



State of Utah

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Environmental Quality

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July 14, 2008

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Dear Ms. Spence:

Subject: Rationale for site specific criteria recommendations for Paria River, Antelope Creek, Indian Canyon Creek, Price River and several tributaries to the Price River

The following document provides the technical rationale in support of site specific criteria determinations for Total Dissolved Solids (TDS) on the Paria River, Antelope Creek, Indian Canyon Creek, Price River and several tributaries. These recommendations are the result of extensive analyses and source assessments to determine total maximum daily loads for TDS. These studies found the predominant sources of loading originating from uncontrollable natural sources, saline geologic formations that are prevalent throughout these watersheds. Potential anthropogenic sources were found to be controlled to the maximum extent feasible, primarily through the use of efficient irrigation techniques. The following text has been excerpted from the original documents, *Paria River Water Quality Management Plan, TMDLs for Total Dissolved Solids in the Duchesne River Watershed, and Price River, San Rafael River, and Muddy Creek TMDLs for Total Dissolved Solids.*

### **Rationale for site specific criteria for Paria River**

In evaluating the water quality data and land use patterns it is apparent that the predominant source of TDS loading into the Paria River is from naturally occurring saline geologic formations prevalent throughout the watershed, particularly Tropic shale. Therefore we are proposing the development of site specific criteria that reflects the natural background concentrations of TDS in the Paria River.

### **Site-Specific Criteria**

Development of site-specific criteria is recommended for the Listed Sections of the Paria River since the information available indicates that the observed spike in TDS at the lower end of the Paria River Reach-1 is due to inputs from

a shallow alluvial aquifer. Paria River Reach-3 is located in a sparsely populated and relatively undeveloped landscape with no known anthropogenic sources of TDS.

Guidance for developing site-specific criteria is summarized in two memorandums issued by EPA. A Region 8 Memorandum (Moon 1997) addressed procedures for *Use Attainability Analysis and Ambient Based Criteria*, and a memorandum from EPA Office of Science and Technology (Davies 1997) addressed the subject: *Establishing Site-Specific Aquatic Life Criteria Equal to Natural Background*. These two memoranda were consulted for guidance and direction in developing site-specific criteria for the Paria River. The applicable points from these memoranda for developing site-specific criteria are:

1. Site-specific criteria are allowed by regulation subject to EPA review and approval;
2. Site-specific numeric aquatic life criteria may be set equal to natural background where natural background is defined as: background concentrations due only to non-anthropogenic sources; and
3. Previous guidance provided the direction to use the 85<sup>th</sup> percentile of the available representative data for natural ambient water quality conditions.

The Utah Standards of Quality for Waters of the State provide for adjustment of site-specific standards to background where the adjustment does not impair designated beneficial uses.

“Total dissolved solids (TDS) limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water. The total dissolved solids (TDS) standards shall be at background where it can be shown that natural or un-alterable conditions prevent its attainment. In such cases rulemaking will be undertaken to modify the standard accordingly.”<sup>1</sup>

### **Paria River Reach-1**

Two stations within Paria River Reach-1 were evaluated for setting site-specific criteria. The Paria River at Highway U12 Crossing station (495187) measures TDS in the Paria River upstream of Cannonville. The second station, Paria River at Kodachrome Basin Road crossing (495186) is located at the lower end of the reach and below Henrieville Wash.

The data distribution for these two stations is illustrated using box and whisker plots (Figure 0-1). Box and whisker plots are commonly used for comparing distributions because the center, spread, and overall range of data are graphically apparent. In a box and whisker plot the ends of the box are the upper and lower quartiles, so the box spans the interquartile range, the median is marked by a solid light line inside the box, the mean is marked as a solid heavy line, and the whiskers are the two lines outside the box that extend to the highest and lowest observations.

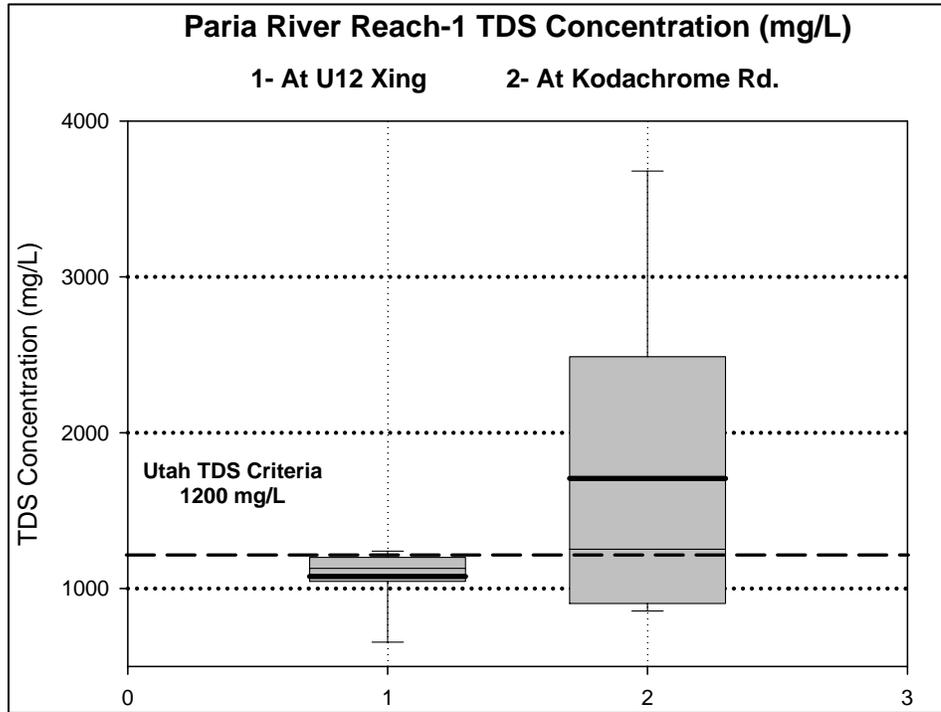
The TDS data used to construct the box and whisker plots for each station were collected between August 2000 and December 2002. The box plot for the upper station (Paria River at Highway U12 Crossing - 495187) shows that the majority of data are below the statewide criteria of 1,200 mg/L; however, at the downstream station (Paria River at Kodachrome Basin Road crossing - 495186) the TDS concentration increases, with 50% of the TDS samples exceeding the 1,200 mg/L criteria.

There are irrigation water withdrawals within the Paria River Reach-1; however, there is not sufficient agricultural use to explain the spike of TDS at the lower end of the reach. There is

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<sup>1</sup> Footnote to Table 2.1.4.1, Numeric Criteria for Domestic, Recreation, and Agricultural Uses, R317-2, Standards of Quality for Waters of the State, UAC R-317-1, March 01, 2004, Utah Department of Administrative Rules.

qualitative information on the high TDS associated with saline aquifers in the area, which appears to be the most logical explanation for the increase in TDS concentrations observed.



**Figure 0-1 Concentration of TDS at Two Stations on Paria River Reach-1 Compared to the Utah Standard for Irrigation of 1,200 mg/L**

Statistics for Paria River at Kodachrome Basin crossing (495186), the station with the highest TDS concentration, are summarized in Table 4-1. We recommend the site-specific criteria be 2,500 mg/L. This will ensure that the site-specific standard is set at an appropriate level that reflects the natural background concentrations of TDS.

**Table 0-1 Statistics and Site-Specific Criteria for Paria River Reach-1 Based on Station 495186 - Paria River at Kodachrome Basin Road Crossing**

Statistic	TDS Concentration (mg/L)
Count	15
Mean	1,492
Median	1,094
Min	822
Max	3,444
85th Percentile	2,461
State Criteria - Irrigation	1,200
State Criteria - Stockwater	2,000
Recommended Site-Specific Criteria	<b>2,500</b>

Notes: Data period, October, 2000 to December 2002.

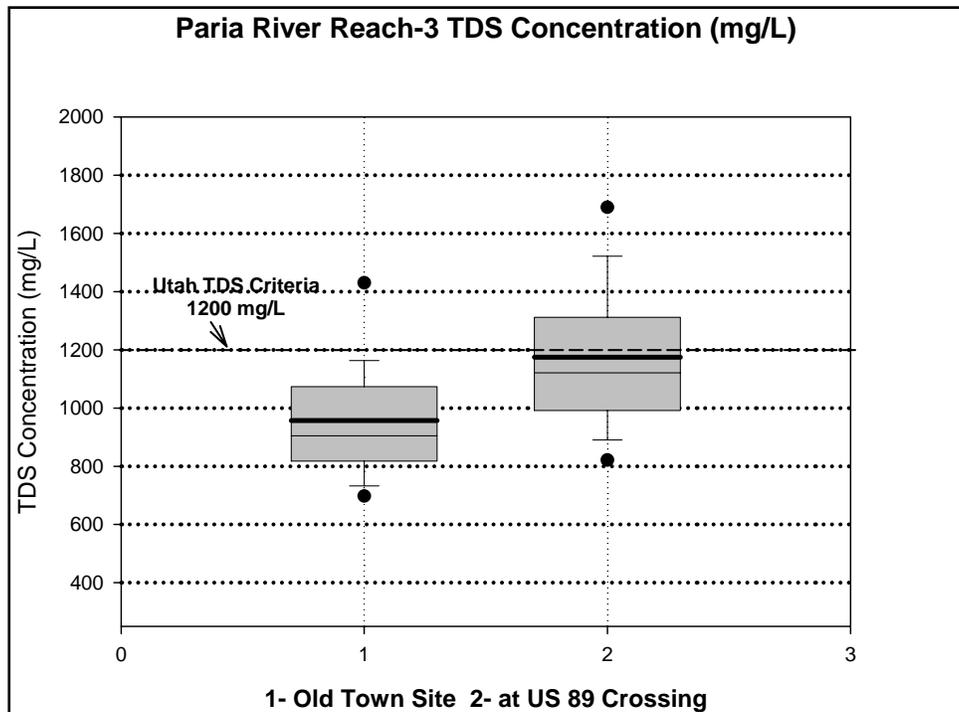
### Paria River Reach-3

Two stations within Paria River Reach-3 were evaluated for setting site-specific criteria. Paria River at Old Town Site station (599455), measures TDS in the Paria River just above the Listed Section, at river mile 21.5. Cottonwood Creek flows into the river approximately two miles below this site. Cottonwood Creek has a low TDS concentration with a mean of 657 mg/L, less than in the Paria River at that point. The second river station, Paria River at US89 Crossing (495185), located at river mile 9.5 has the highest TDS concentration in the reach. As indicated earlier, the TDS concentration decreases at the State line as measured by the Arizona state monitoring stations (101078 and 101077). (Note: River Miles were measured from the Utah-Arizona state line to provide a point of reference.)

The data distribution for these two stations are also illustrated in box and whisker plots (Figure 0-2). The data used to construct these box plots included the entire data record at the stations including the TDS values generated from correlation with specific conductance. The majority of data at the upper station, Old Town Site, is below the statewide criteria of 1,200 mg/L.

Downstream 12 river miles the TDS concentration increases and 37% of the TDS samples exceeded the 1,200 mg/L criteria.

There are no current (or legacy) human activities in this primitive and mostly road-less reach that would explain this increase in TDS. There is evidence of some illicit off road vehicle use through the river channel in this area but we feel through continued public education and enforcement it can be addressed before it becomes a significant problem in terms of TDS loading. The source of TDS is considered a natural condition related to input to surface water from a higher salinity aquifer as discussed in Section **Error! Reference source not found.**



**Figure 0-2 Concentration of TDS at Two Stations on Paria River Reach-3 Compared to the Utah Standard for Irrigation of 1,200 mg/L**

Statistics for Paria River at US89 Crossing (495185), the station with the highest TDS concentration, are summarized in Table 0-2. We recommend the site-specific criteria be 1,500 mg/L. This will ensure that the site-specific standard is set at an appropriate level that reflects the natural background concentrations of TDS.

**Table 0-2  
 Statistics and Site-Specific Criteria for Paria River Reach-3  
 Based on Station 495185 - Paria River at US89 Crossing**

<b>Statistic</b>	<b>TDS Concentration (mg/L)</b>
Count	132
Mean	1,174
Median	1,121
Min	325
Max	2,564
85th Percentile	1,467
<b>State Criteria</b>	
Irrigation	1,200
Stockwater	2,000
<b>Recommended Site-Specific Criteria</b>	<b>1,500</b>

Notes: Data period, February 1976 to July 2002.

### Rationale for site specific criteria for Antelope Creek and Indian Canyon Creek

Development of site-specific criteria is recommended for the 303(d)-listed segments of Indian Canyon Creek and Antelope Creek.

The Utah Standards of Quality for Waters of the State provide for development of site-specific TDS standards where the adjustment does not impair designated beneficial uses.

“Total dissolved solids (TDS) limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water. The TDS standards shall be at background where it can be shown that natural or un-alterable conditions prevent its attainment. In such cases rulemaking will be undertaken to modify the standard accordingly.”

In addition, the EPA Region 8 memorandum *Use Attainability Analysis and Ambient Based Criteria* (Moon, 1997) provides guidance for developing site-specific criteria. The memorandum recognizes that ambient-based criteria are usually proposed for sites where the existing water quality (exceeding statewide water quality criteria) is perceived to be “natural” or, alternatively, resulting from “irreversible human-induced conditions.” Sites where the local geology may result in naturally elevated concentrations of salts or minerals are those most often proposed as sites warranting ambient-based criteria.

Data are not available for Indian Canyon Creek and Antelope Creek during times of “natural” conditions—prior to the manmade changes to support irrigation in the area. It is assumed that conditions in these watersheds can improve to some extent, based on slight decreases in TDS concentrations over the last decades. However, it is unlikely that these watersheds can feasibly meet the current TDS water quality criterion of 1,200 mg/L due to a combination of naturally saline soils and irreversible modifications from irrigation activities. Of the approximately 62,000 acres included in the Indian Canyon Creek watershed, only 248 acres (<1 percent) are irrigated. Similarly, less than 1 percent of the approximately 800,000 acres of Antelope Creek watershed are irrigated and a majority of the 430 irrigated acres in this watershed have already been treated with salinity control projects.

The proposed site-specific TDS criteria for Antelope Creek and Indian Canyon Creek are based on the 90<sup>th</sup> percentile concentration of available ambient water quality data. This approach is consistent with other TDS site-specific criteria developed in Utah (e.g., Sevier River, Price River, San Rafael River and Virgin River). The proposed criteria are listed in Table 8-1.

**Table 0-3. Recommended site-specific TDS criteria for Indian Canyon Creek and Antelope Creek**

Creek	Proposed Site-Specific TDS Criterion (mg/L)	UDEQ Station Used in Calculation	Station Location
Indian Canyon Creek	2,183	493453	Above confluence with Strawberry River
Antelope Creek	2,655	493423	At U.S. 40 Crossing

As required by Utah Water Quality Standards, the recommended site-specific criteria will support the affected designated uses of irrigation and stock watering. Iowa Department of Natural Resources conducted a review of available water quality standards and literature information regarding levels of TDS and the effect on waterbody uses (<http://www.iowadnr.com/water/standards/files/tdsissue.pdf>). Toxicity test data presented in the paper indicate that the safe upper limits of TDS in water consumed by beef cattle and dairy cattle are 10,000 mg/L and 7,150 mg/L, respectively. In addition, the Canadian Water Quality Guidelines identifies 3,000 mg/L as the maximum acceptable limit for livestock drinking water (CCREM, 1987) and The National Academy of Sciences *Water Quality Criteria 1972* (NAS and NAE, 1973) indicates that if TDS is between 1,000 – 2,999 mg/L, the waters should be satisfactory for all classes of livestock and poultry. They may cause temporary and mild diarrhea in livestock not accustomed to them or watery droppings in poultry, but should not affect their health or performance.

The site-specific criteria are also expected to support the water use for crop irrigation. Ayers and Westcot (1994) identified the crop tolerance for more than 70 different field crops related to the salinity of irrigation water. Electrical conductivity values are provided for crop yield potentials of 50 percent, 75 percent, 90 percent and 100 percent. Observed TDS and electrical conductivity measurements from field samples in Indian Canyon Creek and Antelope Creek were used to establish a regression equation of the two parameters ( $R^2=0.999$ ) for each stream to identify equivalent electrical conductivity values for the proposed TDS criteria. The conductivity values were then compared to the information in Ayers and Westcot (1994), indicating a resulting crop yield of approximately 80 percent for both streams, based on information for alfalfa, a dominate crop in the watersheds.

### Excerpted Summary Table and Figures

**Table 0-4. Summary of TDS data for UDEQ water quality stations recording exceedances of the TDS target**

Station ID	Station Description	No. of Samples	Avg (mg/L)	Min (mg/L)	Max (mg/L)	CV	First Sample	Last Sample
493423	Antelope Cr at U.S. 40 crossing	23	2,012.61	334	2,764	0.28	10/15/1980	5/28/1996
493453	Indian Canyon Cr above confluence with Strawberry R	40	1,860.05	290	2,562	0.19	8/1/1979	5/24/2001



**Rationale for site specific criteria for two segments of the Price River, as well as 4 tributaries to the Price River including Soldier Creek, Coal Creek, Pinnacle Creek and Gordon creek**

The following information is taken from the document titled Price River, San Rafael River, and Muddy Creek TMDLs for Total Dissolved Solids, West Colorado Management Unit, Utah, which was approved by EPA in April of 2004.

“Due to the uncertainty in what are achievable TDS concentrations in each watershed, it is recommended that the selection of site-specific TDS criteria be established at this time. The site-specific criteria should be revisited after implementation of BMPs and subsequent monitoring of the resulting changes in the TDS concentrations in each of the stream reaches. In order to establish site-specific criteria, the dataset from 1990 to 2001 was reviewed for the lower stations in each watershed, and the 90<sup>th</sup> percentile TDS concentration determined. This 90<sup>th</sup> percentile was selected as the criteria for many of the segments. This recognizes that much of the WCRW (West Colorado River Watershed) is a groundwater-dominated system, and that due to the presence of Mancos Shale, will have elevated TDS concentrations. While the State would like to achieve the current 1,200 mg/L criterion, it is unlikely that it can be achieved, except in the highest portions of the watersheds. This designation also recognizes that, with only minor exceptions, water used for irrigation in the WCRW is sourced from the upper portion of the watersheds, where TDS levels are typically less than 500 mg/L and therefore meet the agricultural criteria of 1,200 mg/L.”

The geologic map of the West Colorado River Watershed shows that Mancos shale is a dominant feature. On the west side of the watershed the Mancos shale layer begins at approximately 7,500 feet in elevation. On the east side of the watershed it is at approximately 7,200 feet in elevation. In recognizing that water coming in contact with the Mancos shale has naturally high concentrations of TDS, we propose the higher TDS site specific criteria. However, above the Mancos shale formation the water is higher quality with TDS concentrations below the Utah standard of 1,200 mg/l. As a result, we are proposing the following more specific language to reflect that and be protective of that higher quality water:

1. Price River and tributaries up to 7,500 feet in elevation from confluence with Green River to confluence with Soldier Creek: 3,000 mg/l

2. Price River and tributaries up to 7,500 feet in elevation from the confluence with Soldier Creek to Carbon Canal Diversion: 1,700 mg/l with the following 4 exceptions:
3. Soldier Creek and tributaries up to 7,200 feet in elevation from confluence with Price River: 1,700 mg/l
4. Coal Creek and tributaries to 7,200 feet in elevation from confluence with Price River: 1,700 mg/l
5. Pinnacle Creek and tributaries to 7,500 feet in elevation from confluence with Price River: 3,800 mg/l
6. Gordon Creek and tributaries to 7,500 feet in elevation from confluence with Price River: 3,800 mg/l

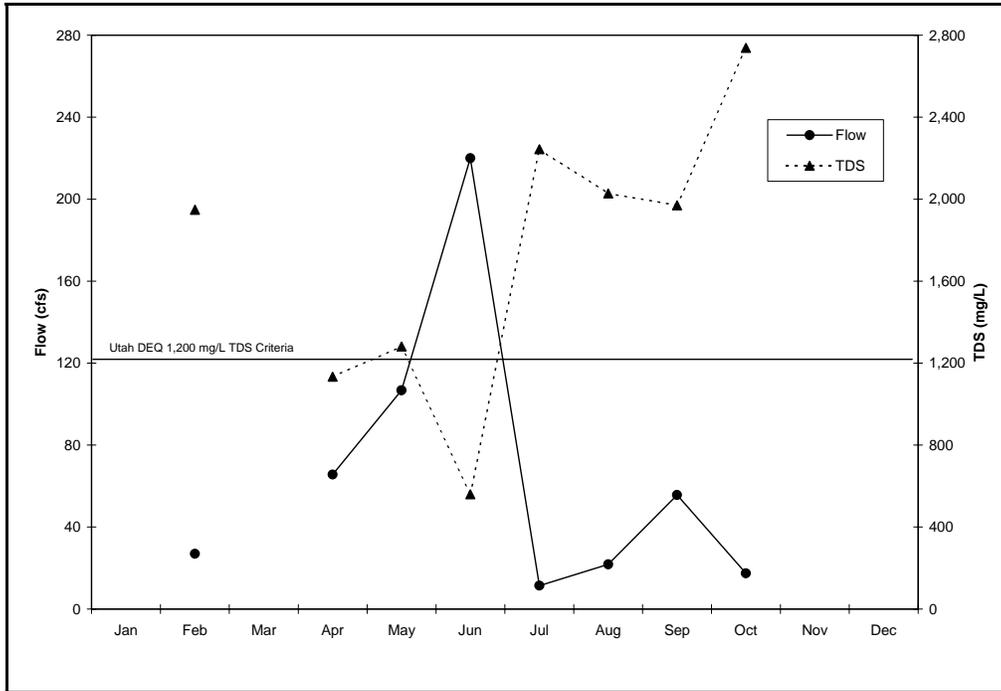
**Excerpted Summary Table and Figures**

**Table 3-6 Water Quality Data for the Price River Watershed**

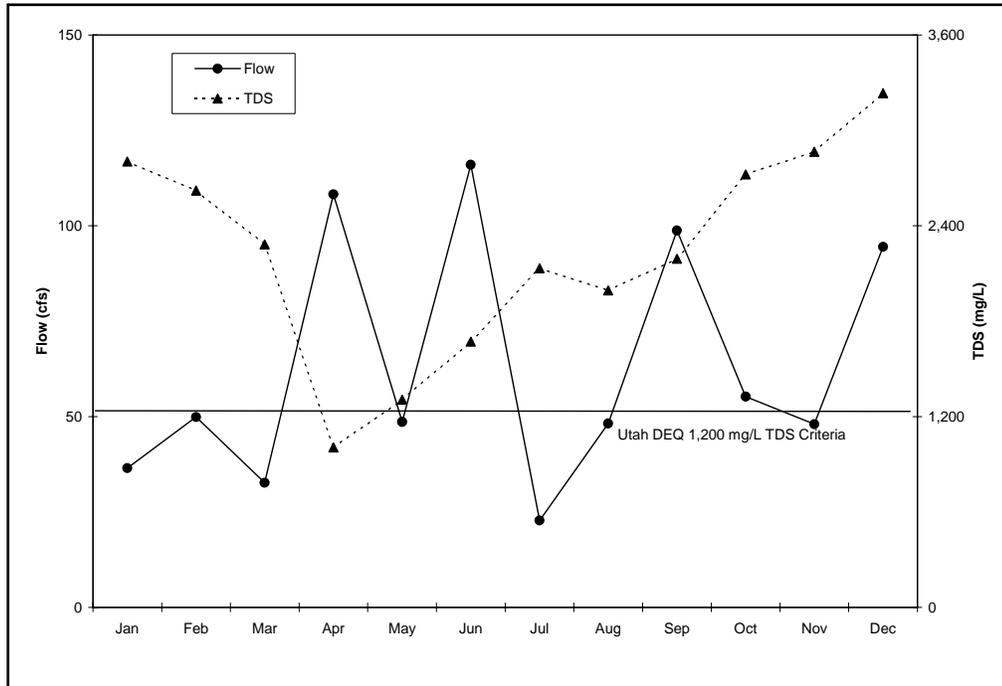
Site ID	Description	TDS (mg/L)				No. of samples	Number of Violations	Support <sup>1</sup>
		Min	Max	Mean	Upper 95% Confidence Interval			
493161	Price River at mouth	652	3,442	1,618	1,781	20	14	NS
493165	Price River at Woodside	548	4,866	2,164	2,166	71	57	NS
493239	Price River above Price WWTP in Wellington	408	2,918	1,511	1,933	21	11	PS
493253	Pinnacle Creek above Confluence with Price River <sup>2</sup>	888	4,038	2,470	2,634	12	10	NS
493137	Gordon Creek above Price River confluence	1112	2254	1,765	2183	6	5	NS
493281	Price River above Price River Coal	172	518	297	300	72	0	FS

<sup>1</sup> NS = Not Supporting; PS = Partially Supporting; FS = Fully Supporting (as listed in the RFP for the TMDL)

<sup>2</sup> While Gordon Creek is listed as the impaired segment, the impairment listing was based on sampling of Pinnacle Creek. However, subsequent sampling of Gordon Creek demonstrates that it is also impaired due to TDS concentrations and Gordon Creek is listed in the draft Utah 2004 303 (d) list of impaired waters.



**Figure 3-2 Average Monthly Flow and TDS at STORET 493239 (Price River above Price WWTP at Wellington Bridge)**



**Figure 3-3 Average Monthly Flow and TDS at STORET 493165 (Price River near Woodside at US 6 crossing)**

The following table shows the calculated 90<sup>th</sup> percentile values of TDS for each target site and also the recommended TDS site specific criteria.

<b>Target Site</b>	<b>90th Percentile TDS (mg/L)</b>	<b>Listed Stream Reaches Above or Near Target Site</b>	<b>Recommended Criteria (mg/L)</b>
<b>Price River</b>			
493239- Above WWTP at Wellington Bridge	3,800	Pinnacle <sup>1</sup> and Gordon Creeks and their tributaries from confluence with Price River to headwaters	3,800
	2,800	Price River and tributaries from Coal Creek to Carbon Canal diversion	1,700 <sup>3</sup>
493165- Lower Price River near Woodside	3,200	Price River and tributaries from confluence with Green River to near Woodside	3,000
	3,200	Price River and tributaries from near Woodside to Soldier Creek confluence	3,000

3. Based on achievement of 50% of the potential load reduction listed in Table A-2 multiplied by the 90<sup>th</sup> percentile.

The entire documents from which the above information have been derived are available online at [www.waterquality.utah.gov/TMDL](http://www.waterquality.utah.gov/TMDL) in the approved TMDL section. If you have any further questions please contact me directly at (801) 538-9215 or via email at [carladams@utah.gov](mailto:carladams@utah.gov)

Sincerely,

Carl Adams  
TMDL / Watershed Planning Program Manager