Onion Creek
TMDL
Grand County, Utah

Prepared by

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Onion Creek TMDL

Waterbody ID	**Onion Creek**
Location	**Grand County, Utah HUC# 14030005**
TMDL Pollutants of Concern	**Total Dissolved Solids (TDS)** **Temperature**
Impaired Beneficial Uses	**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.**
Loading Assessment	**Current TDS criteria cannot be attained due to high TDS input from natural sources.** **Temperature exceeds 27° standard during summer months as a result of solar heating and poor riparian condition.**
Water Quality Targets/Endpoints	
TDS	**Delist based on unachievable standard.** **Develop site-specific TDS criteria not to exceed 3000 mg/l. Two segments above and below Stinking Springs**
Temperature	**Temperature not to exceed state standard relative to assessment criteria.**
Implementation Strategy	
TDS	**Develop site-specific TDS standard.**
Temperature	**To attain a temperature reduction in Onion Creek this TMDL recommends restricted access to the stream channel by off road vehicles (ATV's, 4X4 vehicles, etc.).** **Riparian restoration to facilitate canopy cover.**
This document is identified as a TMDL for Onion Creek and is officially submitted to the U.S. EPA to act upon and approve as a TMDL.	

I. INTRODUCTION

Onion Creek is a tributary 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 (see Figure 1). 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 1 – 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.

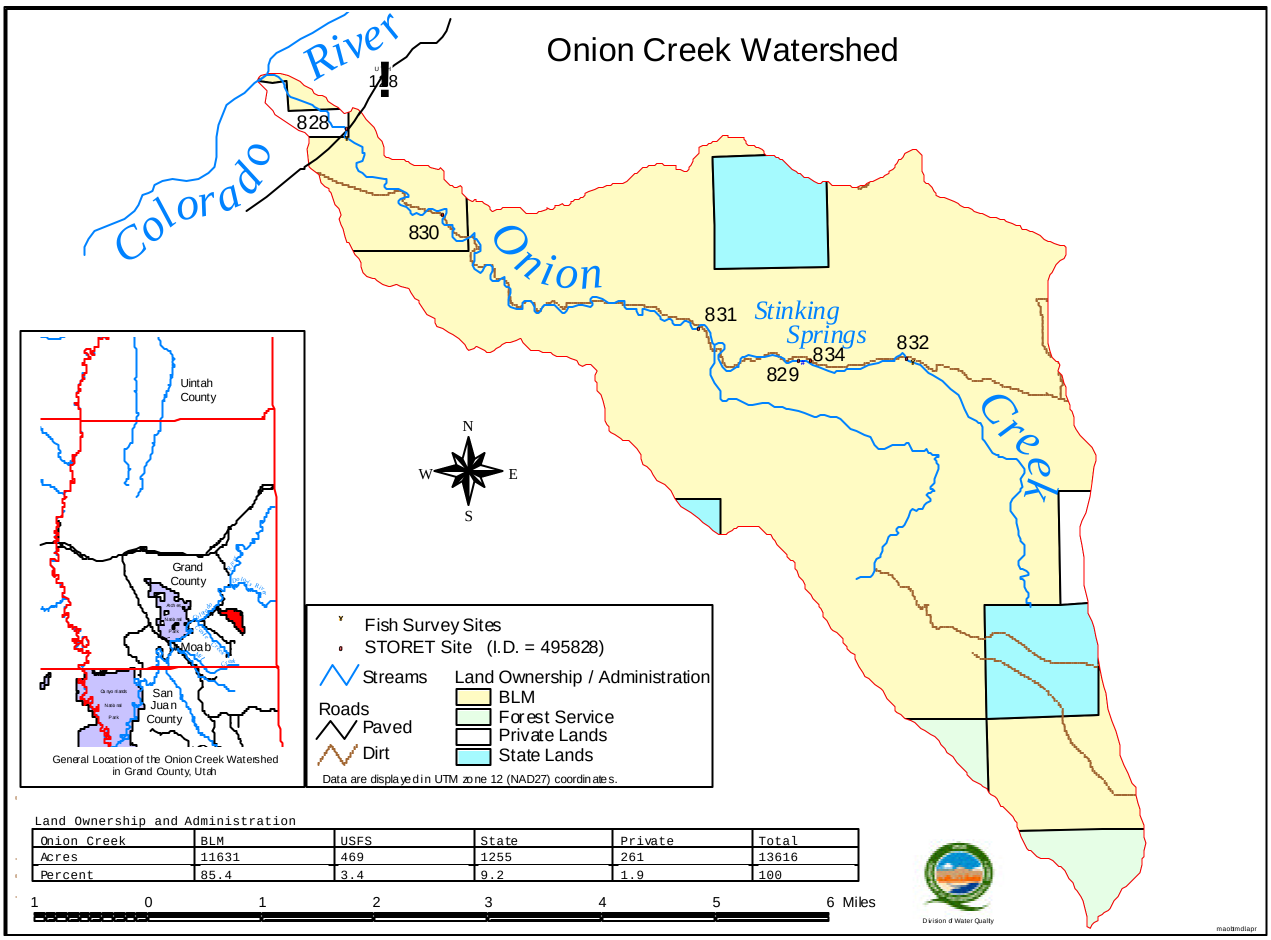


Figure 1 – Onion Creek Watershed

Vegetation in the Onion Creek watershed is predominantly Evergreen Sub-Desert Shrubs with small patches of Evergreen Woodlands and Grass Steppe. In the upper end of the watershed there is a private ranch with approximately 795 acres in agriculture production.

II. WATER QUALITY STANDARDS

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. Tables 2-4 show the TMDL status, pollutants of concern and the beneficial use classification of Onion Creek.

Table 2 – 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 3 – 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 4 – 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.

Public Law 92-500, the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act), enacted by Congress in 1972 and amended in 1977 and 1981, provides a national framework for water quality protection. The Clean Water Act recognizes that it is the primary responsibility of the States to prevent, reduce and eliminate water pollution; to determine appropriate uses for their waters and to set water quality criteria to protect those uses. Section 303(d) of the Clean Water Act requires that each state reviews and, if necessary, revises its Water Quality Standards at least once every three years. This serves to ensure that the requirements of state and federal law are met and that water quality criteria are adequate to protect designated water uses.

III. TECHNICAL ANALYSIS & SIGNIFICANT SOURCES

Total Dissolved Solids

The state's standard for TDS associated with Class 4 waters is $\leq$1200 mg/l. As can be seen in figure 2 Onion Creek exceeds this standard in 10 out of 12 samples (83%) taken between July 1997 and June 1998. The average TDS for the sample period was 2030 mg/l with an average exceedence of 830 mg/l.

Significant Sources

Field studies were conducted in 1992 (see Appendix A) to determine the cause of the high TDS in Onion Creek. The study indicated that the gypsum intrusion in the middle of the watershed is the major source of salinity via groundwater to Onion Creek. Stinking Springs, the major groundwater source in this section, is extremely high (> 8,000 mg/l) in dissolved solids. Conclusions from the fieldwork include:

1. Above Stinking Springs at the last road crossing Onion Creek carried 448 mg/l TDS.
2. All side streams tested had higher concentrations of TDS than the main stream.
3. The TDS concentration of the main stream increased as each side stream from the gypsum intrusion joined it.
4. The greatest concentration of TDS occurred in Stinking Spring, having 8,180 mg/l TDS.
5. Stinking Spring is the source contributing the greatest concentration of TDS to the waters of Onion Creek.

All the sites sampled below Stinking Spring had conductivities and TDS concentrations exceeding state standards (see table 5), showing a slightly increasing trend downstream.

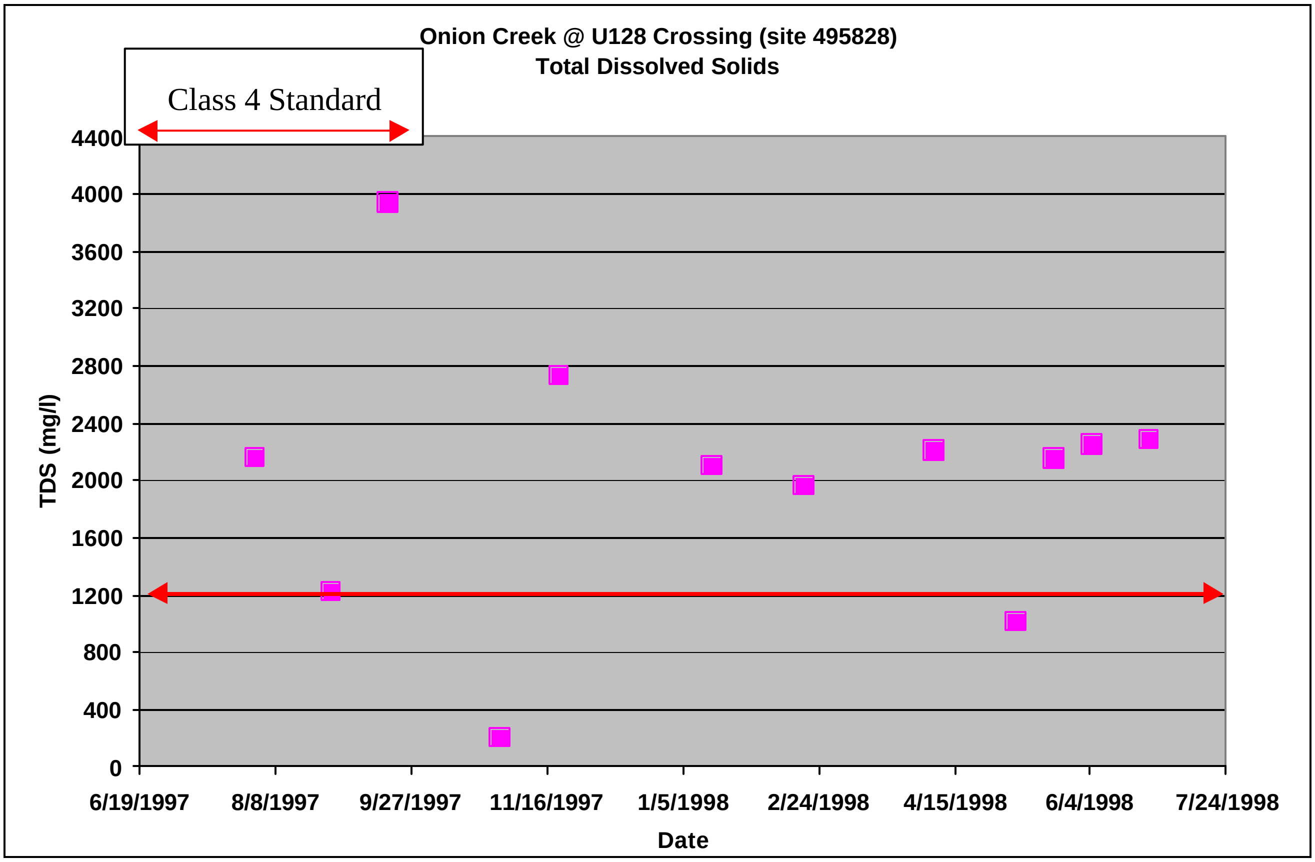


Figure 2 - Onion Creek TDS

Synoptic surveys were conducted in November 2000 and April 2001by the Technical Advisory Committee primarily to investigate the validity of the previous work done on Stinking Springs. Although the concentration was not as high as previously measured, the data collected (Specific Conductance reading of 13,950 on 4-10- 01) did validate the excessive high concentration of TDS from this source.

Table 5 – Field Measurements *

Site #	Time	PH Units	Temp. Deg. C	TDS (mg/l)	Conductivity (umhos)	Site Description
1	12:15	8.43	17.4	448	821	Above intrusion
2	12:20	8.44	13.7	738	1369	Perennial side stream
3	12:30	8.42	18.1	496	841	100’ below confluence
4	12:45	8.55	17.5	712	1245	Second side stream
5	12:55	8.6	20.5	590	1039	100’ below confluence
6	13:50	8.73	22.5	744	1350	Third side stream
7	14:00	8.64	22.5	621	1100	100’ below confluence
8	14:35	7.58	10.9	1041	2002	Seep in channel
9	14:55	7.35	14.5	8,170**	19,310	“Stinking Springs”
10	15:00	8.34	22.4	1462	2856	100’ below Stinking Springs
11	15:15	8.44	24.4	1435	3120	1000’ below site #10
12	15:30	8.46	24.1	1441	3240	1000’ below site #11
13	15:50	8.46	24.6	1474	3277	1000’ below site #12
14	16:00	8.44	24.3	1609	3283	1000’ below site #13
15	16:10	8.43	24.6	1630	3233	1000’ below site #14

*** Summarized from study by L. Guymon in Appendix A**
**** Corrected from Guymon’s 81,700**

Temperature
The temperature impairment in Onion Creek during the 1997-1998 intensive monitoring cycle is depicted in Figure 3. 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.

<u>Significant Sources</u>
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 20 road crossings that occur between the highway and Stinking Springs (see Figure 4). 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 tostreambank erosion and increase sediment. Frequent stream alterations by County road crews cause additional riparian problems and eliminate riparian cover.

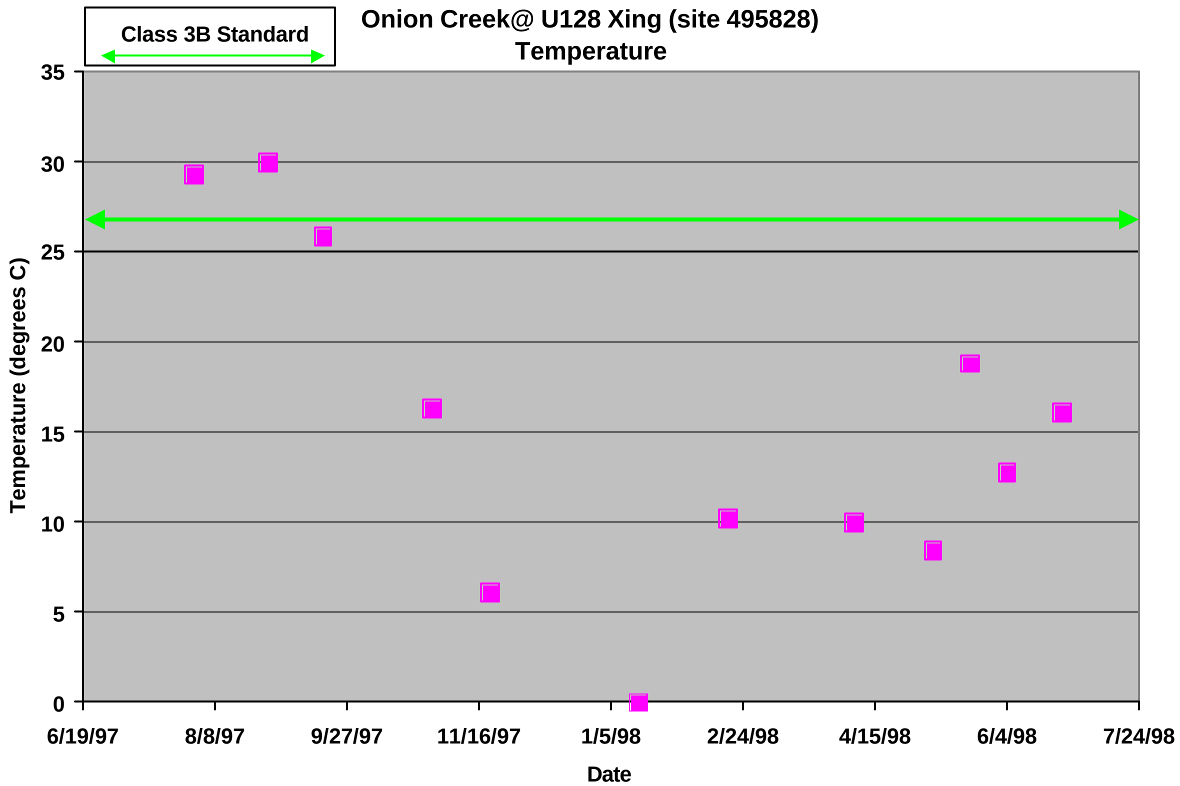


Figure 3 - Onion Creek temperature data

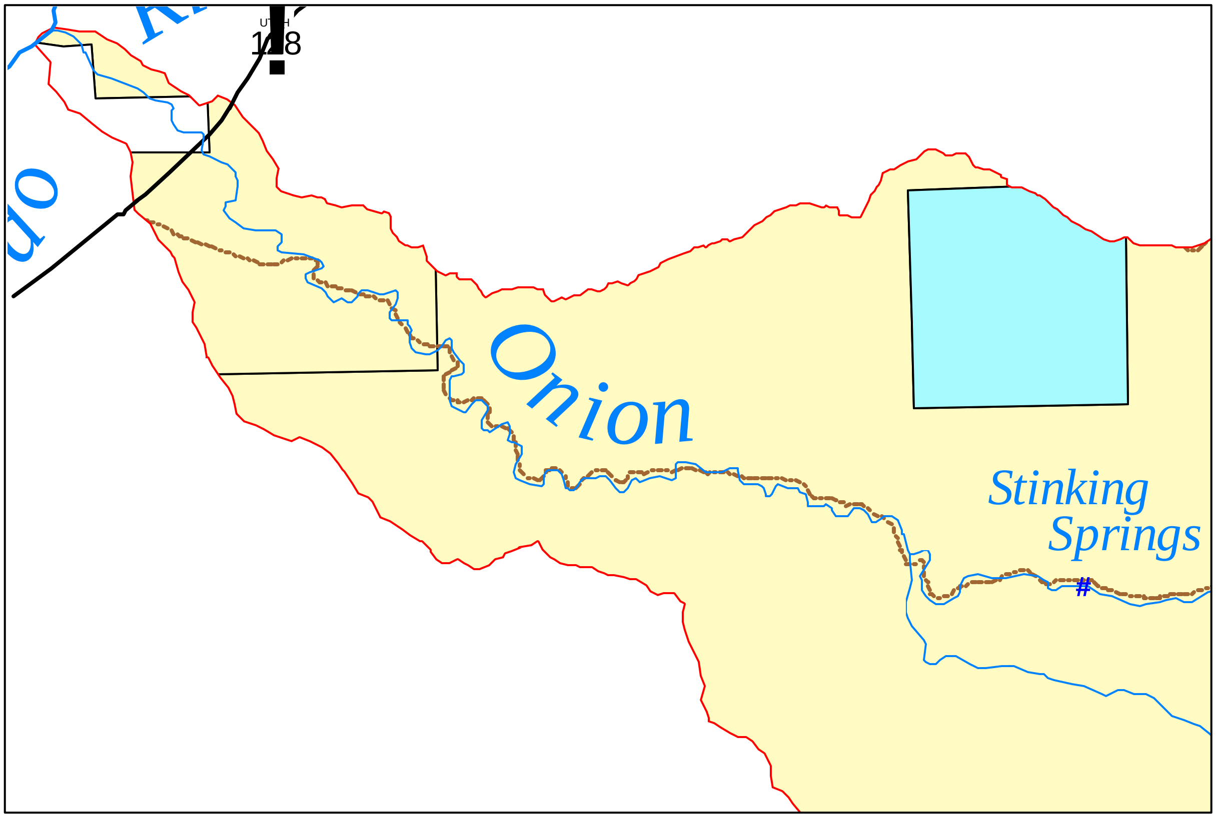


Figure 4 - Onion Creek road crossings

The following application of a simplified approach in predicting the effect of shading on stream temperatures shows that a 15% reduction in solar radiation by increasing canopy cover will permit the stream to meet its temperature criteria for warm water fisheries.

To determine the effect of restored riparian vegetation on stream temperatures a simple model published in EPA's *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water – Part 1* (1985) was used. The model predicts a stream equilibrium temperature based upon average dewpoint temperature for the critical time period (July & August), mean daily windspeed and the net incoming solar radiation. The estimated reduction in solar radiation due to stream shading was derived from guidelines set forth by Pluhowski (1968).

T_d (average dewpoint temperature for August) = 40?F
U (mean daily windspeed) = 9.2 mph
H_{sn} (net incoming shortwave radiation) = 2188 btu/ft^2/day

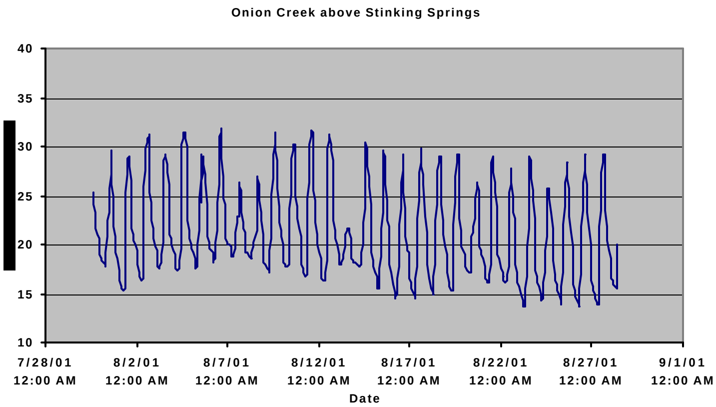
Equilibrium temperature (E_i) under unshaded conditions
a. $f(U) = 70+0.7(U^2)$
b. $T=(E_i+T_d)/2$
c. $B=0.255-0.0085(T)+0.000204(T^2)$
d. $K=15.7+(B+0.26)(f(U))$
e. $E_{i+1}=T_d+H_{sn}/K$

Table 6 – Solar & Climate data for Onion Creek

Month	Solar Radiation KWh/m^2/day	Solar Radiation BTU/ft^2/day	Average Dewpoint Temperature (F)	Mean Wind Speed (mph)
July	7.3	2314.65	40	9.4
August	6.5	2060.99	40	9.1

The wind speed function f(U) is computed once and the dewpoint temperature (T_d) is initially used in place of the equilibrium temperature (E_i). If E_i and E_{i+1} differ by more than 1? than E_{i+1} is used in equation b and the procedure is repeated until convergence is attained. After three iterations of the model the equilibrium temperature of Onion Creek under unshaded conditions was found to be 29°C.

After applying a 15% reduction in incoming solar radiation (H_{sn}=1860 btu/ft^2/day) the new equilibrium temperature was found to be 25.5°C, which meets the state criteria for warm-water fisheries and provide a 1.5 °C factor for margin of safety.



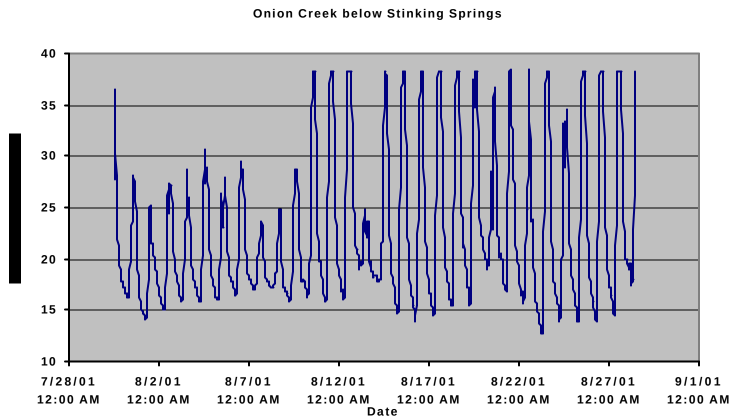


Figure 5 – Diurnal temperature fluctuations above and below Stinking Springs.

As identified in Figure 3 temperature exceedence only occurs during the summer months following peak recreation and concurrent with peak solar radiation. Examining the diurnal temperature fluctuation above and below Stinking Springs in Figure 5 during this peak season, and considering the access to the channel below Stinking Springs identified in Figure 4, it seems most likely that off road vehicle use in the stream is a major cause of temperature impairment and riparian degradation (which further contributes to the temperature impairment) in Onion Creek. The Technical Advisory Committee has also identified frequent channel alterations caused by heavy equipment as being a significant source of impairment.

Based on the above information it is clear that without improved channel morphology and riparian condition the temperature in Onion Creek will continue to exceed the state's 27° Celsius standard during the summer months.

IV. TMDL

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

V. MARGIN OF SAFETY AND SEASONALITY (MOS)

Temperature exceedence only occurs during the summer months as can be seen in Figure 3. Improvement in channel geometry and riparian condition as a result of restricted instream use by off road vehicles should result in increased shading and a significant reduction in solar radiation inputs. A 10% reduction in solar input will reduce the modeled Onion Creek temperature to within standard limits. The additional 5% is identified as a MOS. The MOS will also include future monitoring to evaluate the effectiveness of restoring the riparian corridor through application of these BMP's.

VI. ALLOCATION OF LOAD REDUCTIONS

Based on the technical analysis Onion Creek cannot meet the state water quality standard for total dissolved solids. Natural inputs will continue to cause TDS to rise above 1200 mg/l. Because the only input causing a TDS increase is naturally occurring, no allocation can be made.

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).

VII. PUBLIC PARTICIPATION

Information concerning the Onion Creek TMDL has been distributed throughout Moab. A brochure was developed to help people understand TMDL's. A public meeting and open house were held to explain the assessment and recommendations to those interested. The main land manager in the basin is the BLM. The local BLM office is represented on the Technical Advisory Committee for the watershed.

Technical Committee			
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Appendix A

Onion Creek Preliminary Test Results
By L. Guymon

Objective: Measure the pH, Temperature Celsius, Total Dissolved Solids and Conductivity of the surface waters of Onion Creek, it's tributaries, seeps and springs out of the Gypsum intrusion. Determine what, if any, contribution of salts the Gypsum Intrusion may have to the waters of Onion Creek.

Procedure: Calibrate pH meter in the field according to instrument instructions. Using a pH meter, conductivity meter and total dissolved solids (TDS) meter, measure the parameters of surface waters according to instrument instructions. Rinse probes with D.I. water after each measurement.

Locations: In order to get a basis from which to work, I walked up Onion Creek to above the Gypsum Intrusion. The first sample site was in Onion Creek's mainstream above a perennial side stream flowing out of the Gypsum Intrusion. The perennial side stream was then sampled. The third sample was taken in the main stream 100 feet below the confluence of the two. It was assumed that complete mixing had occurred at this distance.

This same procedure was followed for each of the flowing tributaries and seeps along Onion Creek in the Gypsum Intrusion. Stinking Spring was sampled, then 100 feet below it, the main stream of Onion Creek was sampled. For approximately a mile below Stinking Spring and the Gypsum Intrusion, Onion Creek was sampled at 1000-foot intervals.

The first sample site was identified as "Site #1" and each site below it was numbered consecutively (2, 3, 4…etc.).

Conclusions: The main stream of Onion Creek carried 448 parts per million (ppm) TDS upon approaching the Gypsum Intrusion. All side streams tested had higher concentrations of TDS than the main stream. The TDS concentration of the main stream increased as each side stream from the Gypsum Intrusion joined it.

The greatest concentration of TDS occurred in Stinking Spring itself, having 81,800 ppm TDS and 19,310 micro-semens (uS) conductivity. Stinking Spring is the source contributing the greatest concentration of dissolved solids to the waters of Onion Creek.

Stinking Spring is on the downstream side of the Gypsum Intrusion and the last of the tributaries to Onion Creek from the intrusion. All the sites sampled for approximately a mile below the intrusion had conductivities and TDS concentrations close to the same values, showing no trend toward increasing or decreasing. From this observation, combined with the low concentrations observed above the intrusion, the conclusion can be drawn that the Gypsum Intrusion contributes substantially to the concentration of dissolved solids in the waters of Onion Creek.

Measurements made 5-4-92 by L. Guymon						
Calibrating pH Meter:						
Standard pH 7 = pH 6.99 at 29.5 degrees Celsius						
Standard pH 10 = pH 10.01 at 25.2 degrees Celsius						
Site #	Time	pH Units	Temp. Deg. C	TDS (ppm)	Cond. (uS)	Site Description
1	12:15	8.43	17.4	448	821	above intrusion
2	12:20	8.44	13.7	738	1369	perinnial side stream
3	12:30	8.42	18.1	496	841	100' below confluence
4	12:45	8.55	17.5	712	1245	second side stream
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6	13:50	8.73	22.5	744	1350	third side stream
7	14:00	8.64	22.5	621	1100	100' below confluence
8	14:35	7.58	10.9	1041	2002	seep in channel
9	14:55	7.35	14.5	81,700	19310	"Stinking Spring"
10	15:00	8.34	22.4	1462	2856	100' below Stinking Spring
11	15:15	8.44	24.4	1435	3120	1000' below site #10
12	15:30	8.46	24.1	1441	3240	1000' below site #11
13	15:50	8.46	24.6	1474	3277	1000' below site #12
14	16:00	8.44	24.3	1609	3283	1000' below site #13
15	16:10	8.43	24.6	1630	3233	1000' below site #14

Detailed Description of Sample Sites

Site #1: Most upstream sample site, above the Gypsum Intrusion and the perennial side stream out of the intrusion.
Site #2: First perennial side stream flowing out of the intrusion.
Site #3: Onion Creek proper 100’ below the confluence of the first perennial side stream.
Site #4: Second perennial side stream flowing out of the Gypsum Intrusion, flowing more than the first side stream, estimated flow 0.25 cfs.
Site #5: Onion Creek proper 100’ below the confluence of the second perennial side stream.
Site #6: Third perennial side stream flowing out of the intrusion, below road culvert crossing.
Site #7: Onion Creek proper 100’ below the confluence of the third perennial side stream.
Site #8: Seep in the center of Onion Creek channel, near the left bank. This seep is the largest volume of all the seeps.
Site #9: “Stinking” Spring itself. Located on the right bank, this seep is relatively small volume, smells strongly of sulfur gas and has the characteristic black deposits of heavy mineral content on the surrounding vegetation and soils.
Site #10: Onion Creek proper 100’ below “Stinking” Spring.
Site #11: Onion Creek proper 1000’ below site #10.
Site #12: Onion Creek proper 1000’ below site #11.
Site #13: Onion Creek proper 1000’ below site #12.
Site #14: Onion Creek proper 1000’ below site #13.
Site #15: Onion Creek proper 1000’ below site #14.

Appendix B

Results of 2000 Fishery Survey on Onion Creek
By Louis Berg

Fish and habitat surveys were conducted at three locations on Onion Creek during 2-3 November. Station A was located about 1 mile above the Hwy 128 crossing. Station B was at Stinking Springs approximately 6 miles above Hwy 128. Station C was located about 1 mile above Stinking Springs and 7 miles above Hwy 128. Fish surveys at Stations A and C consisted of electrofishing a 528-foot length of stream and identifying and counting all fish collected during a single pass. No search for fish occurred at Station B. Habitat surveys at all three stations involved measuring or rating these characteristics: water temperature, mean width, mean depth, amount of cover, and quality of substrate. Water flow was visually estimated at Station C.

Six speckled dace, 99 red shiners, and 1 Plains killifish were collected at Station A. Speckled dace are a native species, whereas the other two species are exotic. All three are considered warmwater species. Because the water was turbid, sampling was inefficient and many more fish were observed than collected. A larger fish (at least 6 inches) was observed but missed, and was suspected of being a native species of sucker. No trout were collected or observed. Habitat characteristics were suitable for the species collected but not for trout. Station A had a water temperature of 43 F, a mean width of 9.8 feet, a mean depth of 1.3 inches, a poor cover rating, and a good substrate rating. There was evidence of flash floods and frequent channel movement. Summer water temperatures probably reach 80 F.

Habitat characteristics at Station B were similar to Station A and it is suspected that fish are present. Quality of habitat appear suitable for small warmwater fish but not for trout. Station B had a water temperature of 47 F, a mean width of 6.0 feet, a mean depth of 1.0 inch, a good cover rating, and an excellent substrate rating. There was evidence of flash floods and frequent channel movement. Summer water temperatures probably exceed 70 F.

At Station C no fish were collected. Onion Creek at this location had a water temperature of 48 F, a mean width of 5.0 feet, a mean depth of 3.5 inches, a fair-good cover rating, and an excellent substrate rating. Flow was estimated at 1.5 cfs. The stream channel in this area was stable. These habitat characteristics appear suitable for development of a trout fishery. However, macroinvertebrates needed as food for trout were scarce, summer water temperatures may exceed 70 F, and the Utah Division of Wildlife Resources currently has no plans to introduce trout into Onion Creek. A probable reason for lack of small warmwater fish at Station C is the steeper gradient/higher velocity of the stream in this area.