

1) Limiting or excluding ATV's and 4x4 vehicles from riparian areas through signing, patrolling, fencing of key access points, or other methods, thereby allowing natural reestablishment of vegetative cover;
2) Directly establishing vegetation on streambanks through plantings;
3) Proper permit compliance for road maintenance; or
4) Other BMP's developed by the land management agency (BLM).

Goal: Improve temperature of Onion Creek to meet state water quality standards (27 degrees C)

Objective: Reduce sediment coming from eroding poor condition streambanks.

Task: Limiting or excluding ATV's and 4x4 vehicles from riparian areas through signing, patrolling, fencing of key access points, or other methods, thereby allowing natural reestablishment of vegetative cover

Products: Establish suitable vegetative cover on streambanks. Reduce sediment, with associated phosphorous.
Cost: $0

Task: Directly establishing vegetation on streambanks through plantings

Product: Stability of stream banks that will benefit fifteen (5) miles of stream banks and stream channel reducing sediment loading to Onion Creek.
Cost: $5,017

Objective: Improve road crossings (road areas prone to flooding) to reduce sediment from flood events and subsequent annual maintenance and repair. Improve areas where roads flooding and washouts occurred through use of gabions, rip-rap walls, geotextiles and barbs. Ensure proper permit compliance for road maintenance.

Task : Mobilize Equipment from Moab to Onion Creek
Task : Stabilization Area Preparation Work
Task : Construct 14' wide Road (204 l.f.)
Task : Pull in Ditches and Water Bars
Task : Finish shape stream embankment
Task : Install gabions, barbs and/or rip rap walls

Product: By reestablishing meanders, flow velocities will be dissipated during high water events, resulting in decreased erosion and increased channel stability. In addition, habitat conditions for fish will be improved with return to a more natural channel configuration

Objective/tasks Accomplishments:

Objective: Reduce Sediment coming from eroding poor condition streambanks

Task: Limiting or excluding ATV's and 4x4 vehicles from riparian areas through signing, patrolling, fencing of key access points, or other methods, thereby allowing natural reestablishment of vegetative cover. (Completed fall 2004 to November 2005)

Signs (#3) have been placed at major stream crossings which previously had provided entry into the stream channel. These signs state that ATV or motorized traffic is not allowed in the streams and vehicles should stay on established roads. Some areas adjacent or across the stream, that have previously supported ATV or other motorized traffic, have also been marked closed (signs are in place stating "restoration sites" or "no entry"). Regularly throughout the year the BLM patrols the area to enforce regulations and during special events (like Jeep Safari, etc.) there is an increase in BLM patrols. Where ATV and other motorized vehicle traffic has been eliminated or reduced and where vegetation previously grew there has been an increase in vegetative growth.

Task: Directly establishing vegetation on stream banks through plantings. (Completed at initial site)

In 2004 a pilot project was undertaken with the involvement of the County Road Department, BLM, Utah State University Extension, Corps of Engineers, Utah Division of Water Quality and others to plan and then plant a stretch of Onion Creek with willows and cottonwoods. It was felt that having more vegetation along the stream would assist in lowering stream temperatures. There are some cottonwoods along the upper reaches of Onion Creek but none along the lower stretches (where most of the erosion problems have occurred) and there were limited willows as well. A stretch of the creek between sites 2 and 3 was selected and holes were dug down past the water line to provide for adequate moisture throughout the year. A total of 21 cottonwoods and 20 willows were planted along this stretch. As of September 2007, 70% of the cottonwoods were rated good to fair, 15 % were rated poor and 15% have died. A portion of the damage was related to excessive stream flooding before other project tasks (gabions and barbs at sites 1, 2 &4) were completed. As of September 2007, 70% of the willows were rated fair and 30% have died (most likely the willow deaths were due to an area of extremely high salt concentration). At

this time the general consensus is that the plants have done as well or better than had initially been expected. The expectation is that there will be increased native plant species along the stream either through natural revegetation and/or through the use of cuttings, etc., for future plantings.

Objective: Improve road crossings to reduce sediment production from annual maintenance and repair. Proper permit compliance for road maintenance.

TASK: Mobilize Equipment from Moab to Onion Creek. (Completed)
Moving of equipment and supplies from Moab to Onion Creek was initiated in November of 2004 and subsequent periods through 2007 as road work site repairs were undertaken.

TASK: Stabilization Area Preparation Work. (Completed from fall 2004 to summer of 2007 as required for individual site work)
Sand bags and plastic were placed in the stream to divert it away from the sites requiring work and equipment was moved to the specific site(s).
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TASK: Finish & shape stream embankment and install geotextile underlay. (Completed from fall 2004 to summer 2007 as required for individual site work)
On sites requiring gabion cages (sites 1 & 2) embankment edges were shaped and a geotextile underlay was put in place. On sites requiring rip rap walls (sites 3 & 5) embankment edges were shaped and a geotextile underlay was put into place.

TASK: Install Reno Mattress on Geotextile and/or construct channel barbs and/or place rip rap walls. (Completed)
Preliminary to this work discussions were undertaken with Mike Allred (Division of Water Quality) and Casey Ford (Utah Division of Water Rights who was the supervisor of the stream bed alteration permit and the state engineer's representative) concerning the pros and cons of reno mattress vs gabion cages and it was determined after these discussions that gabion cages were the best option for sites 1 and 2.

Gabion cages were constructed from prefabricated cages (approximately 3' x 1.5' x 9' and 3' x 3' x 9') and placed two feet deep in the stream channel. The cages were installed over geotexile underlay and filled with clean cobble stone between 3 & 8" in diameter. The cages were used because it allowed for constructing a 14' wide road without encroaching into the stream which the reno mattress would not have allowed.

Channel Barbs were constructed at sites 1, 2, 3, 4, & 5. Channel barbs are used to deflect water away from the road, streambank, gabion cages and rip rap walls. Casey Ford suggested adding channel barbs alongside the gabions to protect the gabions from being undercut and to create currents that would deposit sediment against the gabion cages, streambank and rip rap walls. It was thought that they would not be destroyed by a flood event, would assist in keeping the gabions, rip rap walls, etc., intact and if damaged by a flood event would be easier to repair than the gabions or rip rap walls. This has proven to be the case. Due to their success they were added to all other completed sites.

Channel barbs are a linear structure, using large 3 to 4' diameter angular boulders (in this instance) that are placed from the road/stream edge or gabion cage into the stream pointing upstream. These structures ranged from approximately 5 to 9' long, 3 to 5' wide and approximately 7 to 8' tall at the stream/road edge tapering to the stream channel. Each location had a series of barbs averaging 5 to 7 (up to 10) and 15' to 30' apart.

The sediment that the barbs cause to be deposited creates areas for vegetation to establish or recover and vegetation has been seen growing in these areas.

At site #4 it was determined that using just channel barbs would accomplish the needs for that area. The road had not been washed out at this site but the stream bank had been damaged.

At site #3, an 8 ft. wide by 9 ft. deep (starting 2 ft. below the streambed) rip-rap wall approximately 200 ft long was installed and channel barbs built along that length and 50 ft. upstream. (Completed fall 2006 to fall 2007)

At site #5, a French drain was installed because of a spring along side of where the road was to be placed. The road bed was positioned, streamside bank shaped and geo-textile fabric laid and a 220 ft. long rip-rap wall was built (starting 2 ft. below the streambed). Channel barbs were installed along that length and 50 ft. upstream.

Task: Pull in Ditches and Water Bars
Task: Construct 14' wide Road (204 l.f.) (Completed)
After installing barbs the road was built using fill dirt (native soils) from approved sites, packed and smoothed. The road was built up to the high water mark.

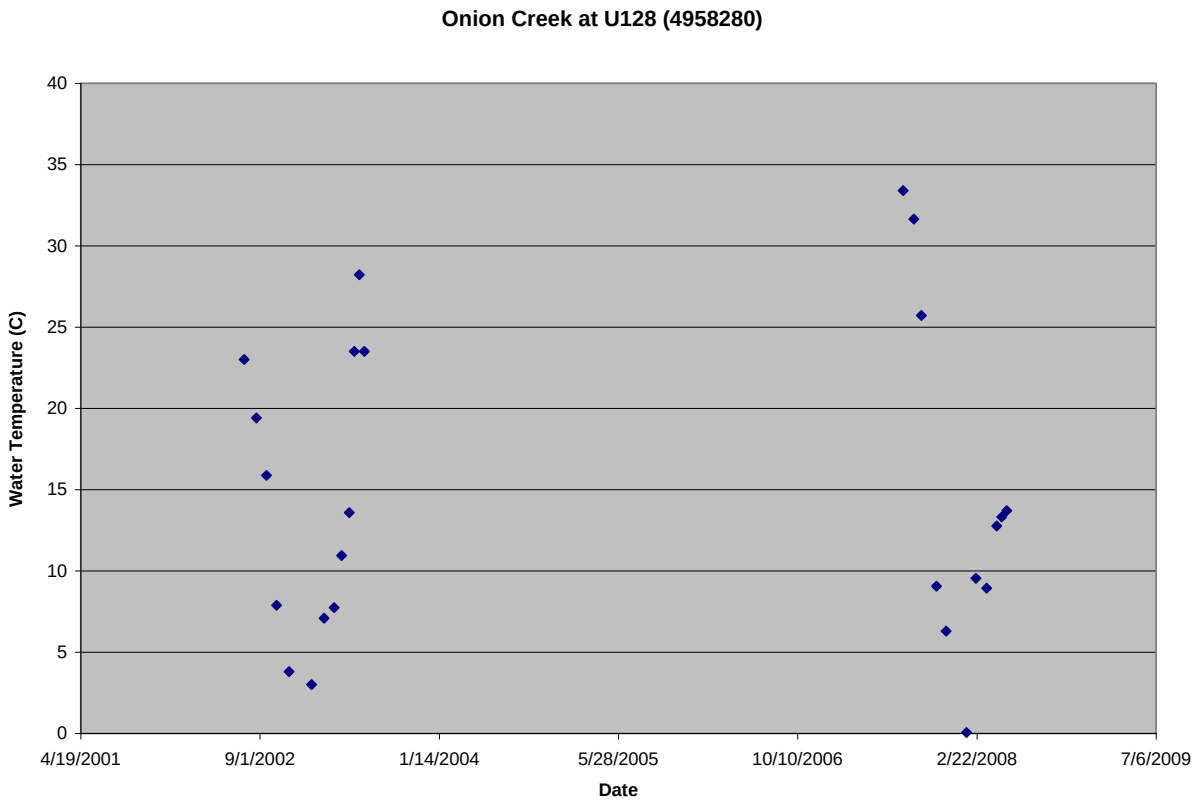
There was a large flood event in September of 2005 and except for a few channel barbs all of the structures held up as hoped for and those channel barbs that were damaged were repaired easily. The gabion cages and barbs helped to limit flood waters encroaching on road segments which in previous flood events would have wiped out portions of the roads moving heavy sediments down stream. While no actual measurements were taken its estimated that these structures, during the September flood event, reduced sediment loads by approximately 3000 cubic yards because roads that had previously been flooded and had sediments washed into the stream were not flooded. Subsequent "flood" events had shown that the channel barbs, gabion cages and rip-rap walls are performing satisfactorily. At all these sites sediment is being deposited in appropriate places, vegetations is growing and roads are not being washed out as before so sediment is not being moved in the stream from the improved road areas.

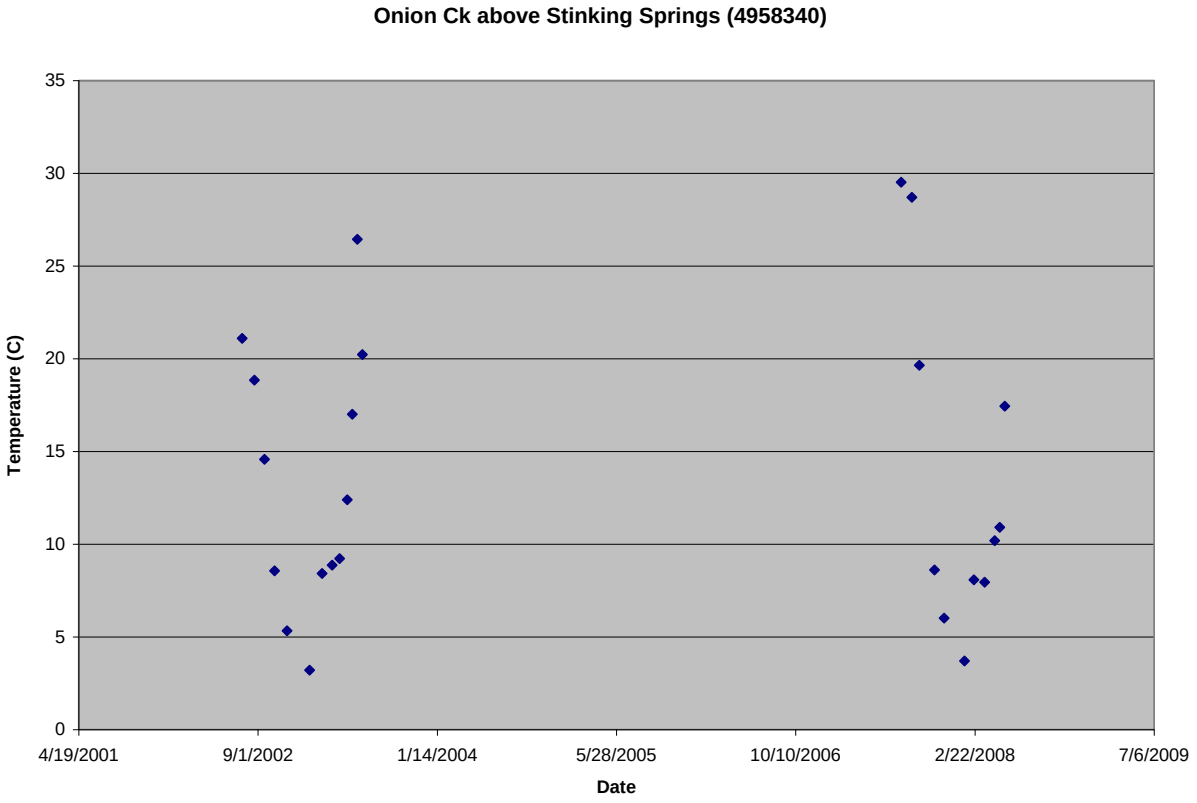
The stream appears to be realigning itself away from the barbs with some indication that it is narrowing and deepening in spots. Deepening and narrowing of the stream, over time, will improve temperature issues. Vegetation is recovering at all sites.

Planned and Actual Milestones, Products and Completion Dates:
The implementation project began in 2004. Six sites have been addressed. Three more have been identified as needing stabilization techniques.

Evaluation of Goal Achievement and Relationships to the State NPS Management Plan:
Cooperative efforts between all stakeholders has been exemplary. The project goals and achievements correspond closely with the State NPS Management Plan.

Long Term Results:
The following charts show the water quality temperature over the period of the TMDL and the implementation. No significant change has occurred to date however many nonpoint source implementation projects require several years to see a change in the water quality monitoring data.





Best Management Practices:

Signs were placed throughout the drainage to inform recreationist to keep out of the stream with ORV's. The Jeep Safari now uses another route that does not include driving in the channel. Vegetative plantings were placed along the channel for about 100 yards. More plantings will be put in place as volunteer project occur. A variety of streambank stabilization techniques have been used including barbs, rock structures and gabions. Six locations were stabilized.

Monitoring Results for Demonstration Projects:

Monitoring efforts by the BLM (Ann Marie Aubry) include stream channel cross-section surveys, water quality sampling, and repeat photography. Water quality sampling is currently underway, conducted by State of Utah staff, with 2 sites sampled every 6 weeks. Total Suspended Sediments (TSS), Total Dissolved Solids (TDS) and stream temperature are part of this monitoring effort. More intensive stream temperature monitoring was done in 2001 and will be repeated this summer (2008), using Hobo recorders.

Stream channel cross-section surveys have been completed at 3 stabilization sites, and at 2 sites without road stabilization work for comparison. The stream channel surveys were completed using a transit and level. Measurements were collected at least every 2' along a strike perpendicular to the creek. The survey station site was marked with rebar, so long term studies can be completed accurately.

Site #	Road work done	Pre-work survey	Post-work survey	Additional surveys
Site #1	1-2005	6-2004	3-2005	10-2007
Site #2	1-2005		4-2005	9-2007
Site #5	3-2007	3-2006 (2)	10-2007 (2)	

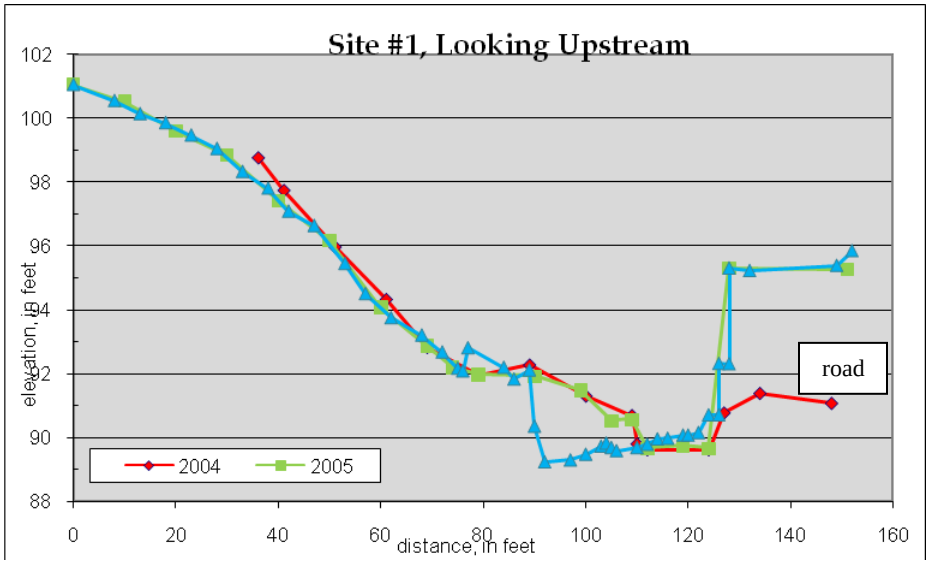
Road Stabilization Site #1:

The site farthest downstream is site #1, one of the first sites to be stabilized. The road runs between a low rock wall and the stream channel. Prior to stabilization, this portion of the road washed out every couple of years. To repair the road, material was gathered from the stream channel and floodplain and replaced in the roadbed. This further destabilized the stream channel, continuing the wash outs.

Looking upstream at road wash-out, road on right

This site was surveyed before stabilization work, while the road was washed out, in 2004. Surveying was done again, shortly after road stabilization was complete, in 2005. Surveying was repeated again in 2007, almost 2 years after road work was done. These surveys are representative of the entire stream segment affected by road washouts at this site.

The stream channel has changed dramatically. The active channel has shifted about 20' to the north, and deepened slightly. The shape of the stream channel has changed from a wider shallow channel (5' wide, 2" deep) to a narrow deeper channel (2' wide, 5" deep). The road has not washed out since stabilization, saving 20,000 cubic feet of sediment from washing downstream every 2 years (on average).



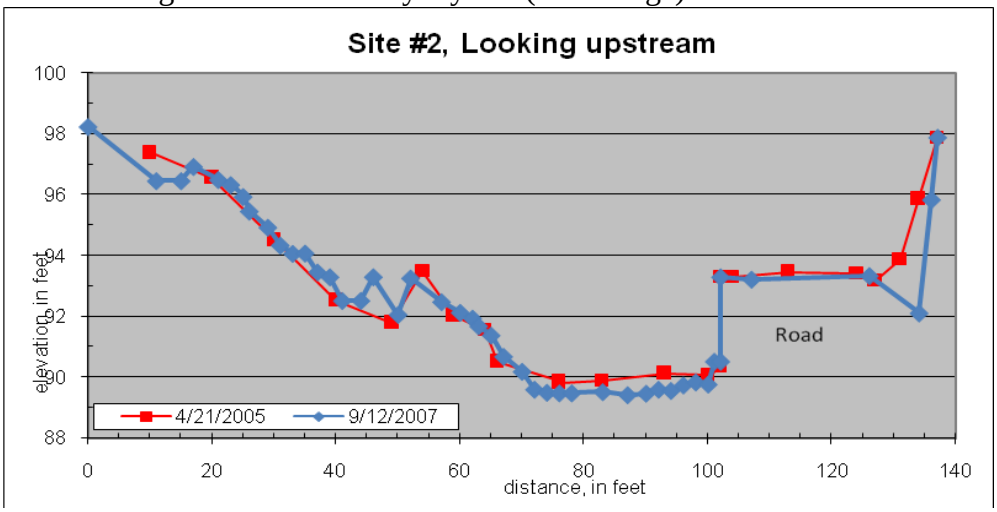
Looking upstream, May 2007

Road Stabilization Site #2:

The next site upstream is site #2, one of the first sites to be stabilized. Again, the road runs between a low rock wall and the stream channel. Prior to stabilization, this portion of the road washed out every couple of years. To repair the road, material was gathered from the stream channel and floodplain and replaced in the roadbed. This further destabilized the stream channel, continuing the wash outs.

Looking upstream at site #2 after road wash-out, 2002

This site was surveyed just after the road stabilization work was done in 2005, and again in 2007. Although the stream channel has not shifted much, it is becoming deeper with a more distinct channel. The road has not washed out since stabilization, saving over 12,000 cubic feet of sediment from washing downstream every 2 years (on average).

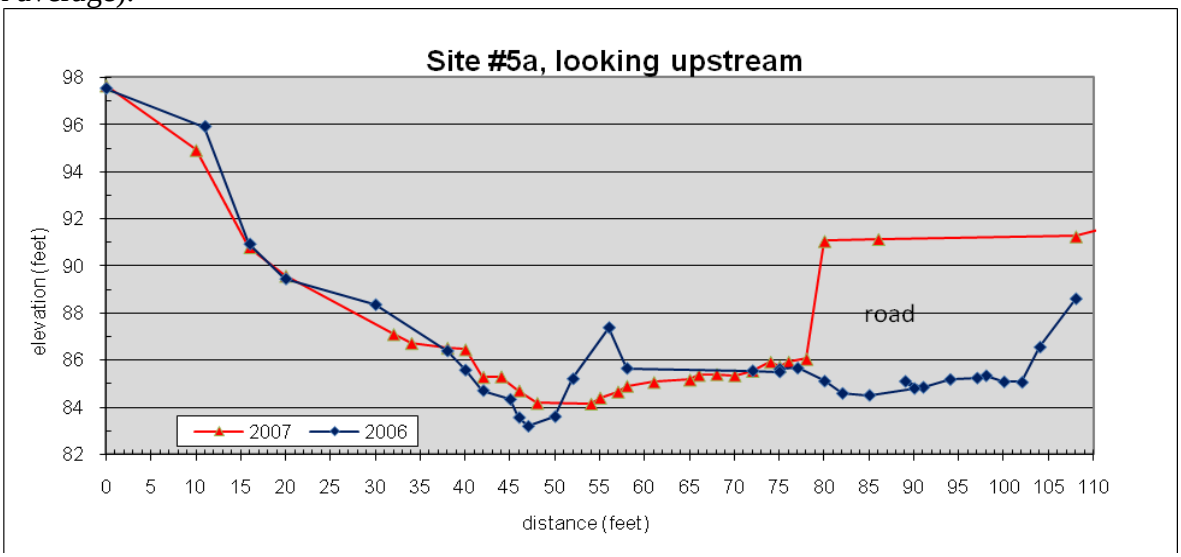


Road Stabilization Site #5:

Site #5 is at the Stinking Springs section of Onion Creek. This site was a major problem for years, as the road washed out more frequently than any other site prior to stabilization. The canyon is very narrow here, with no room for natural sinuosity and the road.

Looking upstream, road was on right before flooding

Two surveys were set up at this location. This site was surveyed prior to road stabilization in 2006 and again after stabilization work was done in 2007. The road has not washed out since stabilization, saving over 30,000 cubic feet of sediment from washing downstream every year (on average).



Public Involvement and Coordination: **State Agencies:**

Utah Division of Water Quality; Utah State University Extension

Federal Agencies:

BLM; Corps of Engineers; EPA

Local Governments, Industry, Environmental, and Other Groups

Grand County and Grand County Road Department;

Other Sources of Funding

Aspects of Project That Did Not Work Well

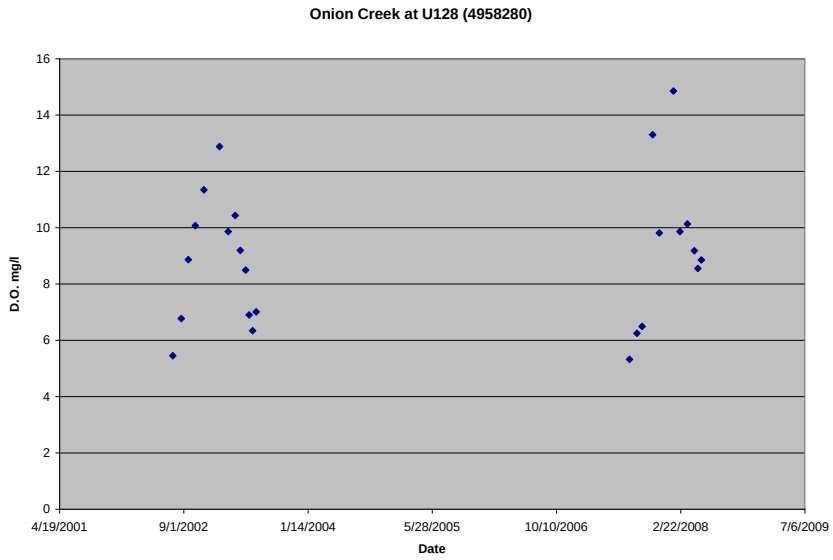
It may be to early to tell but it appears as though there are no aspects of the project that did not work well.

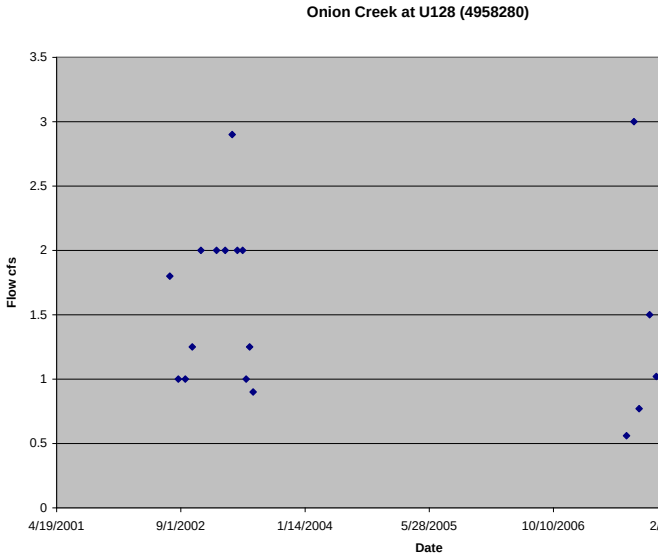
Future Activity Recommendations

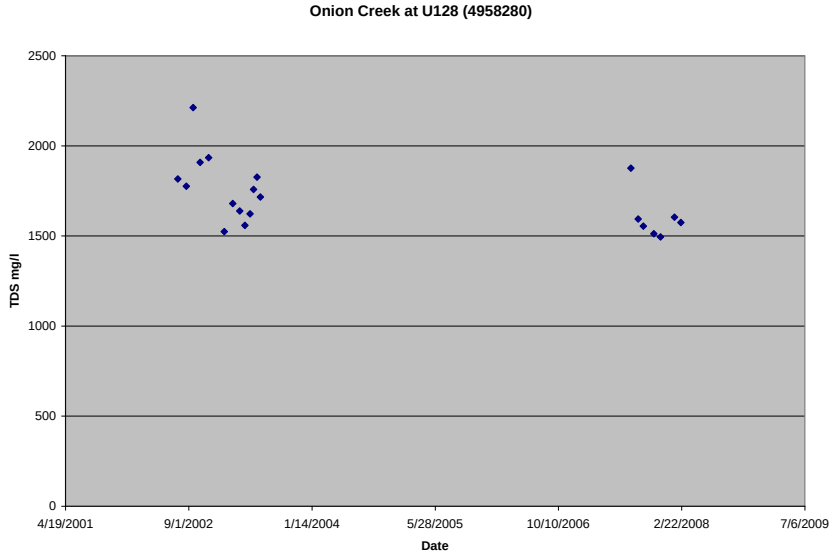
List of Appendices

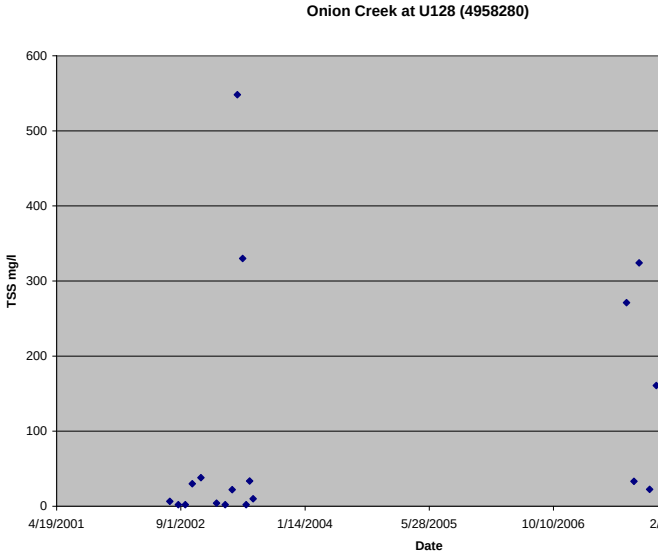
Maps:
Onion Creek Road Improvements 2004-2007
Written Outputs
Monitoring of Project Effectiveness
Tour Agendas
Date Reports

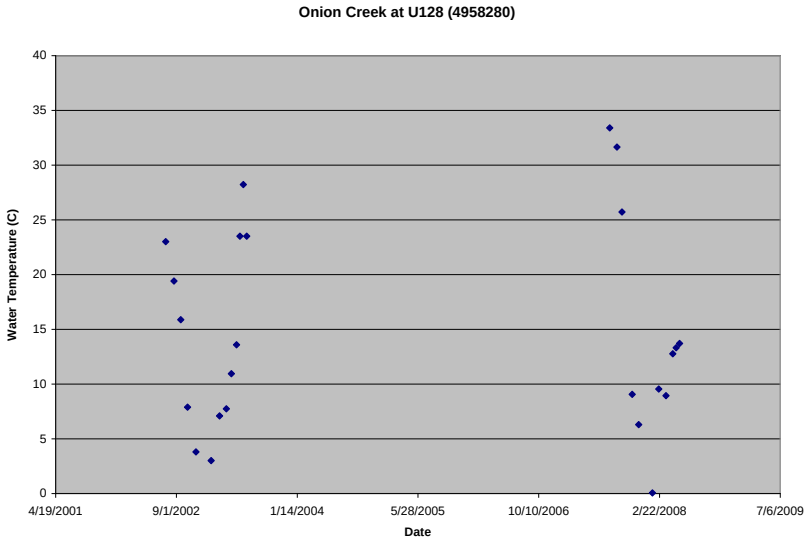
Pre and post Water Quality Data for Onion Creek at U128 crossing.

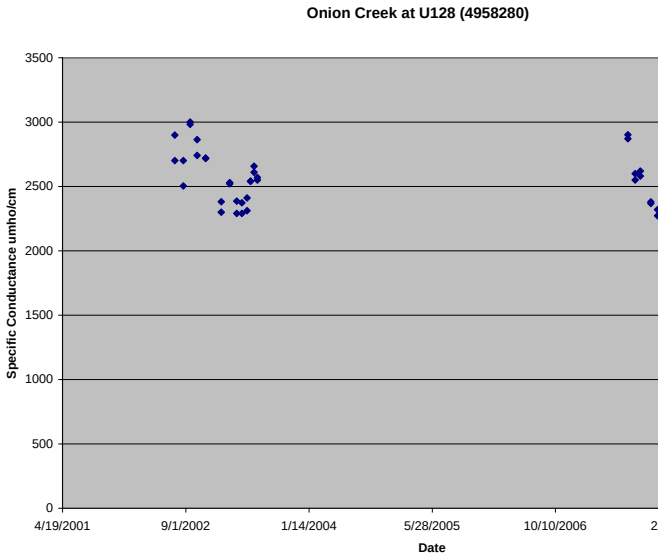

Onion Creek at U128 (4958280)
D.O. mg/l
0
2
4
6
8
10
12
14
16
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Date


Onion Creek at U128 (4958280)
Flow cfs
0
0.5
1
1.5
2
2.5
3
3.5
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
Date


Onion Creek at U128 (4958280)
TDS mg/l
0
500
1000
1500
2000
2500
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Date


Onion Creek at U128 (4958280)
TSS mg/l
0
100
200
300
400
500
600
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
Date


Onion Creek at U128 (4958280)
Water Temperature (C)
0
5
10
15
20
25
30
35
40
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Date


Onion Creek at U128 (4958280)
Specific Conductance umho/cm
0
500
1000
1500
2000
2500
3000
3500
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
Date