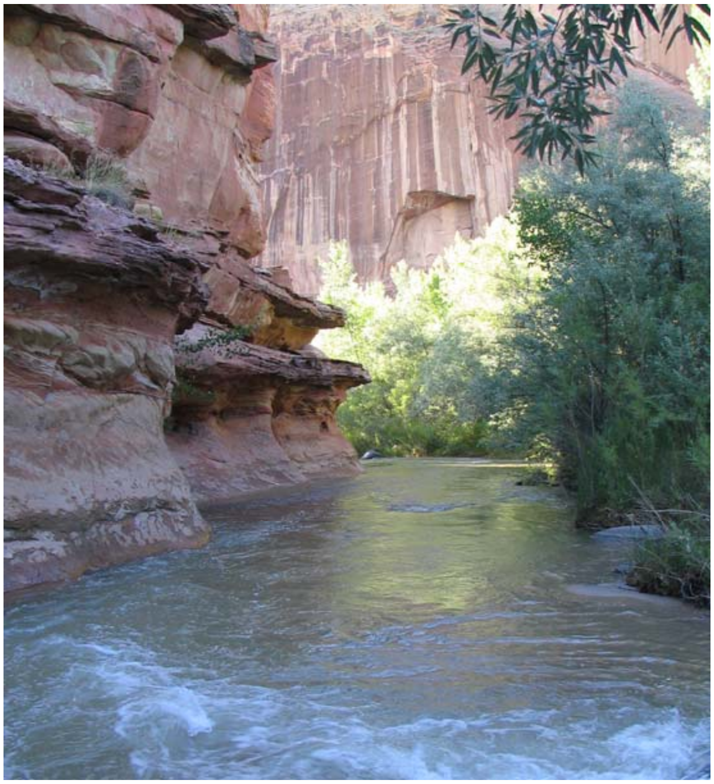
ESCALANTE RIVER

USE ATTAINABILITY ANALYSIS



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ESCALANTE RIVER WATERSHED
USE ATTAINABILITY ANALYSIS

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1.0 INTRODUCTION

1.1 Background and Document Organization

This document presents a Water Quality Management Plan (WQMP) for the Escalante River Watershed located in southern Utah. The Utah Division of Water Quality (DWQ) developed this Water Quality Management Plan with assistance from the Canyonlands Soil Conservation District. The DWQ contracted Millennium Science & Engineering to assess water quality impairments of the Escalante River and assist the Canyonlands Soil Conservation District in developing this Watershed Water Quality Management Plan. Many private individuals, agencies, and consultants contributed to these efforts. A list of contributors is provided in **Appendix 1**.

The Escalante River begins on the Aquarius Plateau, with the headwaters on Boulder Mountain and flows southeast into the Colorado River at Lake Powell. The river changes in character as it flows through the different physiographic regions – the Colorado Plateau, Canyonlands and the Southern High Plateaus. The headwaters are in coniferous forests, such as ponderosa pine and Douglas fir. The conifer forest transitions into the pinyon pine and juniper zone, followed by the sagebrush, and shadscale zones. Although the main stem of the Escalante River begins northwest of the town of Escalante, most of the flow comes from its side tributaries such as Pine Creek, Death Hollow, and Calf Creek. Below town the Escalante River enters the Bureau of Land Management (BLM)-administered Grand Staircase-Escalante National Monument (GSENM) established in 1996.

Utah's Year 2002 303(d) list (DWQ, 2002) identifies the Upper Escalante River as being impaired due to exceedence of Utah's temperature criteria for cold water species of game fish and other aquatic life (beneficial use category 3A).

Section 1 of the Water Quality Management Plan provides background on the Environmental Protection Agency (EPA) Total Maximum Daily Load (TMDL) process, Utah's watershed management approach, and describes the characteristics of the watershed. **Section 2** describes the water quality criteria that apply to the TMDL. **Section 3** evaluates impairment by evaluating the water quality, water quantity, and temperature data. **Section 4** describes the use attainability analysis (UAA). **Section 5** describes the project implementation plans and best management practices (BMPs) to attain the water quality goals and targets, and describes a monitoring plan to evaluate implementation and effectiveness. **Section 6** addresses the implications of future land use on water quality and the implementation of management practices. Conclusions and recommendations are presented in **Section 7**. **Section 8** is a comprehensive list of references cited in this document.

All maps are provided in **Appendix 2**. **Appendices 3 through 6** provide supporting data on water quality, flow conditions, and climate. **Appendix 7** lists acronyms used in the document. Review comments and responses are provided in **Appendix 8**.

1.2 The TMDL Process

Water quality standards are set by States, Territories, and Tribes. They identify the scientific criteria to support a water body's beneficial uses such as for drinking water supply, contact recreation (swimming), aquatic wildlife, and agricultural uses (including irrigation of crops and stock watering). A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards (EPA, 1999). The Clean Water Act, Section 303(d), establishes the TMDL program. As part of the TMDL process, the maximum amount of the pollutant of concern that a water body can contain and still support its beneficial uses is allocated to its contributing sources. Therefore, a TMDL is the sum of the allowable loads of the pollutant of concern from all contributing point and nonpoint sources. The calculation must include a margin of safety to account for future growth and changes in land use, uncertainties in data collection, analysis, and interpretation.

Section 303(d) and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130), requires that States report water bodies (i.e., lakes, reservoirs, rivers, and streams) that currently do not support their designated beneficial use(s). EPA regulations require that each State submit a prioritized list of water bodies to be targeted for improvement to EPA every two years. These regulations also require States to develop TMDLs for those targeted water bodies. Thus, those water bodies that are not currently achieving, or are not expected to achieve, applicable water quality standards are identified as water quality limited. Water bodies can be water quality limited due to point sources of pollution and nonpoint sources of pollution. Pollutants that can cause use impairment include heavy metals, pathogens and nutrients for which there are numeric standards. In addition to pollutants, impairments may originate from sources such as habitat alteration or hydrologic modification that have associated narrative standards (DWQ, 2002). Section 303(d)(1)(A) and the implementing regulations (40 CFR 130.7(b)) provide States with latitude to determine their own priorities for developing and implementing TMDLs.

Once a water body is identified as water quality limited, the State, Tribe, or EPA is required to determine the source(s) of the pollutant and to allocate the responsibility for controlling it. The goal of the TMDL is reduction in pollutant loading necessary for a water body to meet water quality standards and support its beneficial uses. This process determines: 1) the amount of a specific pollutant that a water body can receive without exceeding its water quality standard or impair a beneficial use; 2) the allocation of the load to point and nonpoint sources; and 3) a margin of safety. While the term TMDL implies that the target load (loading capacity) is determined on a daily time scale, TMDLs can range from meeting an instantaneous concentration (e.g., an acute standard) to computing an acceptable annual load to a water body (DWQ, 2002).

The Escalante River is listed on Utah's 2002 303d list (DWQ, 2002) for waters requiring the development of a TMDL due to the exceedences of the coldwater fishery temperature criteria for beneficial use 3A. Cooperative monitoring by DWQ and BLM have identified several monitoring stations where temperature exceeded State criteria. Therefore, DWQ prompted this TMDL to identify and quantify sources contributing to temperature increase in the Escalante River watershed.

1.3 Utah's Watershed Approach

Utah's watershed approach is aimed at improving and protecting the State's surface and groundwater resources. Characteristics of the approach include a high level of stakeholder involvement, water quality monitoring and information gathering, problem targeting and prioritization, and integrated solutions that make use of multiple agencies and groups. Federal and state regulations appoint DWQ with the task of preventing, controlling, and abating water pollution. Other state and local agencies have associated responsibilities. Utah's watershed approach is to form partnerships with accountable government agencies and interested groups to combine resources and increase the effectiveness of existing programs.

Throughout the State of Utah a series of ten nested management units provide spatial focus to watershed management activities, thereby improving coordination. Watershed management units in the State may contain more than one stream system, or watershed, defined as the entire area drained by a stream and its tributaries. Delineated watershed units are consistent with the hydrologic basins defined by the Utah Department of Natural Resources - Division of Water Resources for the State Water Plan project (Utah Division of Water Resources, 1990). The watershed management units provide boundaries for evaluating the impact of various stressors on commonly shared resources, provide boundaries for evaluating the impacts of management actions, and provide a better perspective for DWQ and stakeholders to determine environmental objectives and to develop management strategies that account for local and regional considerations.

Each watershed plan will establish management actions at several spatial scales ranging from the watershed scale to specific sites that are influenced by unique environmental conditions. Watershed plans consider a holistic approach to watershed management in which groundwater hydrologic basins and eco-regions encompassed within the units are considered. The goal of Utah's watershed approach is better coordination and integration of the State's existing resources and water quality management programs to improve protection for surface and groundwater resources. Better coordination and integration extends beyond the tiers of government agencies to include all stakeholders in the watershed.

Utah’s watershed approach is based on hydrologically defined watershed boundaries and aims to de-emphasize jurisdictional delineations in watershed management efforts. This approach is expected to accelerate improvements in water quality as a result of increased coordination and sharing of resources. Statewide watershed management is not a new regulatory program, it is a means of operating within existing regulatory and non-regulatory programs to more efficiently and effectively protect, enhance, and restore aquatic resources. The Statewide watershed management approach has been introduced to establish a framework to integrate existing programs and coordinate management activities geographically (DWQ, 2000c).

In addition to the technical components, Utah’s watershed approach is dependant on the critical role stakeholders play in watershed water quality management. The success of the implementation plan, and ultimately the restoration of water quality, depends on the voluntary participation of the stakeholders in Utah's watersheds. Therefore, to be successful, the TMDL development approach must ensure public participation and input at critical points throughout the process.

A successful water quality management plan and TMDL relies as much on voluntary stakeholder participation and buy-in as on the rigor of technical analysis. The advantages of involving stakeholders throughout the TMDL development and implementation process are numerous. Through their voluntary participation, the stakeholders can become more comfortable that the monitoring and modeling programs generate reliable data that are scientifically defensible. Further, effluent limits and Best Management Plans (BMPs) developed by the Stakeholders are less prone to credibility challenges and litigation. Stakeholders are more apt to agree to pollutant reduction or habitat improvement schemes that they helped to formulate.

The boundaries of watershed management units in Utah were drawn so that stakeholders would be aggregated or grouped into areas sharing common environmental characteristics. Defining watershed management units in this way is intended to encourage a sense of ownership in the resident stakeholders and to encourage involvement in stewardship activities. Based on a model successfully used by other states, the program draws on the expertise of those involved in or affected by water quality management decisions. These stakeholders help gather information and design BMPs, then become involved in stewardship activities.

In the Escalante River watershed, both governmental and non-governmental entities worked to achieve a skillful and honest presentation of technical information to the Canyonlands Soil Conservation District and Technical Advisory Committee throughout this TMDL study. These efforts have resulted in a Water Quality Management Plan that assures controls of nonpoint source pollution that are acceptable to those living and working in the watershed.

1.4 Watershed Characterization

1.4.1 Location and Population

The Escalante River is located in Garfield and Kane Counties in southern Utah (Figure 1-1). The 303(d) listed section ("Listed Section") begins at the confluence of Birch Creek and North Creek and ends at the confluence with Boulder Creek.

The Listed Section of the Escalante River is located in Garfield County with two dispersed population centers in the watershed. The town of Escalante, population 800, on the western side of the basin, supports agriculture and tourism. The town of Boulder (population 180) on the eastern side is a ranching community that also provides tourist services. Garfield County had the fifth smallest population in the State of Utah in 2002 (4,599), and is the least densely populated[1]. The county's average annual growth rate from 1990-2000 was 1.8%; while the state averaged 2.7%. Total nonagricultural employment totaled 2,129 in 2001 in Garfield County. Services accounted for the greatest share of nonagricultural employment at 45.2% and government accounted for 28.7% of Garfield County's 2001 employment. Growth in tourism-related industries is expected to continue at a more accelerated pace because of the designation in 1996 of the Grand Staircase-Escalante National Monument. Agriculture and trade were also important. Garfield County had 121,381 acres of private land on 285 farms; 116 were full-time farms (1997). The market value of agricultural products sold was $7.6 million in 1997; crop sales accounted for 18% of agricultural products and livestock sales for 82%. Cattle, hay, dairy products, and sheep are all significant agricultural products of the county. There are 3,330,924 acres in Garfield County. Of that amount, 90% is federally owned, while 5.4% is state owned. The remaining land in Garfield is privately owned, owned by municipal organizations, or state sovereign lands.

[1] County Economic Profiles. Governor's Office of Planning and Budget, Demographic and Economic Analysis. http://governor.utah.gov/dea/WrittenProfiles.PDF

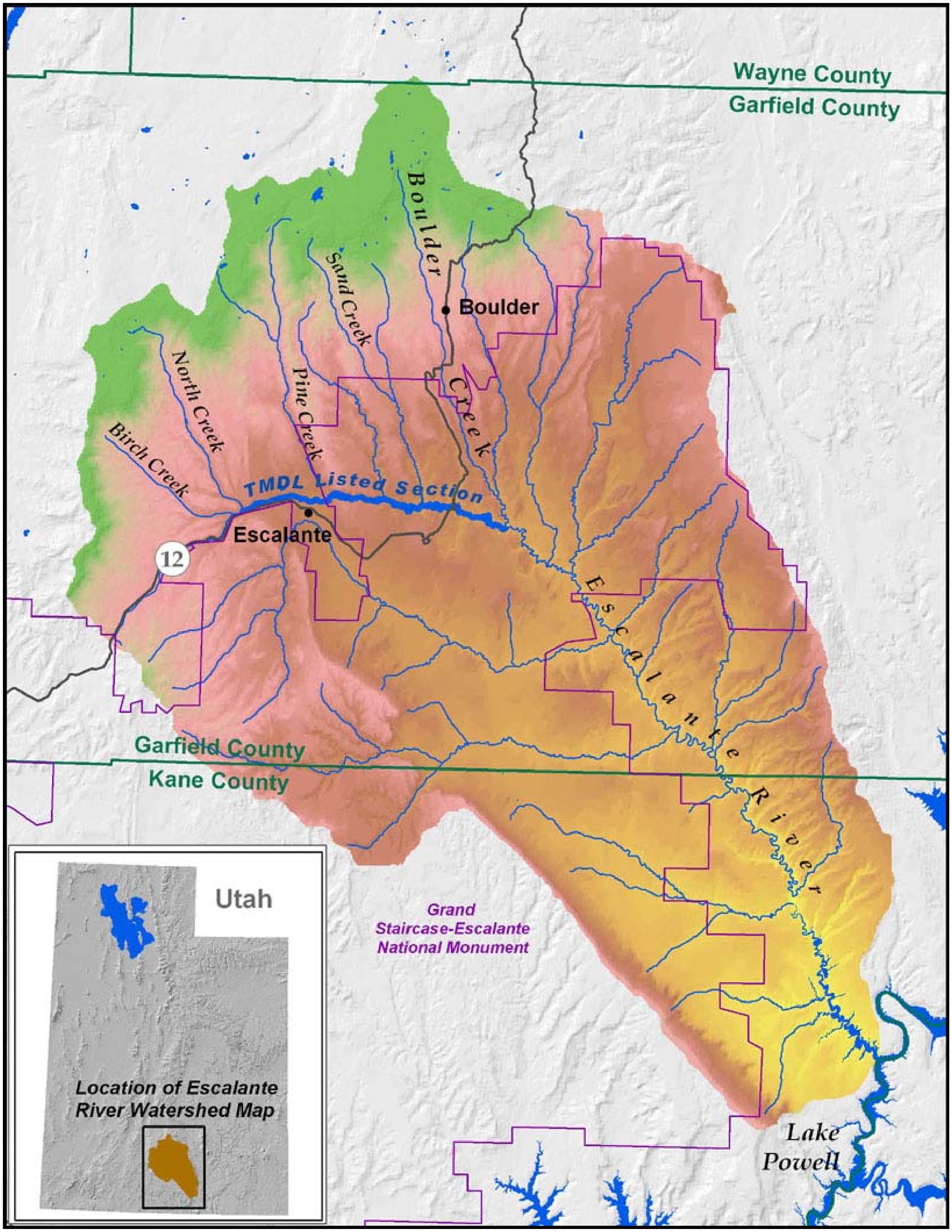

Figure 1-1 Location of the Escalante River

1.4.2 Surface Water Hydrology

Precipitation is highly variable across the Escalante watershed with the highest precipitation occurring in the upland mountains (12 to 16 inches/year) and the lowest in the lowland desert (6 to 8 inches/year). The higher elevations in the watershed receive the majority of precipitation as snow that melts during the spring; otherwise most of the precipitation occurs during the rainy season particularly in the late summer and fall.

Map 1 shows the primary stream network. A continuous dark blue line is not intended to indicate a perennial stream. Many of the stream courses in the study area are indicated as intermittent on 1:24,000 USGS topographic maps. The primary tributaries that influence flows in the study reach are Birch Creek, North Creek, Pine Creek, Death Hollow (and tributary Mamie Creek), Sand Creek, and Calf Creek. Watershed area and elevation are summarized in Table 1-1. Map 2 shows general topography with elevation ranges for the Escalante watershed. The upper watershed streams North Creek and Birch Creek are diverted for irrigation which results in dry stream reaches during most years. Pine Creek is also diverted for irrigation; however, the long-term stream gage on Pine Creek shows fewer periods when the stream is dried up completely.

Table 1-1
Watershed Characteristics within the Escalante Study Area

Watershed	Stream Miles	Area (mi^2)	Elevation (ft)		
			Mean	Min	Max
Birch Creek	13.0	45.7	8,095	6,107	10,594
North Creek	17.2	92.1	8,259	6,075	10,768
Pine Creek	24.3	97.9	8,712	5,688	11,178
Death Hollow (Mamie Cr.)	30.5	46.3	6,996	5,412	10,034
Sand Creek	26.2	44.7	7,636	5,278	11,083
Sweetwater Creek	11.1	30.5	7,738	6,222	11,014
Calf Creek	8.8	9.5	6,107	5,235	6,836
Total	131.1	366.7			

Notes to Table:
1. Stream miles measure the length of the primary channel, not all the potential tributary streams and washes within the subwatershed are measured.
2. We have applied the convention of using the larger watershed area to identify the tributary to the Escalante River formed by Mamie Creek and Death Hollow. Mamie Creek comprises 6.5 stream miles and Death Hollow, 24 miles, for a combined total of 30.5 miles.
3. One square mile equals 640 acres.

The streams that drain from the north off of the Aquarius Plateau – Pine, Death Hollow, Sand, and Calf Creek – are reported to be perennial streams although there are no long term stream gages in these sub-watersheds. Flows in Sand Creek and Calf Creek are enhanced by spring activity and have flows year round.

Two USGS stream flow gages are located within the study area, one on Pine Creek near Escalante (09337000), and the second at the Escalante River near Escalante, Utah (09337500). The annual hydrograph for the Escalante River near Escalante gage (Figure 1-2) shows the peak flows occur in May with the melting of the snow pack. After the peak runoff the flows return to a consistent base flow of approximately ten cubic feet per second (cfs). Low flow data are analyzed further in Section 3.3.

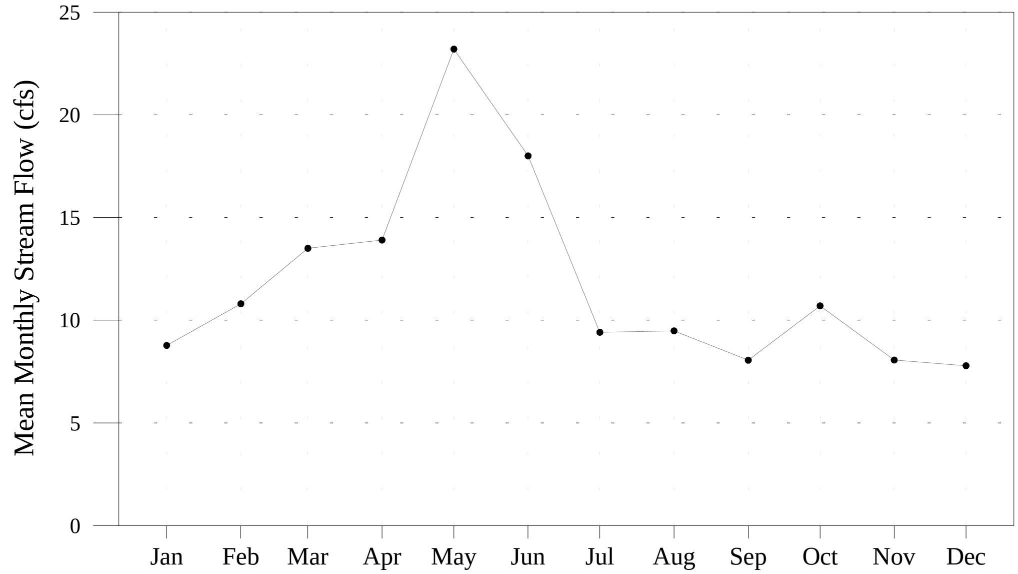

Figure 1-2 Annual Hydrograph at Escalante River near Escalante, Utah[2]

1.4.3 Land Use/Ownership and Land Cover

Land ownership patterns are shown in Map 4, and summarized in Table 1-2. In the upper parts of the watershed the land is managed by the Dixie National Forest. The Box-Death Hollow Wilderness Area occurs within the watershed approximately between Pine Creek to the west and Sand Creek to the east. The dominant land ownership along the Escalante River corridor is the Grand Staircase-Escalante National Monument (GSENM) managed by the Bureau of Land Management (BLM). The monument boundary excludes the private lands in the town of Escalante and the private lands within the Escalante valley upstream of the town to the upper boundary of the study area. Private agricultural lands are used primarily for pasture, hay and livestock grazing. As shown on Map 4, private lands occur primarily within the vicinity of the town of Escalante. The other population center is the community of Boulder located in the upper watershed along Boulder Creek.

Table 1-2
Landownership Patterns in the Escalante Study Area

Watershed	**Land Ownership Area (acres)**					
	BLM	**USFS**	**FS Wilderness**	**Utah**	**Private**	**Total**
Birch Creek	3,777	25,170		52	258	29,257
North Creek	9,515	47,897		1,316	147	58,875
Pine Creek	5,629	49,615	6,437	37	541	62,259
Death Hollow (Mamie Creek)	13,731	2,281	13,612			29,624
Sand Creek	13,343	11,322	3,930			28,595
Sweetwater Creek	800	16,790	1,121		761	19,473
Calf Creek	6,089	18				6,107
Total	52,884	153,094	25,100	1,405	1,707	

[2] Data from USGS Water Resources for years 1911-1912, 1943-1955, and 1971-2004. Gage 09337500. (http://nwis.waterdata.usgs.gov/ut/nwis/monthly/?site_no=09337500&agency_cd=USGS)

1.4.4 Vegetation Characteristics

The Escalante River occurs within the Escalante Canyon physiographic region. The Canyons of the Escalante consist of a maze of twisting, meandering, and interconnecting canyons of Jurassic sandstone that have been slowly carved over the centuries by the Escalante River and its tributaries. The riparian areas along the Escalante River serve as migration corridors for neotropical birds, and are habitat for many relict plant communities which have evolved in these canyons.

The composition of the native vegetation communities is influenced by the steep canyons, limited water, large fluctuations in climate, and seasonal flood events. Map 3 shows the vegetation patterns as identified by the Utah GAP vegetation analysis. GAP refers to a process to identify "gaps" in protection of high biodiversity areas for wildlife species. The resulting vegetation layers are mapped at a comparatively broad scale. Consequently, Map 3 primarily identifies adjacent upland vegetation communities, such as juniper and pinyon pine, but does not map the finer scale riparian communities that influence overhead canopy cover and shade. The riparian community is dominated by native willows and cottonwood, but also includes box elder and invasive tamarisk and Russian olive trees.

1.4.5 Climate

The Escalante watershed is prone to sudden changes in weather especially in higher elevations. The wet period occurs from July to September with thunderstorms and flash floods. Summer temperatures regularly exceed 100 degrees Fahrenheit.

Annual precipitation varies from about 6 inches at the lowest elevations up to approximately 25 inches at the highest elevations. The variation in elevation and precipitation produce three different climate zones: upland, semi-desert, and desert. At the highest elevations, precipitation falls primarily in the winter. The majority of rainfall in the semi-desert areas occurs during the summer months.

The Western Regional Climate Center operated by the Desert Research Institute (Reno, Nevada) acts as a clearinghouse for the National Climatic Data Center. The weather station at the town of Escalante, Utah is the closest long term climate station. The average monthly temperatures and average total precipitation for the 29-year period is shown in Table 1-3. The months of June, July and August are the warmest months during the year with average maximum temperatures between 85 – 90 degrees Fahrenheit. This three month period is when water temperatures would be expected to peak during the year. The higher precipitation in August and September is due to the monsoon-type weather that influences climate in southern Utah.

Table 1-3
Monthly Climate Summaries for Escalante Utah Station 1971 to 2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	42	48	56	64	74	85	90	87	79	67	51	43	65.9
Average Min. Temperature (F)	16	22	28	33	41	48	55	53	46	36	25	18	35.1
Average Total Precipitation (in.)	0.9	0.9	0.8	0.6	0.6	0.4	0.9	1.4	1.2	1.1	0.8	0.6	10.02

1.4.6 Hydrogeology

Hydrogeology refers to the occurrence and movement of water below the Earth's surface. The primary source of available information on the hydrogeology of the Escalante River is the recently completed study by USGS (Wilberg and Stolp, 2003 Draft) that evaluates seepage and summarizes past observations. This study concluded that 15 reaches along the Escalante River neither had measurable gains or losses along the 86 miles studied. The Listed Section of the Escalante River was included in the study. Additional miscellaneous water quality and flow observations compiled in this report do not identify any significant spring flows into the Listed Section of the Escalante River. The springs referred to in the USGS report title all occur below the Calf Creek/Boulder Creek area.

From this preliminary assessment of hydrogeologic information, it appears that spring sources are not a significant contributor to the Escalante River until the confluence with Calf Creek.

1.4.7 Fisheries Information

Non-native and native trout (salmonid species) occur in the Escalante River drainage. Information on the current and historical distribution of these cold water species is useful in evaluating the degree to which the cold water beneficial use (Class 3A) is an appropriate use designation for the Escalante River drainage. A useful summary of salmonid fish distribution is provided in the publication by D. Hepworth, M. Ottenbacher, and C. Chamberlain (2001), biologists with the Utah Division of Wildlife Resources. The following information is summarized from their publication.

Little information on the historic distribution of native Colorado River cutthroat trout (Oncorhynchus clarki pleuriticus) in the Escalante River drainage was available prior to the 1990's. The discovery of Colorado River cutthroat trout in East Boulder Creek, a tributary to the Escalante River, in 1990 led to the speculation that the historic distribution of these native salmonids could have extended as far south as the Escalante River drainage. In 1997 and 1998 the Utah Division of Wildlife Resources biologists conducted field surveys throughout the drainage in search of Colorado River cutthroat trout populations. At the same time, they collected information on the distribution of other native and non-native fish species.

The 1997/1998 surveys discovered five remnant populations of Colorado River cutthroat trout in the 17 headwater streams evaluated. The survey also established the distribution of non-native trout species - brook trout, rainbow trout, brown trout, and non-native cutthroat trout in the upper Escalante River drainage. The Colorado River cutthroat trout occur only at higher elevations in the drainage: - the East Fork and West Forks of Boulder Creek, West Branch Pine Creek, White Creek, and Water Canyon (Figure 1-3). Non-native salmonids, such as rainbow trout, generally also occur at the higher elevations, as well as in the lower reaches of spring-fed tributaries to the Escalante River, specifically Death Hollow, Sand Creek, Calf Creek, and Boulder Creek.

Trout have been stocked in various locations in the watershed beginning in the 1960's. Utah Division of Wildlife Resources surveys in the 1960's and 1970's found Calf Creek, lower Boulder Creek, and lower Deer Creek void of trout. The biologists noted that these streams (and Death Hollow) are in narrow sandstone canyons, which experience frequent flash floods and high summer water temperatures. Brown trout have survived in these streams since the 1980's, but such locations are unlikely historic year-round habitat for native salmonids.

The Utah Division of Wildlife Resource biologists describe the main Escalante River as providing seasonal fish passage, but not as year-round habitat. Note that the Escalante River is mapped as <u>"Non-trout habitat or intermittent"</u> in Figure 1-3. Brown trout were stocked in Calf Creek in 1967. "From Calf Creek brown trout evidently invaded lower portions of Death Hollow, Sand, Boulder, and Deer Creek using the Escalante River for access. During extended periods of low flow and clear water, we found brown trout relatively common in the upper reaches of the river, although it does not provide year-round trout habitat" (Hepworth, et al., 2001).

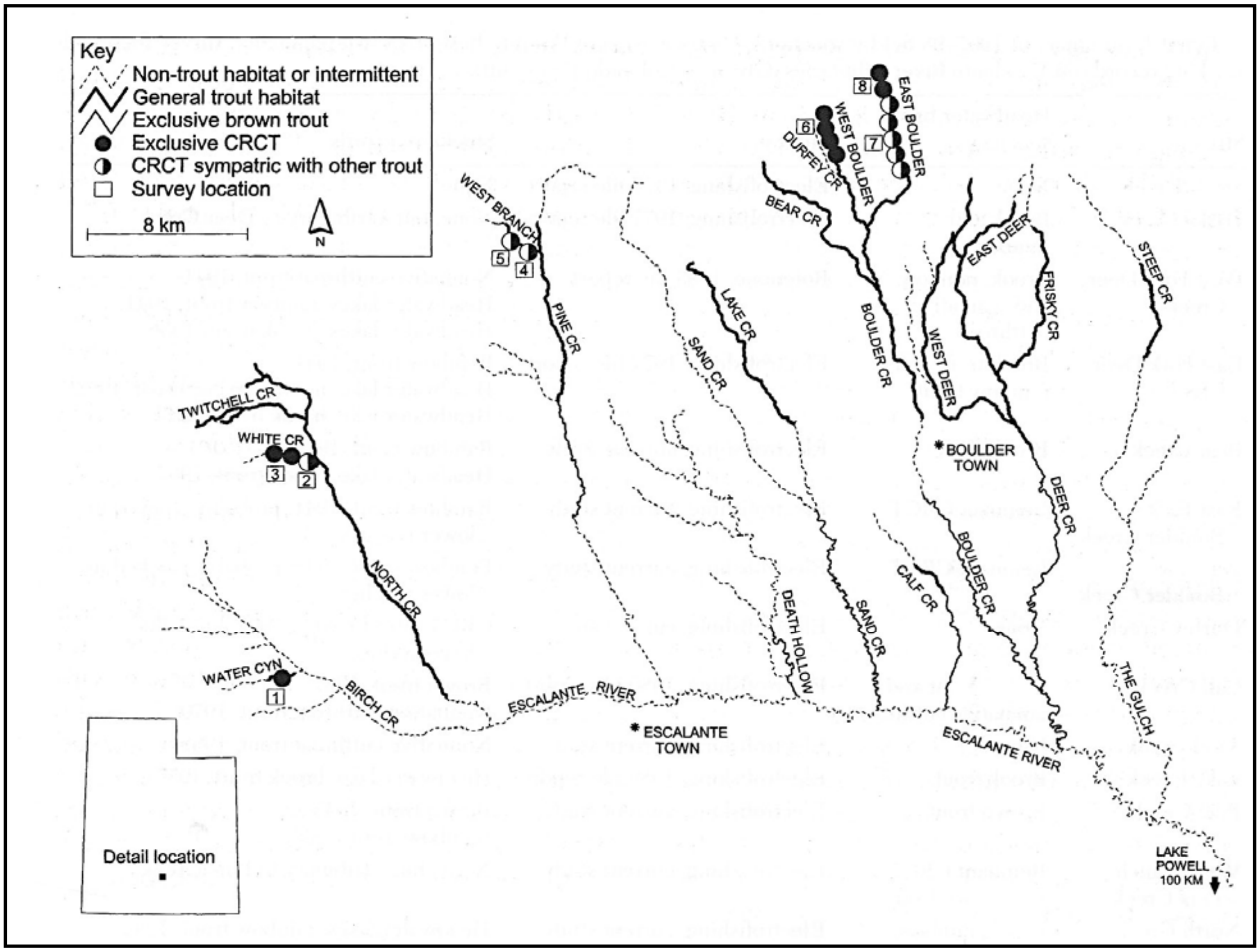

Figure 1-3 Trout Habitat and Distribution of Colorado River Cutthroat Trout in the Upper Escalante River Drainage (from Hepworth, et al., 2001)

2.0 WATER QUALITY CRITERIA

2.1 Beneficial Uses and 303(d) Listed Section

The Utah Water Quality Standards groups waters of the state into classes by beneficial use designation. The Escalante River and its tributaries from the confluence with Boulder Creek, including Boulder Creek, to headwaters are identified as having the following beneficial uses: 2B-secondary contact recreation, 3A-coldwater fishery, and 4-agriculture (Standards of Quality for Waters of the State §R317-2, UAC). A description of these beneficial uses is provided below.

Class 2B - Protected for secondary contact recreation such as boating, wading, or similar uses.

Class 3A - Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Class 4 - Protected for agricultural uses including irrigation of crops and stock watering.

The Escalante River is listed on Utah's 2002 303d list (DWQ, 2002) as waters requiring the development of a TMDL due to the exceedences of the coldwater fishery temperature criteria for beneficial use 3A. The listed section of the Escalante River is described in Utah's Year 2002 303d list as "Escalante River from Boulder Creek confluence to North Creek and Birch Creek confluence" (Table 2-1).

Table 2-1
303(d) Listed Section of the Escalante River

Water body ID	Water body Name	Water body Description	HUC Unit	Beneficial Use Class	Perennial Stream Miles	Cause
UT14070005-012	Upper Escalante	Escalante River from Boulder Creek confluence to North Creek and Birch Creek confluence.	14070005	3A	26.86	Temp

The 303(d) listed section, watershed boundary, and other descriptive features are illustrated on Map 1.

2.2 Water Quality Standards

Utah's Standards of Quality for Waters of the State (§R317-2, UAC) establishes numeric criteria for beneficial use 3A (cold water game fish) including; pH, dissolved oxygen, and temperature. The temperature criterion for cold water game fish is a maximum of 20 degrees Celsius.

Additional criteria are used to determine the degree of beneficial use support. Utah's 2002 303d list (DWQ, 2002) provides guidance on how to apply the numeric water quality criteria for determining the degree of beneficial use support. These criteria are used to evaluate the listing and delisting of a water body. The 303(d) criterion for assessing the degree of support for beneficial use Class 3A is provided in Table 2-2.

Table 2-2
303(d) Criteria for Assessing Aquatic Life - Beneficial Support Class 3A

Degree of Use Support	Conventional Parameters (pH, DO, Temperature)
Full Support	For any one pollutant, no more than one exceedence of a criterion or criterion exceeded in <10% of the samples, if there were two or more exceedences.
Partial Support	For any one pollutant, criterion was exceeded two times, and criterion was exceeded in more than 10% but not more than 25% of the samples.
Non-Support	For any one pollutant, criterion was exceeded two times, and criterion was exceeded in more than 25% of the samples.

3.0 IMPAIRMENT ANALYSIS

3.1 Geographic Extent of the Water Quality Management Plan

This Water Quality Management Plan addresses the 303(d) listed section of the Escalante River. This river section is defined in the 303(d) listing and was further clarified by the DWQ Project Manager. Specifically, the geographical extent of the 303(d) listed section for this TMDL and water quality study includes:

> The main stem of the Escalante River from the Boulder Creek confluence to North Creek and Birch Creek confluence. The lower end of the 303(d) listed section is bounded by, but does not include Boulder Creek. The last STORET monitoring station on the Escalante River within the 303(d) listed section is station 495420 "Escalante River below confl/Calf Creek". The upper boundary is the confluence of North Creek and Birch Creek. The STORET station at the upper end of the 303(d) listed section is station 495466 "Escalante R 3.5 mi W of Town at Weir Gage".

The 303(d) listed section (the "Listed Section") of the upper Escalante River for the TMDL and WQMP is shown on Map 1. The STORET stations discussed above are shown on Map 5.

The primary tributaries within the listed section occur on the north side of the Escalante River; these include (from upstream to downstream) North Creek, Pine Creek, Death Hollow, Sand Creek, and Calf Creek. The tributaries are evaluated as potential contributors of warmer (or cooler) water to the listed section, but are not part of the TMDL study or this WQMP.

Addressing the seasonality of pollutant loading is a required component of a TMDL study. For the Escalante River, exceedence of the water temperature criteria occurs between mid-April and mid-October, with the primary period from June through September (see climate data in Section 1).

3.2 Water Quality and Flow Data

3.2.1 Water Quality Data in STORET

The most complete water quality monitoring station summaries and water quality observation data for the Escalante River exist in the STORET database. STORET, short for STOrage and RETrieval, is a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. Each data entry in the STORET database is accompanied by information on where the sample was taken (latitude, longitude, state, county, Hydrologic Unit Code, and a brief site identification), when the sample was gathered, the medium sampled (e.g., water, sediment, fish tissue), and the name of the organization that sponsored the monitoring.

The EPA STORET database for the upper Escalante River contains 33 stations. Of these 33 stations, 14 stations occur within the Listed Section or on tributaries within 1 to 2 miles of the Escalante River. One station (595387 " Confluence from Escalante River above Wide Hollow Reservoir") contains only one observation and is therefore excluded from further assessment. Table 3-1 provides a summary of the available temperature data for the 13 remaining stations.

Table 3-1
Available Water Temperature Data from STORET Stations within or Near the Listed Section

STORET	Description	No. of Temperature Measurements	Begin Date	End Date	No. of Temperature Measurements 1993-2002	Comment Regarding Application to TMDL
495463	North Creek Above Confluence with Escalante River	21	07/30/97	12/30/02	21	Upstream comparison (outside Listed Section)
495466	Escalante River 3.5 miles West of Town At Weir Gage	31	07/11/80	12/30/02	26	Applicable
495465	*Escalante River Northeast of Escalante At River Ford*	*8*	*07/11/80*	*05/11/82*	*0*	*Out-of-Date*
495459	Pine Creek Below the Box at USGS Station	18	11/26/96	06/19/01	18	Upstream comparison (outside Listed Section)
495464	*Escalante River Below Confluence with Pine Creek*	*8*	*03/10/82*	*09/11/84*	*0*	*Out-of-Date*
599404	Death Hollow Above Confluence with Escalante River	3	10/05/98	09/22/00	3	Low Sample Size
599400	Sand Creek Above Confluence with Escalante River	6	09/23/98	11/26/00	6	Low Sample Size
495424	Escalante River Above Confluence with Calf Creek	120	04/19/79	12/30/02	50	Applicable
599406	*Calf Creek Above Upper Falls*	*5*	*07/29/98*	*10/15/00*	*5*	*Outside TMDL Section*
599407	*Calf Creek Below Lower Falls*	*5*	*07/27/98*	*10/14/00*	*5*	*Outside TMDL Section*
495426	*Calf Creek Above Campground*	*7*	*04/29/92*	*04/04/01*	*2*	*Outside TMDL Section*
495421	Calf Creek Above Confluence with Escalante River	115	04/19/79	12/30/02	44	Tributary to Listed Section (outside Listed Section)
495420	*Escalante River Below Confluence with Calf Creek*	*18*	*02/05/76*	*07/13/78*	*0*	*Out-of-Date*

Note to Table: The italicized text indicates stations that are not useful to the TMDL because the data are out dated or the station is outside the TMDL Listed Section.

The last ten year period (1993 – 2002) is used to illustrate the number of samples occurring within a recent timeframe. The comment column of Table 3-1 provides an initial characterization of the data applicable to the TMDL assessment. Temperature data at three STORET stations were collected in the 1980's - precluding comparison to other stations. These stations are identified as "Out-of-Date". In addition, three STORET stations are outside the Listed Section. When the stations that are "Out-of-Date" and are outside the Listed Section are filtered out, seven stations remain that are useful to the TMDL analysis. Of these seven stations, two stations (599404 and 599400) have a very low sample size and are therefore minimally useful, but retained. The seven remaining stations are listed in Table 3-2 and their locations are shown on Map 5.

Table 3-2
Applicable Water Temperature Data from STORET Stations Within or Near the Listed Section

STORET	Description	No. of Temperature Measurements 1993-2002	No. of Temperature Measurements that Exceed 20°C	Maximum Temperature Measurement (°C)	Comments
495463	North Creek Above Confluence with Escalante River	21	2	22.3	Upstream comparison (outside Listed Section)
495466	Escalante River 3.5 miles West of Town At Weir Gage	26	6	27.2	Escalante River Station
495459	Pine Creek Below the Box at USGS Station	18	2	24.1	Upstream comparison (outside Listed Section)
599404	Death Hollow Above Confluence with Escalante River	3	1	24.2	Tributary to Listed Section
599400	Sand Creek Above Confluence with Escalante River	6	0	18.6	Tributary to Listed Section
495424	Escalante River Above Confluence with Calf Creek	50	8	27.9	Escalante River Station
495421	Calf Creek Above Confluence with Escalante River	44	5	25.6	Tributary to Listed Section

Applicability of the STORET Temperature Data Set for the TMDL

Temperature data in the STORET database was collected as part of a general water quality monitoring program and not specifically to evaluate exceedence of temperature criteria. As such, the data were collected at times of the day dictated by efforts to collect water chemistry samples, not necessarily at optimal periods for monitoring temperature. To evaluate compliance with or exceedence of water quality criteria, temperature observations need to occur during the warmest part of the day. The most efficient and accurate method for collecting these data is the use of continuous temperature sensors. The use of continuous temperature sensors is the minimum standard operating procedure for evaluating compliance or exceedence of water quality criteria.

Observations on the usefulness of the STORET data for the Escalante TMDL are listed below:

- Water temperature data in the STORET database has limited application for identifying exceedences of water quality standards. The available STORET data cannot be used to identify river reaches that should be evaluated further due to the data collection methods described above. Therefore, the statistics in Appendix 3 are only presented for describing the data set, and are not intended for interpretive purposes.
- Temperature measurements in the STORET database cannot be used to provide reliable comparison to water quality criteria since temperature data were not collected to target the maximum daily temperature or the critical season.
- The STORET database cannot reliably be used to confirm listing or recommend delisting of the Listed Section.

For these reasons, a monitoring plan was developed in 2003 to install continuous temperature sensors. This monitoring plan is presented in Appendix 4. A one-season temperature monitoring effort has limitations, but is useful for providing a representative comparison among stations within the same time period. The relative difference between stations is expected to be constant from year-to-year, even if the magnitude of temperature varies due to normal annual climatic fluctuations. The monitoring effort targeted the known critical period for temperature and the resulting temperature observations provide a measure of the potential for supporting cold water biota. The data from the temperature monitoring study in 2003 will be the primary data source for the TMDL analysis. The data described above in the STORET database will not be analyzed further.

3.2.2 USGS Flow Data

There are two USGS stream gaging stations located within the Listed Section: one on Pine Creek near the town of Escalante (USGS Gage No. 09337000); and the second on the Escalante River below Pine Creek (USGS Gage No. 09337500). These stations are summarized in Table 3-3 and their locations are shown on Map 5. The USGS gaging station number, name, and period of data coverage are summarized in Appendix 5.

Table 3-3
USGS Gaging Stations in the Escalante Study Area

USGS Gage Station No.	USGS Gage Name	Data Coverage
09337000	Pine Creek Near Escalante, UT	Aug 1950 to Present
09337500	Escalante River Near Escalante, UT	Jan. 1911 to Dec. 1912 Oct. 1942 to Sept. 1955 Dec. 1971 to Present

The gage on Pine Creek (09337000) is located at an elevation of 730 feet above the Escalante River and provides a long term record of flows. The gage on the Escalante River near Escalante (09337500) provides a long-term record of flows entering the middle of the Listed Section. The annual and monthly stream flow summaries for these gaging stations are provided in Appendix 5.

There are no other continuous stream flow records for the rest of the upper Escalante River or its tributaries. Therefore, the TMDL study will rely on other information to provide an understanding of the flow regime.

3.3 Water Quality Analysis

3.3.1 Summary of Water Temperature Data Collected in 2003

The temperature monitoring plan (included as Appendix 4) was implemented during the 2003 summer as a joint effort between Millennium Science and Engineering (MSE), DWQ, and BLM. The team consisted of Carl Adams (DWQ), MSE Team members John Christensen and Steve Bauer (Pocket Water Inc.), and Joni Vanderbuilt and James Holland (BLM).

The following is a brief summary of the temperature monitoring plan described in Appendix 4. Temperature monitoring stations were selected for sensor placement based on location of tributaries and assessment of existing data. Thirteen stations were selected for water temperature monitoring with additional sensors for air temperature and duplicate monitoring. "Onset" brand (http://www.onsetcomp.com) continuous temperature sensors were used and calibrated prior to going into the field.

Temperature sensors were placed at selected stations between July 8 and July 10, 2003, and were retrieved between October 6 and October 7, 2003. Of the thirteen planned stations, eight sensors were retrieved with sufficient data quality. Several sensors were washed away during flash flooding and several sensors were left dry by low flow conditions preventing use of data from these sites. The water temperature sensors retrieved with acceptable data quality are listed in Table 3-4. Temperature profiles for the stations listed below are provided in Appendix 4.

Table 3-4
2003 Temperature Monitoring Stations with Acceptable Data Quality

2003 Station ID[1]	STORET Station ID	Station Name	Begin Date	End Date	Days Measured
1	none	Escalante River Below North Creek	7/8/2003	10/7/2003	92
2	495459	Pine Creek at USGS Station 09337000	7/10/2003	10/6/2003	89
3	none	Pine Creek Above Escalante	7/8/2003	10/6/2003	39[2]
4	495464	Escalante River Below Pine Creek	7/8/2003	10/6/2003	91
8	none	Escalante River Above Sand Creek	7/8/2003	10/6/2003	91
9	599400	Sand Creek Above Escalante	7/8/2003	10/6/2003	39[2]
10	none	Escalante River Below Sand Creek	7/8/2003	10/6/2003	91
11	495424	Escalante River Above Calf Creek	7/9/2003	10/6/2003	90
12	495421	Calf Creek Above Escalante River	7/8/2003	10/6/2003	90
13	495420	Escalante River Below Calf Creek	7/8/2003	10/6/2003	91

1 Locations shown on map 5.

2 Temperature plot indicates the sensor was dewatered starting 8/16/2003.

Two stations illustrate the temperature series and different conditions that likely influence temperature regimes in the Escalante River stream channel. These stations are "Escalante River below North Creek" and "Escalante River below Sand Creek".

Water temperature data for the station "Escalante River below North Creek" (Figure 3-1) shows a wide range of temperature fluctuations, and the daily maximum temperatures regularly exceed 20 degrees Celsius. The Escalante river channel at this location has limited riparian canopy and very low flows during this time of the year.

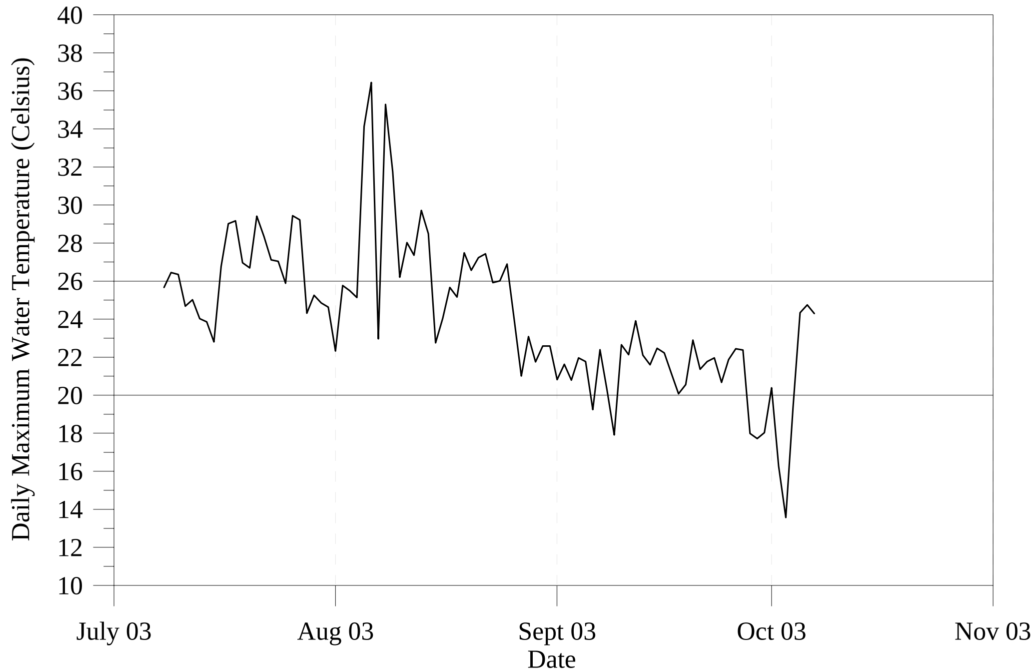

Figure 3-1 Water Temperature for Escalante River below North Creek, Summer 2003

In comparison, the water temperature data for the station "Escalante River below Sand Creek" (Figure 3-2) exhibits a narrower daily temperature variation and lower daily maximum temperatures. The Escalante River at this location has a fairly intact riparian canopy and is likely influenced by spring-fed flows from Sand Creek.

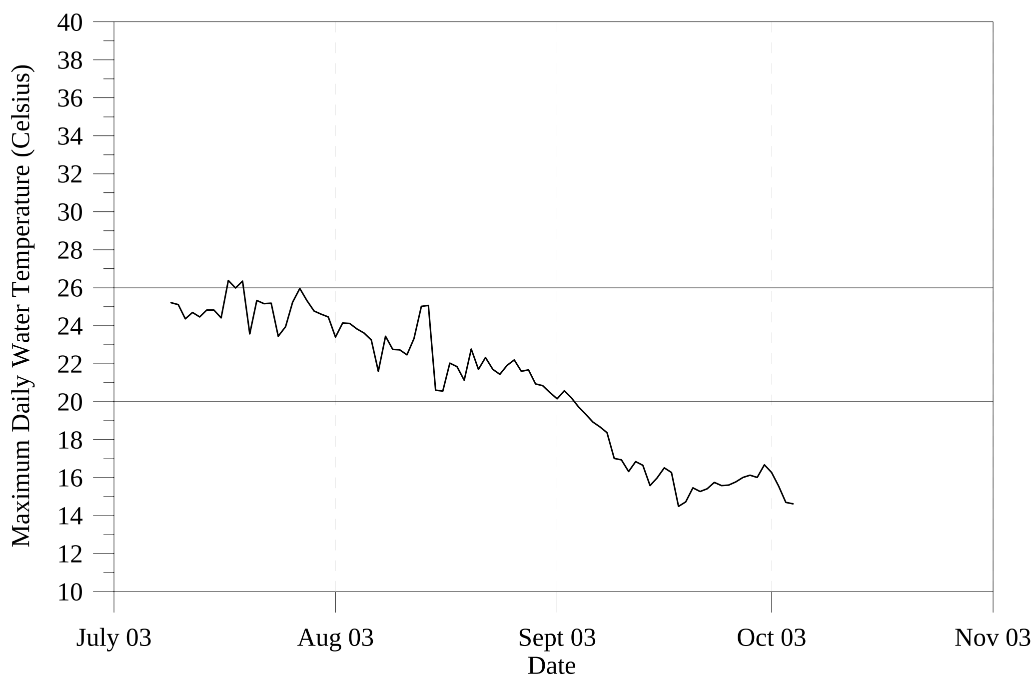

Figure 3-2 Water Temperature for Escalante River below Sand Creek, Summer 2003

Comparison to Water Quality Criteria

Water temperature data collected in 2003 from stations with acceptable data quality are compared to the State of Utah Water Quality Standards in Table 3-5. The temperature criteria for Class 3A waters (cold water biota - the current designated use for the listed reach), is not to exceed 20 degrees Celsius. Inspection of the temperature data in Table 3-5 shows that this criterion was exceeded the majority of the time during the data collection period at all stations.

Additional comparisons to existing criteria are provided in Table 3-5 as examples of evaluating potential site-specific criteria that are also currently in use. The temperature criteria for Utah Class 3B waters (warm water biota) is a maximum daily temperature of 27 degree Celsius. For purposes of comparison, two State of Idaho Department of Environmental Quality (IDEQ) criteria for cold water biota are also shown in Table 3-5. These criteria provide examples of criteria that have been adopted in a nearby State and therefore have a documented technical rationale (Hillman, et al., 1999). Field studies suggest that populations of several salmonid species occur within natural water temperatures that occasionally exceed 25 degrees Celsius (mean daily maximum temperatures in the upper range of 27 to 28 degrees Celsius). Seasonal movements by salmonids between summer and winter habitat is common and trout frequently move throughout the summer in search of suitable habitat (Hillman, et al., 1999).

The 22 degree Celsius criterion used by IDEQ is a daily maximum temperature standard, and the 26 degree Celsius criterion is the daily maximum temperature standard for seasonal cold water aquatic life. IDEQ considers the seasonal cold water criteria as appropriate for the protection and maintenance of a viable aquatic life community of cool and coldwater species, where coldwater aquatic life may be absent during, or tolerant of, seasonally warm temperatures (IDEQ, 2004). The frequency of temperature exceedence along the Escalante River would be much reduced if the 26 degree Celsius seasonal coldwater criterion were applied rather than the current 20 degree Celsius criterion.

Table 3-5
Comparison of 2003 Summer Water Temperature Results to Water Quality Criteria

Map ID	STORET	Station	Days Measured	Days over 20 C	Days over 22 C	Days over 26 C	Days over 27 C
1	none	Escalante River Below North Creek	92	84 (91%)	66 (72%)	26 (28%)	17 (18%)
2	495459	Pine Creek USGS Station 09337000	89	57 (64%)	42 (47%)	8 (9%)	1 (1%)
3	none	Pine Creek Above Escalante	39	39 (100%)	38 (97%)	33 (85%)	21 (54%)
4	495464	Escalante River Below Pine Creek	91	87 (96%)	85 (93%)	67 (74%)	58 (64%)
8	none	Escalante River Above Sand Creek	91	64 (70%)	55 (60%)	22 (24%)	15 (16%)
9	599400	Sand Creek Above Escalante	39	39 (100%)	38 (97%)	3 (8%)	1 (3%)
10	none	Escalante River Below Sand Creek	91	60 (66%)	43 (47%)	4 (4%)	2 (2%)
11	495424	Escalante River Above Calf Creek	90	60 (67%)	51 (57%)	18 (20%)	9 (10%)
12	495421	Calf Creek Above Escalante River	90	63 (70%)	50 (56%)	7 (8%)	0 (0%)
13	495420	Escalante River Below Calf Creek	91	63 (69%)	53 (58%)	23 (25%)	14 (15%)

Flow Observations: Major differences in base stream flow were observed along the Escalante River downstream from the top of the Listed Section. The upper reaches above North Creek were dry at the beginning of the survey in July 2003. Pine Creek at the confluence with the Escalante River was reduced to a minor trickle of water in July 2003, but was entirely dry for a period of time during the data collection period as identified by the extreme high water temperatures detected by the sensor (greater than 35 degrees Celsius, indicating air temperatures (see "Escalante River below Pine Creek" temperature graph in Appendix 4)). The Escalante River channel was dry (or some minor puddles) from Pine Creek to Death Hollow. The Escalante River channel had running water after the contribution of flow from Death Hollow (Mamie Creek), and flowed continuously from the confluence with Death Hollow downstream to Calf Creek (the end of our field observations).

These flow regime observations illustrate a significant difference between the character of the Escalante River above Death Hollow (Figure 3-3) and below Death Hollow (Figure 3-4) where the river is influenced by spring fed tributaries from Death Hollow, Sand Creek, and Calf Creek. The Escalante River above Death Hollow is clearly disconnected by low flows from the section of the river below Death Hollow.

Figure 3-3 Example of Flow and Riparian Conditions - Escalante River above Death Hollow

Figure 3-4 Example of Flow and Riparian Conditions - Escalante River below Death Hollow

Riparian Condition Observations

We had an opportunity to observe riparian conditions along the Escalante River between Calf Creek to Sand Creek, and from Death Hollow to Pine Creek. These areas are within the Grand Staircase Escalante National Monument. Although this is a very qualitative observation, it appears that the vegetative community is currently functioning within the range of natural processes without any obvious current human disturbance. The primary limiting factor that can be attributed to human activities is the reduced stream flow that occurs as a result of diversions in the upper watershed.

3.3.2 Climate and Flow Considerations

Southern Utah is experiencing a drought cycle of lower than average flows and higher temperatures. A critical question then is how representative is the 2003 water temperature data set in relationship to longer time scales. This issue consequently influences the resolution of the Use Attainability Analysis (UAA) and the outcome of the TMDL.

Figure 3-5 and Table 3-6 show the monthly average maximum temperature over a 40-year period (The Escalante, Utah climate station, #422592, uses degrees Fahrenheit, so this temperature scale was retained for this purpose). The most recent 10-year period exhibits higher monthly average maximum temperatures than previous 10-year periods, and Year 2003 set the record high temperature during the 40-year period. Therefore, the 2003 data set represents more extreme high temperature conditions than average conditions and consequently, we need to factor this observation in to the UAA and TMDL recommendations.

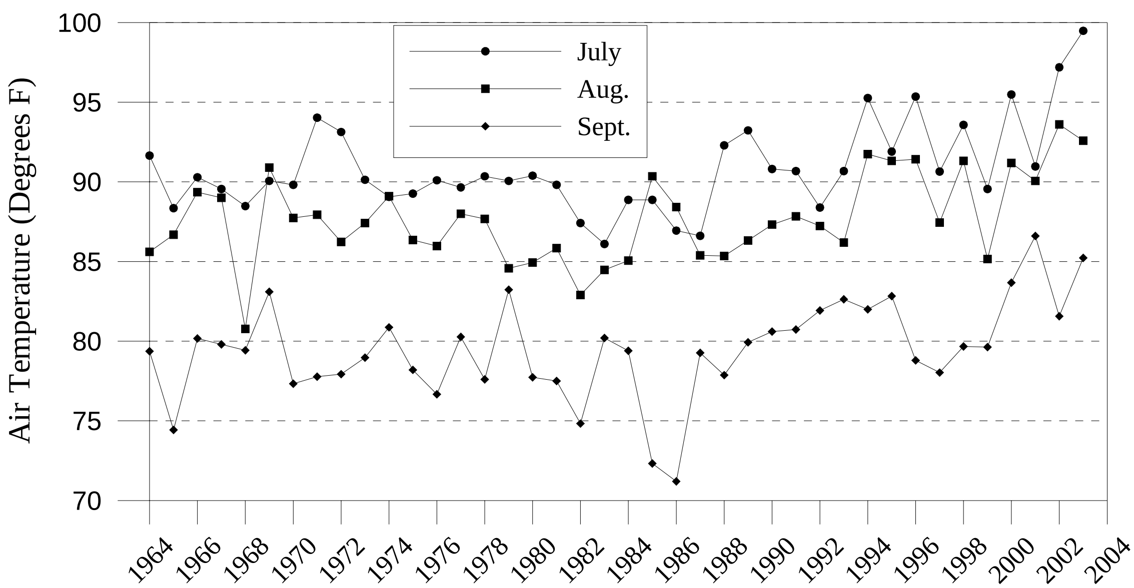

Figure 3-5 Forty Year Monthly Average Maximum Air Temperature for Escalante, Utah

The 8.6 degrees Fahrenheit difference between the 40-year average and the July, 2003 average (Table 3-6) is significant and is expected to have increased water temperatures in the 2003 data set.

Table 3-6
Average Monthly Maximum Air Temperature for Escalante, Utah

Period	Temperature (Degrees Fahrenheit)		
	July	August	September
1964-1973	90.5	87.2	78.8
1974-1983	89.2	86.0	78.7
1984-1993	89.7	86.9	78.6
1994-2003	93.9	90.6	81.8
40-Year Average	**90.9**	**87.7**	**79.5**
2003	99.5	92.6	85.2
Difference	**8.6**	**4.9**	**5.7**

Water temperature measurements collected in 2003 also need to be considered in terms of longer climatic cycles. Utah is experiencing a drought cycle that started in 1999. Previous droughts occurred during 1896-1905, 1930-36, 1953-65, 1974-78, and more recently during 1988-93 and 1999-2002 (USGS 2003). Southern Utah began experiencing drought conditions during the winter of 1998-99. By 2000, drought conditions were evident throughout all of Utah. The current drought is comparable in length and magnitude to previous droughts. During 2002, the fourth straight year of nearly statewide drought conditions, some areas of Utah experienced record-low stream flows. Several record-low stream flows occurred in streams with records dating back to the 1900s.

The primary long term stream gage for the Escalante River is the USGS gage 09337500, "Escalante River near Escalante, Utah." The gage has operated periodically since 1911 to the present with 46 years of data: 1911-12, 1943-1955, 1972-2004. The annual and monthly stream flow statistics are summarized in Appendix 5.

To compare recent flow conditions to the historical record (1911-2002), we calculated monthly normal flows (50th percentile) and below normal (20th percentile) flows for the June to September critical water temperature period. Figure 3-6 shows that flow conditions in 2003 were much lower in comparison to normal flows and below normal flows.

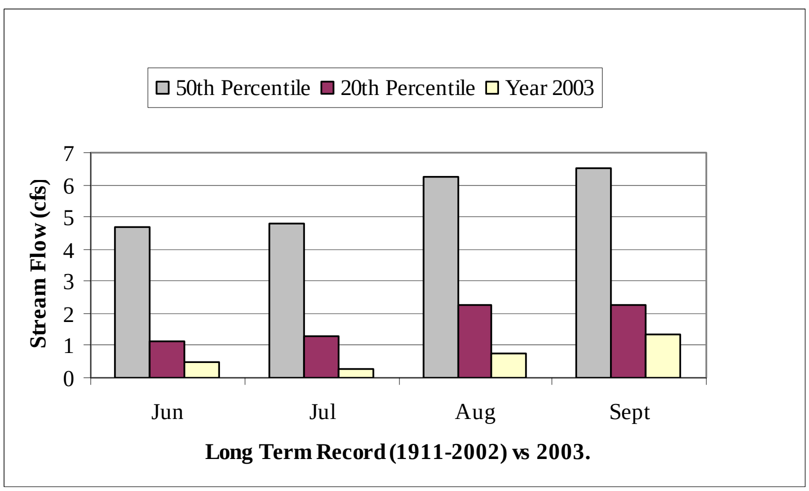

Figure 3-6 Historical Flows Compared to 2003 Flows

Figure 3-6 illustrates that water temperature data collected in 2003 needs to be interpreted carefully with respect to longer term policy decisions. The recent five-year drought has contributed to dewatering the Escalante River channel thus decreasing the available habitat and likely contributing to higher than normal water temperatures.

3.3.3 Utah State University Data Series

The National Aquatic Monitoring Center is located at Utah State University in Logan, Utah and provided some independent water temperature data for the Escalante River. The Aquatic Monitoring Center is a cooperative venture between Utah State University and the U.S. Bureau of Land Management and has studied aquatic life and water temperatures of the Escalante River since 1999. Three reports on the GSENM are available on their website (http://www.usu.edu/buglab/).

Water temperature data from continuous sensors were provided to DWQ by the Aquatic Monitoring Center for two sites on the Escalante River, the first at the trailhead above Pine Creek ("Escalante near Escalante, Utah"), and the second at Highway 12 ("Escalante River near Highway 12 Bridge"). Water temperature data for these sites are available from January 2000 to June 2003; with some data gaps (see Table 3-7). At the "Escalante near Escalante, Utah" station, temperature data are not available for approximately 3 months from June 12 to September 8, 2000. Water temperature data are not available at the "Escalante River near Highway 12 Bridge" station for approximately 1 year from September 2001 to September 2002.

Table 3-7
Aquatic Monitoring Center Water Temperature Monitoring Stations

Station	Station Name	Dates of Available Water Temperature Data
ES-001	Escalante near Escalante, Utah (lat 37.7756 N, long. 111.579 W)	Jan. 2000 to June 2000. Sept. 2000 to June 2003.
ES-120	Escalante River near Highway 12 Bridge (lat 37.7753 N, long. 111.4189 W)	May 2000 to Sept. 2001. Sept. 2002 to June 2003.

Although some data gaps are present, the Aquatic Monitoring Center water temperature data for the Escalante River at these locations are still useful for comparison to the State of Utah water temperature criteria and/or for identification of potential salmonid habitat. A summary of the water temperature results for each of these stations and the application of these results to this study are discussed below.

USU Aquatic Monitoring Center Station - "Escalante near Escalante, Utah"

This station is located on the Escalante River, above the input from Pine Creek, and therefore provides an indicator of the water temperature conditions in the upper reach of the river (Pine Creek to North Creek). This temperature station is also located approximately 1,700 feet upstream from the USGS Gage (09337500); therefore, flow data can be combined with the temperature data. However, it should be noted that the USGS gage is located below Pine Creek and may not represent flows upstream at the water temperature monitoring location.

Temperature data at the "Escalante River at Highway 12" station is useful for comparison to water quality criteria, with some limitations. There are water temperature measurements that exceed 38 degrees Celsius (100 degrees Fahrenheit) and assumed to occur when the temperature probe is out of the water column or in shallow puddled water. Water temperature measurements collected during no flow, low flow, or collected from puddled water are not considered relevant for comparison to water temperature criteria.

To identify periods of no flow or low flow, data from the downstream USGS gage were plotted with temperature data (see Figure 3-7). Periods of low flow (less than 1.0 cfs) and elevated water temperatures (greater than 38 degrees Celsius) occurred in May and September 2000, and in June 2002. These data were not included in the comparison to the water temperature criteria. In addition, the water temperature data gap at this station from June to September of 2000 does not allow for calculation of the year 2000 percent exceedence of the water temperature criteria.

Therefore, with the exception of some elevated water temperatures and low flows in June 2002, the water temperature data for 2001 and 2002 are of sufficient quantity and quality to calculate the percent exceedence.

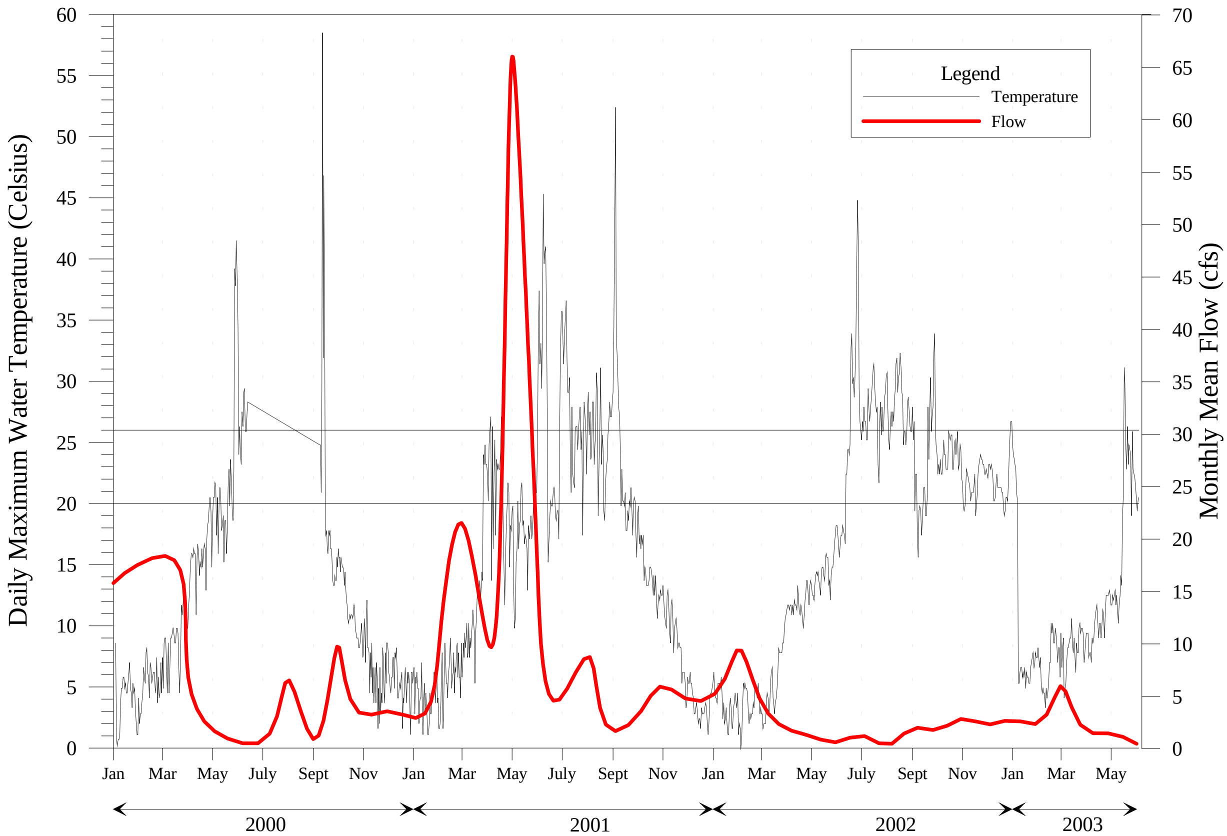

Figure 3-7 Escalante River Temperature near Escalante, Utah and USGS Gage Data

The current water quality criteria of 20 degrees Celsius is exceeded 33% of the time in 2001 and 43% in 2002 in the upper reach of the Escalante River.

Table 3-8
Escalante River at Escalante, Utah
Comparison of Daily Maximum Water Temperature and Temperature Criteria

Station	Days Measured	Days over 20 C	Days over 22 C	Days over 26 C	Days over 27 C
Escalante at Escalante, Utah - Year 2001	358	118	94	49	45
Percent Exceedence		33%	26%	14%	13%
Escalante at Escalante, Utah - Year 2002	287	123	100	41	32
Percent Exceedence		43%	35%	14%	11%

As can be noted by inspection of the temperature and flow in Figure 3-7, the upper reach of the Escalante River is dewatered during the summer months. During May through September the upper reach typically has flows less than 1 cfs and water temperatures above 20 degrees Celsius. This can be attributed to the diversion of water for irrigation in the upper watershed. Therefore, the upper reach of the Escalante River does not provide salmonid habitat during the summer months. However, sufficient flows and lower water temperatures appear to be conducive to salmonid migration for 7 months of the year from October to May.

USU Aquatic Monitoring Center Station - "Escalante River near Highway 12 Bridge"

Temperature data at the "Escalante River at Highway 12" station is not useful for comparison to water quality criteria due to the lack of a complete annual data set. As discussed above, water temperature data for this station are not available for January to mid-May 2000, and September 2001 to September 2002 (see Figure 3-8). In addition, flow data near this station are not available. However, the temperature data at this location can be used to identify periods of potential salmonid habitat.

Similar to the upper reach of the Escalante River, water temperatures appear to be sufficiently cool (less than 26 degrees Celsius) to support a salmonid migratory habitat for a 7 month period from October to May.

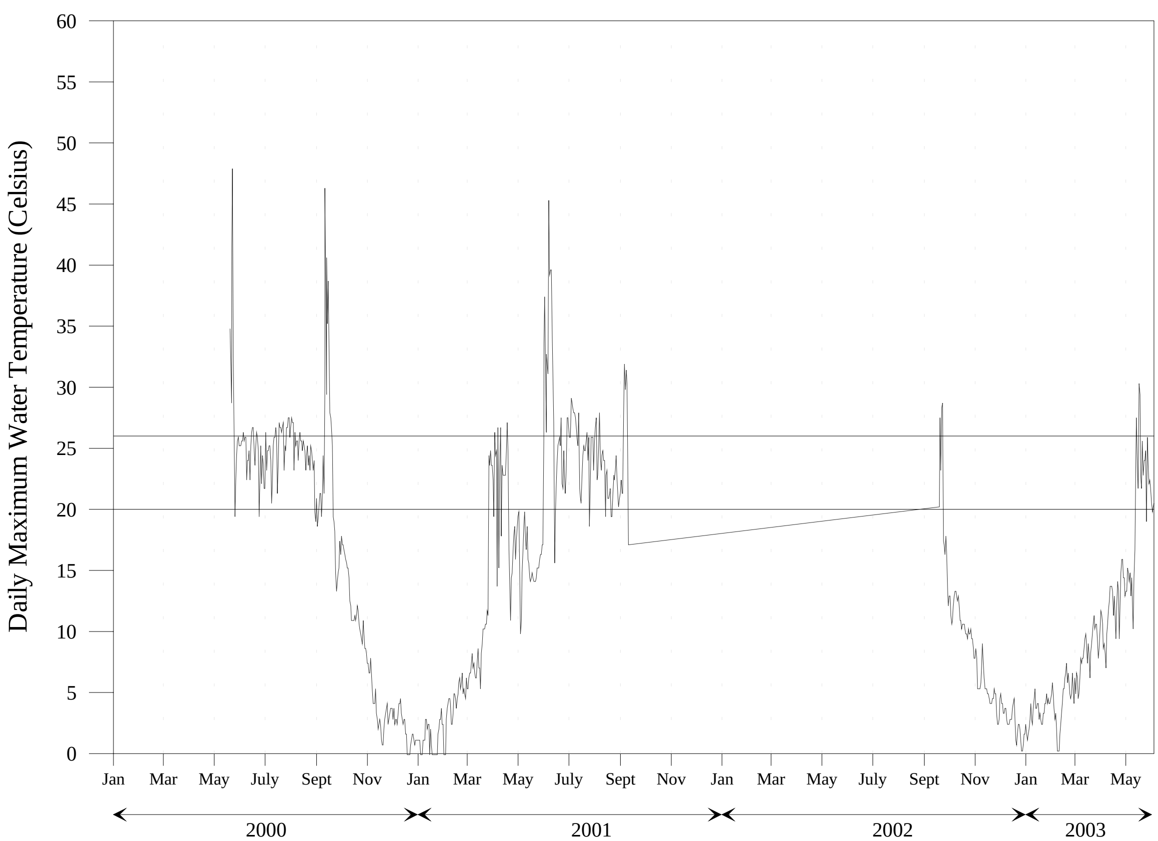

Figure 3-8 Escalante River Temperature near Highway 12 Bridge

4.0 USE ATTAINABILITY ANALYSIS

Options for addressing use attainability analysis and the TMDL components were described in the Data Evaluation Report (MSE 2003). Subsequent field experience, data analysis, and discussion with the DWQ Project Manager led to the following approach based on the conditions observed in the Escalante River. Elements of the approach are outlined below.

4.1 Reach Differentiation

There are different sub-reaches within the study area with respect to stream temperature regimes, flows, pollutant sources, natural versus human causes of temperature increase, and land management practices. Therefore, different approaches for addressing use attainability analysis and management practices are appropriate for each group of similar reaches. For these reasons, the Escalante River is differentiated according to the following reaches:

Escalante River, Boulder Creek to Pine Creek; and
Escalante River, Pine Creek to North Creek/Birch Creek

4.2 Use-Attainability

The distribution of native and introduced species of trout in the Escalante River drainage has been well documented by Utah Division of Wildlife Resources (Hepworth and others 2001). The native Colorado River cutthroat trout occurred at higher elevations in North Creek, Pine Creek, and Boulder Creek watersheds. Introduced salmonid species, brown trout and rainbow trout, occur in the major spring-fed tributaries to the Escalante River or in the upper watersheds of these tributaries where higher elevation and vegetative conditions support cooler water temperature regimes. The temperature regime under relatively natural conditions along the Escalante River and tributaries at the lower elevations do not support sufficiently cold water temperatures to meet the statewide water quality criteria throughout the year.

The spring-fed tributaries on the north side of the Escalante River between Pine Creek and Boulder Creek have sufficiently cool temperature regimes and currently support salmonid fish species, even though water temperatures recorded in 2003 in these tributaries were typically above 20 degrees Celsius (see temperature profiles for Pine Creek, Sand Creek, and Calf Creek in Appendix 4). The Escalante River from Boulder Creek to its headwaters serves as a potential migratory corridor for brown trout in the fall, winter and spring, but does not provide habitat during the summer.

As described in Section 3.3, water temperature at all locations sampled in 2003 exceed the State temperature criteria of 20 degrees Celsius for Class 3A waters the majority of the time during the critical summer period.

Calf Creek provides a good indicator of existing conditions that support cold-water species. Calf Creek is located in the Grand Staircase Escalante National Monument and is managed as primitive recreational area with minimal human disturbance. An established population of brown trout occurs in Calf Creek that provides a popular sport fishery. In addition, the cold-water fish survive in this tributary because of the influence of cold spring water that provides suitable habitat during critical periods of elevated warm water temperatures. In Calf Creek water temperature exceeded the existing State criteria (20 degrees Celsius) 70 percent of the time during the summer in 2003.

Given the existing situation where introduced cold-water species, brown and rainbow trout, occur at naturally high temperatures (above 20 degrees Celsius) in a desert environment it is appropriate to propose a change in beneficial use from 3A (Cold-water fishery) to 3B (Warm-water fishery) that will more accurately reflect the natural temperature regime for this segment of the Escalante River. We also propose to raise the beneficial use classification of the downstream section of the Escalante River (from Boulder Creek to Lake Powell) from 3C to 3B to more accurately reflect that section's proper beneficial use. This will provide a consistent, appropriate classification for this reach that is uniform in other related factors.

4.3 Loading Assessment

A loading assessment typically includes quantitative calculation of current loading, loading capacity, margin of safety, wasteload allocation (point sources), load allocation (nonpoint sources) and load reduction. The following observations can be made regarding the applicability of the load assessment process to the unique conditions of the Escalante River.

Escalante River, Boulder Creek to Pine Creek

This segment of the Escalante River is managed by public agencies. Land ownership affects the potential management practices that can be applied to affect temperature regimes. The USFS manages the upper elevations of the watershed primarily as recreational lands or as a wilderness area (the Box-Death Hollow Wilderness). The lower elevations of the watershed are managed by the BLM as the Grand Staircase-Escalante National Monument. The national monument is managed primarily to protect and restore natural processes along the river corridor. The area within the national monument is managed as a primitive area accessible only on foot or horseback. Grazing allotments were retired along the river by a BLM administrative decision in 1999[3]. There are no known anthropogenic heat sources that can logically be quantified for loading assessment or controlled by management practices. There are few management opportunities that have not already been pursued to improve temperature regimes within the national monument boundaries. Continued control of exotic plants including tamarisk and Russian olive, and restoration of cottonwood trees is recommended. Further management options are constrained by access and operating regulations of the national monument. Therefore, this Water Quality Management Plan suggests no additional BMPs for this reach.

Recommendation: *Since the river corridor from Boulder Creek to Death Hollow is managed under natural conditions a loading assessment will not be completed.*

Escalante River, Pine Creek to North Creek/Birch Creek

This segment of the upper Escalante River has elevated water temperatures and does not have sufficient flows to fully support a year-round cold water fish habitat as required for the Class 3A use designation, due to both natural and anthropogenic factors. The existing and foreseeable situation with respect to flow conditions and biological communities can be summarized as follows:

- The existing channel experiences very low flows during the summer months as discussed in Section 3.3. The 80th percentile flow (a low flow statistic) for the period of record (49 year

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[3] The Record of Decision retired grazing allotments along the mainstem Escalante River, Sand Creek, and Death Hollow. Grazing occurs in benches above Calf Creek, but well outside of the riparian and canyon zone Bureau of Land Management (BLM). 1999. Confirmed with BLM Escalante staff, R. Oiler, February 2005.

record, intermittent data from 1911-2003) ranges from 1.2 cfs in June to 2.3 cfs in September. During normal periodic droughts, the flows are even lower as indicated by 2003 when 80^{th} percentile flows ranged from 0.5 cfs in June to 1.3 cfs in September.

- Flows are low in this reach due to both natural and anthropogenic factors. Average annual precipitation is 10 inches per year as measured at the town of Escalante, Utah weather station, although precipitation in the upper part of the watershed would be expected to be higher. Runoff from the watershed is distributed unevenly throughout the year, associated with snowmelt runoff and late summer and fall thunderstorms. Settlement and stream flow diversions for agricultural irrigation began in the 1870's with the majority of senior water rights filed by the turn of the century and prior to the first long-term flow records. Due to the early history of water use in the upper Escalante River watershed, there is no information to indicate what the pre-settlement conditions of this stream channel would be like with respect to summer base flow, riparian condition, or native fish distribution.
- The Escalante River basin provides naturally fragmented habitat for native Colorado River cutthroat trout. Warm temperatures and high sediment loads restrict native cutthroat use of the main river for much of the year, but allow limited connectivity between tributaries. The existing salmonid fish distribution and habitat conditions suggests that the Escalante River may provide seasonal fish passage to tributaries, but does not support year-round cold water fish use.
- Opportunities to improve flows in this reach are essentially non-existent due to existing water rights appropriated for irrigation, a legacy use dating to the early 1900's. Opportunities to improve the temperature regime are extremely limited, since any improvement in riparian condition is intimately associated with instream flows.
- A heat load assessment is not appropriate in such a severely flow limited reach. An actual heat load assessment would not change the potential projects that are commonly used to reduce heat loading (See Section 5.0).
- The Escalante River from Pine Creek to North Creek/Birch Creek, is primarily in private ownership. Opportunities for improving the riparian area and temperature regime exist in this reach, and therefore Project Implementation Plans (PIPs) and BMPs are recommended in this reach.

Recommendation*: Develop PIPs and BMPs to address stream flow enhancement and temperature reduction by improving the riparian canopy cover along the Escalante River from Pine Creek to North Creek/Birch Creek. Reduction in temperature can only be described qualitatively due to the limitations of the existing information.*

Tributaries to Escalante River: Pine Creek, Death Hollow, Sand Creek, Calf Creek and Boulder Creek - The tributaries to the Escalante River were not listed on the 303(d) list, and therefore are not specifically included in the TMDL. BMPs in the tributaries that may influence temperature regimes in the mainstem Escalante River will be addressed as part of the overall Project Implementation Plan for the listed reaches of the river.

5.0 IMPLEMENTATION PLANS AND BEST MANAGEMENT PRACTICES

The Canyonlands Soil Conservation District (CSCD) will coordinate with local stakeholders and agencies to develop Project Implementation Plans (PIPs) to proceed with a coordinated approach to improve water quality within the watershed. CSCD will establish criteria and select cooperators for implementation of projects. These projects will be designed to minimize land use impacts on water quality in the Escalante River and its tributaries.

The lower Escalante River (Boulder Creek to Pine Creek) is within the Grand Staircase Escalante National Monument. A Record of Decision and approved Management Plan is in place for the Monument (BLM 1999). The Management Plan provides details on resource management, visitor management, and monitoring and adaptive management. The Grand Staircase Escalante National Monument Management Plan will be used to evaluate current management practices in the Monument in relationship to the proposed PIPs for the upper Escalante River (Pine Creek to the headwaters).

The overall project goals are to reduce temperature loading in the upper Escalante River watershed, primarily by enhancement of riparian habitat. In addition, the project goals are intended to inform and educate the community concerning nonpoint source pollution and the importance of managing natural resources within their watershed. To reach these goals, objectives and tasks are defined and a narrative description is provided for each objective and task. Each objective has at least one associated task to be performed to accomplish the objective. Tasks are specific activities that may include milestones, outputs, and identification of responsible parties.

PIPs to reduce temperature in the upper Escalante River incorporate BMPs to address channel bank vegetation, riparian forest buffers and herbaceous cover, streambank protection, channel stabilization, and habitat improvement and management. By implementing appropriate BMPs, we hope to encourage adoption and implementation of similar activities to address water quality problems throughout the entire watershed.

PIPs may be implemented throughout the next several years. An evaluation plan will also be implemented to document progress in achieving improved conditions, to review effectiveness of BMPs, and to provide feedback on the direction of overall watershed health. Based upon the results of this monitoring program, management strategies and implementation priorities may change under the direction of the project sponsors.

Successful projects combine a voluntary approach with cost-share assistance to identify key system components that improve riparian habitat and streambank protection, while allowing management flexibility. A coordination plan is developed to identify the lead project sponsor, describe local support for the projects, describe how the project will coordinate with pertinent 319 and non-319 funded programs, and describe similar activities that are being undertaken in the watershed.

No long-term funding is planned for operation or maintenance of these projects. Individual landowners are responsible for operation and maintenance of BMPs throughout the projected life of the practices. Projects will be inspected by the project lead sponsor. The operation and maintenance of the designed systems will be thoroughly explained to the landowner and they will sign a document indicating their understanding and cooperation. If the landowner does not operate or maintain the system according to NRCS protocols, they will be in violation of their 319 contract and no longer eligible for NRCS assistance. Additionally they may risk having to pay back the federally contributed portion of their project funding.

5.1 Statement of Need

The TMDL-listed section of the Escalante River Watershed is currently not meeting its designated beneficial use for class 3A waters due to exceedence of Utah's temperature criteria for cold water species of game fish and other aquatic life. The dominant land ownership along the Escalante River corridor is the Grand Staircase-Escalante National Monument (GSENM) managed by the Bureau of Land Management. The monument boundary excludes the private lands in the town of Escalante and the private lands within the Escalante valley upstream of the town to the upper boundary of the study area. Private agricultural lands are used primarily for pasture, hay and livestock grazing. The proposed PIPs and BMPs addresses the primary sources of temperature loading identified within the TMDL analysis.

The temperature criterion for cold water game fish is a maximum of 20 degrees Celsius (27 degrees Celsium for warm water game fish). Exceedence of the temperature criteria occurs between mid-May and mid-October, with the primary period from June through September. The spring-fed tributaries on the north side of the Escalante River between Boulder Creek and Pine Creek have sufficiently cool temperature regimes and currently support salmonid fish species. The Escalante River between Boulder Creek and Pine Creek serves as a migratory corridor for the salmonid species in the fall, winter and spring, but does not provide habitat during the hot summers.

The intent of the proposed program is to apply PIPs and BMPs to address temperature reduction by improving the riparian canopy cover and enhancing stream flow. Reduction in temperature can only be described qualitatively due to the limitations of the existing information. By demonstrating these practices to area stakeholders, we hope to encourage them to adopt and implement similar activities to address their own water quality problems. With the support and direction of CSCD, priority will be given to implementation projects that feature improvements to riparian habitat and reduce streambank erosion. Tours of these project sites, news articles and fact sheets will help encourage adoption of these practices elsewhere in the watershed.

5.1.1 Project Water Quality Priority

As required by 26-11-6 of the Utah Code Annotated 1953, the waters of the State of Utah are grouped into classes so as to protect State waters against controllable pollution. The designated beneficial uses for the Escalante River are 2B-secondary contact recreation, 3A-coldwater fishery (proposed to be changed to 3B-warmwater fishery), and 4-agriculture (Standards of Quality for Waters of the State §R317-2, UAC). The listed section of the Escalante River from Boulder Creek to the North Creek/Birch Creek confluence has been identified as impaired due to exceedence of the Utah temperature criterion for protection of cold water fisheries (Class 3A waters). Since the river corridor from Boulder Creek to Pine Creek is managed under natural conditions by public agencies (BLM and USFS) and there are no known anthropogenic heat sources that can logically be quantified for loading assessment or controlled by management practices, PIPs and BMPs are not included for this segment. Continued control of exotic plants including tamarisk and Russian olive, and restoration of cottonwood trees is recommended.

5.1.2 Project Goals

The overall project goals are to reduce temperature of the upper Escalante River segment (Pine Creek to North Creek/Birch Creek) by improving the riparian canopy cover. This will be accomplished through a combination of BMPs designed to promote adequate channel bank vegetation and herbaceous cover, channel stabilization, and streambank protection. Public education will be addressed by offering tours of demonstration sites and publishing news articles and fact sheets to encourage adoption of these practices elsewhere in the watershed. Specific project goals are as follows:

Goal #1: Reduce temperature loading to impaired reaches of the Escalante River and its tributaries.

Goal #2: Inform and educate the community concerning temperature loading and the importance of maintaining and improving water quality within the watershed.

Goal #3: Provide administrative services to project sponsors documenting matching contributions, tracking individual project progress, coordinating team efforts, and generating reports and data in a timely manner.

5.1.3 Objectives and Tasks

Goal #1: Reduce temperature loading to impaired reaches of the Escalante River and its tributaries.

Objective 1: Improve stability of stream channels and minimize stream bank erosion to enhance flows in impaired reaches of the Escalante River and its tributaries.

Task 1: Select and identify project cooperators.

Output - Problem identification, cooperator selection. This will be led by CSCD cooperatively with the local work group and will be conducted in the early spring of the first contract year.

Task 2: Develop stream bank protection plans using BMPs (stream channel stabilization, stream bank and shoreline protection).

Output - Stream bank protection plans. This will be conducted in spring of the first and third contract years. Design work will be performed by NRCS and CSCD staff.

Task 3: Implement projects.

Output - Implementation will occur between fall of the first and third contract years through spring of the second and fourth contract years. Projects will be implemented by landowners, NRCS and CSCD staff will advise, review, and certify project implementation.

Task 4: Monitor water quality above and below projects (see Section 5.3 for Monitoring Plan).

Objective 2: Enhance the riparian corridor to reduce temperature to the river and its tributaries.

Task 5: Select and identify project cooperators.

Output - Problem identification, cooperator selection. This will be led by CSCD cooperatively with the local work group and will be conducted in the early spring of the first contract year.

Task 6: Develop riparian improvement plans using BMPs (establish channel bank vegetation, enhance herbaceous cover, provide riparian forest buffer, where appropriate).

Output - Riparian improvement plans. This will be conducted in spring of the first and third contract year. Design work will be performed by NRCS and CSCD staff.

Task 7: Implement projects.

Output - Implementation will occur between fall of the first and third contract year through spring of the second and fourth contract years. Projects will be implemented by landowners; NRCS and CSCD staff will advise, review and certify project implementation.

Task 8: Monitor water quality above and below projects (see Section 5.3 for Monitoring Plan).

<u>Goal #2:</u> Inform and educate the community concerning temperature loading and the importance of maintaining and improving water quality for the designated beneficial uses within the watershed.

Objective 1: Two tours will be conducted focusing on: 1) stable stream channels and stream bank protection; and 2) enhanced riparian corridors.

Task 9: Conduct riparian area/stream bank tour.

Output - The tours will be conducted either near project completion or shortly after. USU Extension, UACD, CSCD staff and the landowner will jointly plan this tour.

Objective 2: Share general and technical information with producers and area stakeholders.

Task 10: Develop Fact Sheet and Newspaper Article

Output - Fact sheet and newspaper article. These products will be completed during implementation of the project and will be disseminated during tours after project completion and other times of the year. USU Extension, UACD, and NRCS will collaborate on the content of these products. USU Extension and UACD will jointly produce and disseminate them.

<u>Goal #3:</u> Provide administrative services to project sponsors documenting matching contributions, tracking individual project progress, coordinating team efforts, and generating reports and data in a timely manner.

Objective 1: Provide administrative services.

Task 11: Track Match and Prepare Reports

Output - Documented matching fund records and prepare Semiannual, Annual and Final reports. UACD and CSCD staff will coordinate this effort. Completed semiannually, at the end of the first contract year and again at the completion of the project. UACD and CSDC staff will prepare these products.

5.1.4 Best Management Practices

The following BMPs are considered for the Escalante River Water Quality Management Plan and may be used along with the information and education efforts to improve water quality in the watershed. Numeric codes following each BMP indicate NRCS standards and specification numbers taken from the NRCS Field Office Technical Guide.

1. Channel Bank Vegetation (322)
2. Channel Stabilization (584)
3. Riparian Forest Buffer (391)
4. Riparian Herbaceous Cover (390)
5. Stream Habitat Improvement and Management (395)
6. Streambank and Shoreline Protection (580)

All projects will include BMP's and will be planned to the level of a total resource management system in accordance with NRCS standards and specifications. The following procedures will be used to achieve project goals:

1. Isolate water quality problem sources.
2. Select and implement projects for watershed maintenance/improvement.
3. Promote fair and cost effective nonpoint source pollution control.
4. Monitor progress and evaluate economic benefits of implementing water quality improvements.
5. Create a public awareness of water quality concerns and educate the public on how they can protect water quality for themselves and the community. Promote community involvement in project implementation activities by use of volunteer groups.

5.1.5 Permits

All appropriate permits will be secured as needed. Project sponsors will ensure compliance with all local, state, and federal regulations pertaining to project activities such as not disturbing sensitive habitats, not filling or degrading wetlands.

5.1.6 Lead Sponsor

CSCD is the lead project sponsor and is empowered by the State of Utah to devise and implement measures for the prevention of nonpoint source water pollution. Additionally, CSCD is able to enter into contracts, receive and administer funds from agencies, and contract with other agencies and corporate entities to promote conservation and appropriate development of natural resources. Memoranda of Understanding with state, federal and local agencies along with individual cooperator agreements empower CSCD and individual cooperators to accomplish this work.

5.1.7 Assurance of Project Operation and Maintenance

No long-term funding is planned for operation or maintenance of these projects. Individual landowners are responsible for operation and maintenance of BMPs throughout the projected life of the practices. Projects will be inspected by the project lead sponsor. The operation and maintenance of the designed systems will be thoroughly explained to the landowner and they will sign a document indicating their comprehension. If the landowner does not operate or maintain the system according to NRCS protocols, they will be in violation of their 319 contract and no longer eligible for NRCS assistance. Additionally they may risk having to pay back the federally contributed portion of their project funding.

5.2 Coordination Plan

5.2.1 Lead Project Sponsor

CSCD will oversee detailed project development, planning, implementation, approval, creation of fact sheets and educational materials, administration and reporting. Some of these duties will be transferred to UACD, NRCS, DEQ, USU Extension Service and others as per Memoranda of Understanding. CSCD will be responsible for writing the final project report pursuant to EPA and State requirements.

UACD will oversee project administration, matching fund documentation, and contracting with agencies and individuals. They will also provide staffing assistance at the direction of CSCD.

5.2.2 Local Support

CSCD is coordinating with local stakeholders and agencies to develop a watershed plan to further define water quality problems in the Escalante River watershed and to proceed with a coordinated approach to improve water quality within the watershed. CSCD will establish criteria and select cooperators for implementation of projects. This project will be used to show landowners and cooperators BMPs for minimizing land use impacts on water quality in the Escalante River and its tributaries.

5.2.3 Coordination and Linkages

CSCD anticipates coordinating efforts with the following other entities, agencies, and organizations:

Cooperators - provide match for cost share, implementation of water quality plans

Utah State University Extension - I&E, Technical assistance

NRCS - Technical planning design and oversight

Utah Department of Agriculture & Food - Technical assistance, I&E assistance

Utah Division of Water Quality - Standard program monitoring, Technical assistance

EPA - Financial assistance

Utah Association of Conservation Districts - Administration, contracting, staff and technical assistance

Utah Division of Water Rights- Permits advisory and monitoring assistance

Utah Division of Water Resources - Advisory

5.2.4 Similar Activities

Other activities similar to those described in this water quality management plan have not been identified in the Escalante River watershed. BLM has expressed interest in brush control along riparian corridors to clear tamarisk and Russian olive growth to facilitate cottonwood establishment. However, no projects have been implemented to date.

5.3 Evaluation and Monitoring Plan

5.3.1 Sampling and Analysis Plan Goals

Monitoring plan goals are to track BMP implementation and effectiveness, and evaluate progress in achieving improved water temperature conditions as these nonpoint source controls are implemented. The project lead sponsor has a strong commitment to demonstration of success of these pollution prevention and remediation strategies, but a limited monitoring budget, and therefore the monitoring effort needs to be shared with DWQ and other agency cooperators.

The monitoring goals are divided into two primary objectives:

1) Implementation and effectiveness monitoring to evaluate project BMPs; and
2) Trend monitoring to evaluate success in meeting water quality standards and goals.

The lead sponsor, CSCD, is the lead entity for carrying out the implementation and effectiveness monitoring. The DWQ is the lead entity for completing trend monitoring.

Implementation monitoring in comparison to effectiveness monitoring focuses on documenting the number and location of BMPs or PIPs applied to meet water quality goals. This requires developing an accounting system of practices, or using currently established reporting procedures familiar to the lead sponsor, to track project implementation.

Effectiveness monitoring evaluates whether BMPs were successful at meeting their intended purpose, such as reducing water use, reducing infiltration or reducing bank erosion. Effectiveness monitoring does not require water quality sampling to be effective. Simple methods, as described below, can be used to evaluate BMP effectiveness. Implementation and effectiveness monitoring can be carried out by CSCD staff, volunteers, or associated personnel in the agricultural community.

Trend monitoring involves monitoring change in water temperature over time. Detecting trends requires statistical design, commitment to long-term monitoring over time and high sample frequency. Trend monitoring needs to be carried out by an organization, such as DWQ, with sufficient infrastructure and funding to assure long-term monitoring.

Work activities associated with monitoring goals listed above include the following:

1) Develop a project-specific monitoring plan to evaluate BMP effectiveness as projects are approved for monitoring. Since each project may be comprised of multiple BMPs or multiple land-owners, only general monitoring approaches for effectiveness monitoring are described in this document.

2) Monitor water temperature at long-term monitoring sites to demonstrate sustained and overall improvements in water quality. This task will be completed by the DWQ or a team from cooperating agencies.

3) Maintain a common database of all data collected pertaining to the projects. The database will be developed and maintained by lead agency support staff at the Utah Association of Conservation Districts (UACD).

4) Review data and include data summaries in annual reports. This activity will be performed as sub-tasks within tracking and reporting tasks.

5.3.2 Implementation and Effectiveness Monitoring

Implementation and effectiveness monitoring are the responsibility of CSCD and cooperating agencies such as NRCS, Utah State University Extension, and Utah Department of Agriculture. The monitoring methods therefore focus on those protocols that can be effectively carried out by natural resource staff with an agricultural background.

The Project Implementation Plan identifies two objectives with associated BMPs to achieve Goal #1 - reducing temperature loading to impaired reaches of the Escalante River. The general monitoring approach that is appropriate for these objectives is described below.

Implementation Monitoring

State and federal agricultural organizations affiliated with CSCD have a number of standard reporting procedures that are used to track management practices. The Soil Conservation District in consultation with these agencies is best suited to determine the tracking and reporting system that works for them. The tracking system needs to address the BMPs identified as part of the Project Implementation Plan, specifically:

Recommended Best Management Practices

a. Channel Bank Vegetation (322)
b. Channel Stabilization (584)
c. Riparian Forest Buffer (391)
d. Riparian Herbaceous Cover (390)
e. Stream Habitat Improvement and Management (395)
f. Streambank and Shoreline Protection (580)

Effectiveness Monitoring

Where implementation monitoring is designed to answers the questions, "*Were BMPs applied? If so, Where and How Many?*" Effectiveness monitoring should answer the question. "*Were the BMPs effective at reducing pollutant inputs?* Effectiveness monitoring is best carried out by the local sponsor because of their relationship with local landowners and operators. Effectiveness monitoring plans should be built into each implementation grant as a necessary part of doing business. Although simple procedures can be used, effectiveness monitoring still requires resources to design the project specific plan, make field measurements, and develop reports.

The general monitoring approach is described below for the objectives that are listed under Goal # 1, reducing temperature loading to impaired reaches of the Escalante River (Section 5.1.3, Objectives and Tasks). Objective #1 and #2 are addressed by a similar combination of BMPs and therefore employ a similar monitoring approach.

Objective 1: Improve stability of stream channels and minimize stream bank erosion to enhance flows in impaired reaches of the Escalante River and its tributaries.

Objective 2: Enhance the riparian corridor to reduce temperature to the river and its tributaries.

Monitoring Approach:

BMPs for stream channel stabilization reduce inputs of sediment and salts by decreasing erosion within the near bank region of the stream channel. Since streambank erosion is a natural process BMPs should emphasize working with natural stream dynamics and avoid the use of hardened structures such as riprap that was used in the past. BMPs generally focus on revegetating streambanks by direct planting of riparian shrubs and forbs or bioengineering methods such as installing willow bundles.

Implementation and effectiveness monitoring will evaluate the success in establishing a riparian buffer and stabilizing the streambank. Planting success is evaluated by using a transect or grid method to count the number of live stems retained over time compared to that planted. Revegetation success for erosion control is evaluated by measuring soil cover, which can be estimated by measuring percent coverage at a portable plot (such as a 3 foot square) and repeating the measurements over time along an established transect. Bank stabilization can be measured by using bank pins to directly measure bank erosion rates, establishing cross-sections that can be accurately resurveyed over time, or by using photopoints.

Details of methods for these approaches can be found in documents such as:

- Bauer, S. B., and Burton, T. A., 1993. Monitoring protocols to evaluate water quality effects of grazing management of western rangeland streams. US EPA Region 10, Water Division, Surface Water Branch. EPA 910/R-93-017.
- Bedell, T. E., and Buckhouse, J. C., 1994. Monitoring primer for rangeland watersheds. US EPA Region 10, EPA 908-R-94-001.
- Harrelson, C. C., Rawlins C. L., and Potyondy, J. P., 1994. Stream channel reference sites: an illustrated guide to field technique. USDA Forest Service: General Technical Report RM-245.

5.3.3 Trend Monitoring

Trend monitoring is used to answer two primary questions: 1) Are water temperature criteria being met; and 2) are water temperatures decreasing over time with implementation of BMPs? Since site-specific criteria were recommended as part of this Water Quality Management Plan (not to exceed 26 degrees Celsius), a third question should also be answered: does the site-specific criteria prove to be appropriate given more data collected over different climatic regimes.

A water temperature monitoring plan was prepared as a part of the Data Evaluation Report and these stations were sampled in 2003 to provide data for this water quality management plan. This monitoring plan is contained in Appendix 4. The 2003 water temperature monitoring locations are recommended for trend monitoring.

As noted in Table 5-1, thirteen water temperature monitoring stations were established for the 2003 monitoring event. Seven of these monitoring stations were located at existing DWQ STORET sites. Six new stations were added for water temperature monitoring to provide coverage of the listed 303(d) segment and tributaries.

Table 5-1
Suggested Station Locations for Temperature Monitoring

Map ID	Station ID	Station Name	Purpose
1	**New**	**Escalante River Below North Creek**	Influence upstream of TMDL reach
2	495459	Pine Creek Below The Box at USGS Station	Example of temp regime in the upper watershed.
3	**New**	**Pine Creek Above Escalante River**	Influent tributary
4	495464	Escalante River Below Confluence with Pine Creek	Measures influence of tributary
5	**New**	**Escalante River Above Death Hollow**	Measures influence of tributary
6	599404	Death Hollow Above Confluence with Escalante River	Influent tributary
7	**New**	**Escalante River Below Death Hollow**	Measures influence of tributary
8	**New**	**Escalante River Above Sand Creek**	Measures influence of tributary
9	599400	Sand Creek Above Confluence with Escalante River	Influent tributary
10	**New**	**Escalante River Below Sand Creek**	Measures influence of tributary
11	495424	Escalante River Above Confluence with Calf Creek	Measures temp at lower end of canyon reach
12	495421	Calf Creek Above Confluence with Escalante River	Influent tributary
13	495420	Escalante River Below Confluence with Calf Creek	Measures influence of tributary

Note: Bold – indicates stations initiated in 2003.

Sample Period and Frequency

Water temperature monitoring is completed using data loggers that record temperature continuously. Data can then be summarized on a daily basis and used to calculate the percent of days that exceed the criteria. Additional information that may help explain the temperature observations can be obtained such as: canopy density, channel cross-section, flow estimate during the period, and photos of riparian condition.

Water temperature monitoring will be implemented during summer base flows (May through October). Monitoring should be completed prior to BMP implementation and after BMP implementation. Because of the high variability in water temperature due to annual climatic differences, observations over several years will be necessary to identify any changes attributed to implementation of BMPs.

5.4 Long-Term Funding Plans for Operation and Maintenance

No long-term funding is planned for operation or maintenance of these projects. Maintenance of these projects will be the responsibility of the private landowner. Projects will be inspected by the project lead sponsor, UACD and NRCS staff. The operation and maintenance of the designed systems will be thoroughly explained to the landowner and they will sign a document indicating their understanding and cooperation. If the landowner does not operate or maintain the system according to NRCS protocols, they will be in violation of their 319 contract and no longer eligible for NRCS assistance. Additionally they may risk having to pay back the federally contributed portion of their project funding. We do anticipate increased interest in participation of BMP application and anticipate moving to a watershed-wide implementation phase in the future.

5.5 Public Involvement

There has been public involvement from the inception of the project, through proposal development, review, and submission. CSCD will select project participants and give oversight to project planning and implementation. This group actively seeks public input into the prioritization of natural resource problems and concerns. We anticipate volunteer help to be provided at many phases of the project.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Water Quality Impairment

Utah's Year 2002 303(d) list (DWQ, 2002) identifies the Upper Escalante River as being impaired due to exceedence of Utah's statewide temperature criteria (20 degrees Celsius) for cold water species of game fish and other aquatic life (beneficial use category 3A). The 303(d) listed section ("Listed Section") begins at the confluence of Birch Creek and North Creek and ends at the confluence with Boulder Creek. The 303(d) listing was based on instantaneous temperature readings obtained during routine water quality sampling. Because this data is insufficient to assess the listing or complete a TMDL, continuous temperature sensors were installed at key locations in 2003 to fill this data gap. Temperature monitoring aided in: 1) determining the spatial distribution of temperature conditions in the mainstem Escalante and major tributaries, 2) identifying localized reference temperature conditions that support salmonid fishes, and 3) evaluating natural versus human causes of heat.

Continuous temperature monitoring confirmed the exceedence of the statewide temperature criteria (20 degrees Celsius) at all locations monitored. Exceedence of the temperature criteria varied from 64 percent to 96 percent including the cooler water tributaries that currently support non-native species of trout.

Additional continuous water temperature monitoring data obtained from the National Aquatic Monitoring Center at Utah State University confirms the exceedence of the 20 degree Celsius temperature criteria in the Escalante River. Water temperature data was provided by the Aquatic Monitoring Center for two stations on the Escalante River: "Escalante at Escalante, Utah" (directly above Pine Creek); and "Escalante River near Highway 12 Bridge". Exceedence of the temperature criteria ranged from 33 percent to 43 percent.

Natural Characteristics

The Escalante River flows through three different physiographic regions – the Colorado Plateau, Canyonlands and the Southern High Plateaus – with correspondingly different temperature regimes and habitat conditions with respect to support of cold water biota. The headwater zones at higher elevations in the watershed are characterized by coniferous forests which together provide the cooler water needed to support cold water biota. These forests transition to the pinyon pine and juniper zone, followed by the sagebrush, and shadscale zones. Precipitation volume, and therefore the ability to sustain flows, varies by elevation from 12 to 16 inches per pear in the upland mountains to 6-8 inches per year in the lowland desert.

The Listed Section occurs in the Canyonlands physiographic region characterized by pinyon pine, juniper and sagebrush on the uplands and ribbons of cottonwood, alder, willow and tamarisk along the river corridor. The Canyonlands region is also characterized by low flows much of the year interspersed with pulses of storm generated flash floods that create highly erosive and scouring conditions. The bedrock channels with low flows do not develop characteristic pool and riffle habitat that supports cold water biota.

The months of June, July and August are the warmest months during the year with average maximum air temperatures between 85 and 90 degrees Fahrenheit. This three month period is when natural conditions of ambient temperature and extreme low flows contribute to high water temperatures.

The natural temperature regimes in tributaries to the Listed Section of the Escalante River are different than the mainstem Escalante River due to different watershed and hydrologic conditions. Pine Creek supports resident salmonid populations at the higher elevations. Death Hollow (Mamie Creek), Sand Creek, and Calf Creek which flow into the Listed Section of the Escalante River are influenced by springs and are characteristically narrower providing longer periods of topographic shade. These characteristics contribute to cooler water temperature which periodically support introduced salmonid fishes.

Land Management Characteristics

The upper elevations of the watershed are managed by the Dixie National Forest and include large areas managed as wilderness. The main stem of the Escalante River begins northwest of the town of Escalante. Private agricultural lands near the town of Escalante depend on irrigation from the Escalante River and tributaries for pasture, hay and livestock water. The dominant land use along the Escalante River corridor in the Listed Section is the Grand Staircase-Escalante National Monument managed by the Bureau of Land Management and established in 1996. The monument boundary excludes, but surrounds, the private lands along the upper valley.

The Grand Staircase-Escalante National Monument was established by presidential proclamation in 1996. The Approved Management Plan and Record of Decision for the national monument was signed November 1999 and effective 2000. The goal of the plan is to protect the remote and undeveloped character of the monument for its historic and scientific resources. The majority of the monument (94 percent), 1.8 million acres, is managed as Outback (mechanized) or Primitive Zones (non-mechanized) for undeveloped and primitive recreational use.

The primary potential source of temperature alteration within the public lands is from livestock grazing. However, in implementing the National Monument Plan, the BLM has worked with permitees to gradually reduce the potential effect of livestock grazing. Livestock grazing allotments were retired along the mainstem Escalante River, in Sand and Death Hollow watersheds in 1999 in the Record of Decision (BLM 1999). BLM has implemented projects since adoption of the plan to restore altered watersheds and improve conditions.

The current management of the National Monument has already established restoration and recovery as the primary management direction. No anthropogenic sources of heat can be identified within the National Monument that are not already addressed under the existing management program direction.

Division into Sub-Reaches

Two sub-reaches were identified within the study area with respect to stream temperature regimes, flows, pollutant sources, natural versus human causes of temperature increase, and land management practices. Therefore, different approaches for addressing use attainability and management practices are appropriate for each group of similar reaches. For these reasons, the Escalante River is differentiated according to the following reaches:

Escalante River, Boulder Creek to Pine Creek; and

Escalante River, Pine Creek to North Creek/Birch Creek

Escalante River, Boulder Creek to Pine Creek

The Escalante River has reliable perennial flow beginning at Death Hollow and gradually increasing in flow downstream with major inputs from the spring-fed tributaries, Sand Creek and Calf Creek. The river corridor during the summer is characterized by low flows in a wide shallow channel with a variable cottonwood willow canopy. The Utah Division of Wildlife (UDW) has documented the occurrence of salmonid fish in lower Calf Creek, Sand Creek and Death Hollow. The Escalante River provides a seasonal migratory corridor for salmonid fish but is classified by Utah Division of Wildlife Resources biologists as non-trout habitat.

The Escalante River above Death Hollow is characterized by low flows due to both natural conditions and irrigation withdrawals. During the summer the river is dewatered in various sections of this reach depending on annual conditions of drought cycles and seasonal irrigation demand. This section of the Escalante River is classified by UDW biologists as non-trout habitat or intermittent.

Escalante River, Pine Creek to North Creek/Birch Creek

This segment of the upper Escalante River has elevated water temperatures and does not have sufficient flows to fully support a year-round cold water fish habitat as required for the Class 3A use designation, due to both natural and anthropogenic factors.

The existing channel experiences very low flows during the summer months and ranges from 1.2 cfs in June to 2.3 cfs in September. Flows are low in this reach due to both natural and anthropogenic factors. Runoff from the watershed is distributed unevenly throughout the year, associated with snowmelt runoff and late summer and fall thunderstorms. Settlement and stream flow diversions for agricultural irrigation began in the 1870's with the majority of senior water rights filed by the turn of the century and prior to the first long-term flow records.

The Escalante River drainage provides naturally fragmented habitat for native Colorado River cutthroat trout. Warm temperatures and high sediment loads restrict native cutthroat use of the main river for much of the year, but allow limited connectivity between tributaries. The existing salmonid fish distribution and habitat conditions indicate that the Escalante River provides seasonal fish passage to tributaries, but does not support year-round cold water fish use.

The Escalante River from Pine Creek to North Creek/Birch Creek, is primarily in private ownership. Opportunities for improving the riparian area and temperature regime exist in this reach, and therefore Project Implementation Plans (PIPs) and BMPs are recommended in this reach.

Tributaries: Pine Creek, Death Hollow, Sand Creek, Calf Creek and Boulder Creek.

The tributaries on north side of the Escalante River are influenced to different degrees by cold water springs and therefore have naturally cooler water that supports cold water biota. These tributaries are not included on Utah's 303(d) list.

Site-Specific Criteria

Given the existing situation where introduced cold-water species, brown and rainbow trout, occur at naturally high temperatures in a desert environment, it is appropriate to propose site-specific criteria. Analysis of water temperature data at sites that currently support cold-water biota in the Escalante drainage suggests a site-specific criteria of 26 degrees Celsius. However, it should be noted that the main Escalante River will still exceed the increased site-specific criteria during the hot summer months.

Project Implementation Plans and Best Management Practices

Boulder Creek to Pine Creek

This segment of the Escalante River is managed by public agencies primarily to maintain the primitive lands character. The USFS manages the upper elevations of the watershed primarily as recreational lands or as a wilderness area (the Box-Death Hollow Wilderness). The lower elevations of the watershed are managed by the BLM as the Grand Staircase-Escalante National Monument. The national monument is managed primarily to protect and restore natural processes along the river corridor. There are no known anthropogenic heat sources that can logically be quantified for loading assessment or controlled by management practices. There are few management opportunities that have not already been pursued to improve temperature regimes within the national monument boundaries. Continued control of exotic plants including tamarisk and Russian olive, and restoration of cottonwood trees is recommended. Further management options are constrained by access and operating regulations of the national monument. Since this section of the river corridor is already managed under stringent restoration and protection guidelines no further BMPs are proposed to improve temperature regimes in this Water Quality Management Plan.

Pine Creek to North Creek/Birch Creek

The overall project goals for this segment of the Escalante River are to reduce water temperatures by improving the riparian canopy cover. This will be accomplished through a combination of BMPs designed to promote adequate channel bank vegetation and herbaceous cover, channel stabilization, and streambank protection. Public education will be addressed by offering tours of demonstration sites and publishing news articles and fact sheets to encourage adoption of these practices elsewhere in the watershed.

The Canyonlands Soil Conservation District (CSCD) will oversee all project development, planning, implementation, approval, creation of fact sheets and educational materials, administration and reporting. CSCD is coordinating with local stakeholders and agencies to improve water quality within the watershed. This project will be used to show landowners and cooperators BMPs for minimizing land use impacts on water quality in the Escalante River and its tributaries.

A monitoring plan will be used to track BMP implementation and effectiveness, and evaluate progress in achieving improved water temperature conditions as these nonpoint source controls are implemented.

There has been public involvement from the inception of the project, through proposal development, review, and submission. CSCD will select project participants and give oversight to project planning and implementation. This group actively seeks public input into the prioritization of natural resource problems and concerns.

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