TMDL Water Quality Study of Echo Creek Watershed, Utah

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Utah Department of Environmental Quality
Division of Water Quality
TMDL Section

Echo Creek TMDL

Waterbody ID	Echo Creek and tributaries to the headwaters HUC #16020101
Location	Summit County, Northern Utah
Pollutant of Concern	Sediment
Impaired Beneficial 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
303(d) List Priority Status	High
Current Load Loading Capacity (TMDL) Load Reduction	69,100 tons/yr 40,000 tons/yr 29,100 tons/yr (42%)
Wasteload Allocation UPDES Load Allocation Margin of Safety	 0 lbs/yr, no UPDES permitted facilities within the watershed 40,000 tons/yr Addressed implicitly by using conservative methods of measuring macroinvertebrate response
Defined Targets/Endpoints	1) Remediation efforts will continue at Echo Creek until measures of biological condition for 3 consecutive samples fall within 80% of values observed at comparable reference sites
Implementation Strategy	1) Installation of sediment detention basins and grade stabilization structures 2) Riparian restoration projects, including stabilization of gully erosion and head cutting, re-establishment of woody riparian vegetation, and riparian corridor fencing to decrease livestock impact. 3) Elimination of broadcast weed spraying
This document is identified as a TMDL for waters in the Echo Creek drainage and is submitted under §303d of the Clean Water Act to U.S. EPA for review and approval.	

TMDL Water Quality Study of Echo Creek

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1.0 INTRODUCTION

Echo Canyon is located in Summit County approximately 4 miles north of the city of Coalville, Utah. It is a small but significant tributary to the Weber River. It flows through Echo Canyon parallel to Interstate 80 and a major railway. Echo Creek has been observed to carry large amounts of sediment causing problems downstream. Much of the sediment load can be attributed to natural sources due to the geology of the watershed, which will be addressed later in detail. Echo Canyon often experiences short but intense thunderstorms that deliver significant amounts of sediment to the creek. The problem is exacerbated by the fact that much of lower Echo Creek has been channelized and confined between Interstate 80 and railroad tracks. Inadequate bank protection, overland erosion, and non stabilized cut and fill areas also contribute sediment loading.

The purpose of this document is to characterize Echo Creek's watershed, address its placement as a high priority for TMDL development on the 303(d) list for sediment, and offer several solutions for reducing sediment loads into Echo Creek.

Figure 1-1. Present day photo of Echo Creek. The railroad has constricted the meanders of the stream and it has responded by down cutting. Notice the absence of woody riparian vegetation and eroding banks.

1.1 Maps

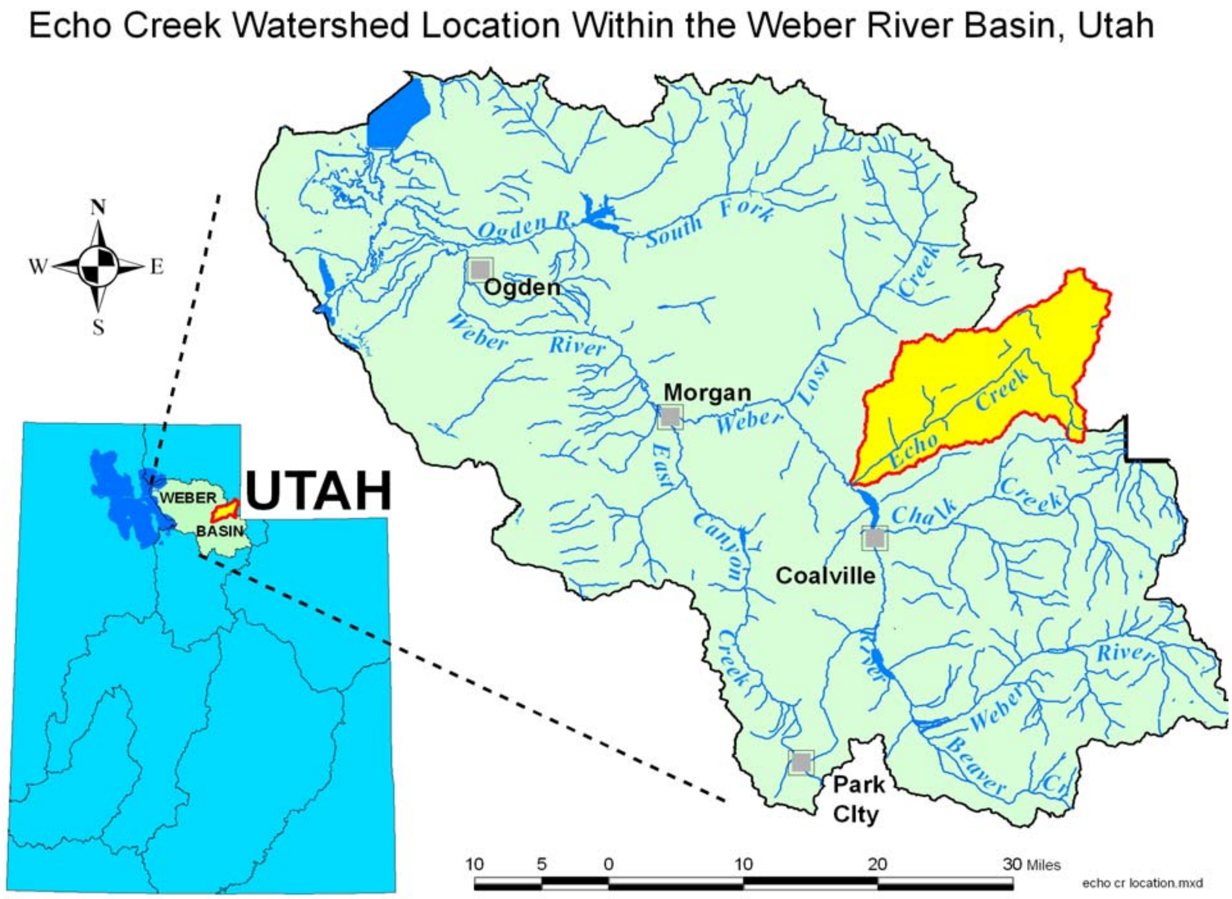

Figure 1-2. Echo Creek Watershed location within the Weber River basin, Utah.

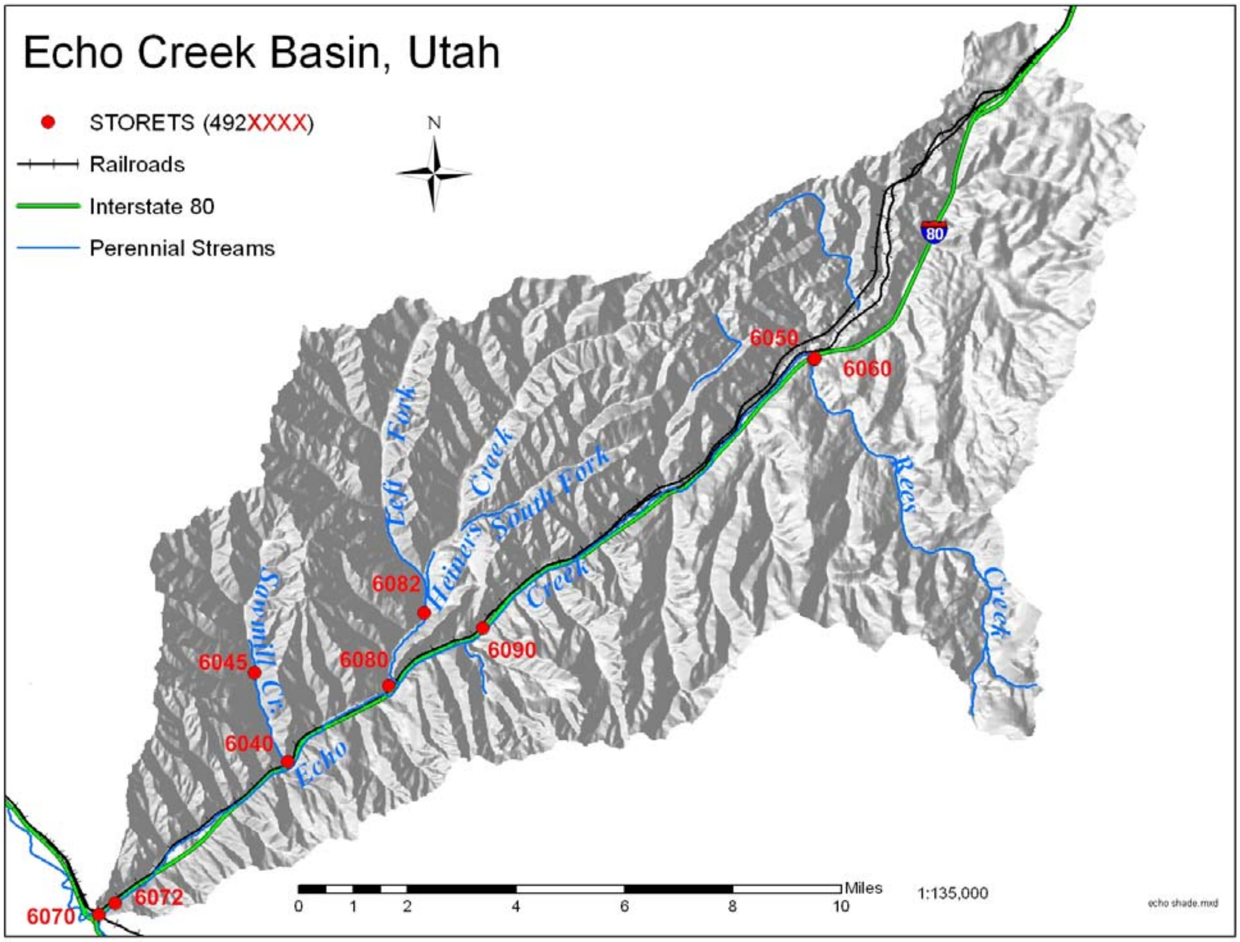

Figure 1-3. Echo Creek basin detail.

Water Quality STORET site numbers and descriptions
4926040: Sawmill Creek above Echo Creek
4926045: Sawmill Creek 2.5 miles above Echo Creek (reference site)
4926050: Rees Creek above Echo Creek
4926060: Echo Creek above Rees Creek
4926070: Echo Creek above Weber River
4926072: Echo Creek 1 mile above Weber River
4926080: Heiners Creek above Echo Creek
4926082: Heiners Creek 2 miles above Echo Creek
4926090: Echo Creek 2 miles above confluence with Heiners Creek

1.2 Hydrology

The hydrology of the Echo Creek Watershed is typical of semi-arid regions, the climate is characterized by cold, moist winters and warm, dry summers. Temperatures range from -40 degrees to 90 degrees Fahrenheit. The frost free period is approximately 50 to 60 days. Average annual precipitation ranges from 12 inches at 6000 feet elevation to 22 inches at 8800 feet.

About 65% of the precipitation falls as snow from October through April and 35% occurs as rain from May through September. December through April is the wettest period. July and September are the driest months. High intensity convective storms are common, especially during August. These localized “cloud bursts” may produce 2 to 3 inches of rainfall in less than a hour[1]. The steep topography of the watershed funnels the rainfall into the stream channels with high velocities and great potential for erosion. This is evident by high Total Suspended Solid (TSS) concentrations and turbid water appearance during and after rain events.

Echo Creek is a third order stream and the watershed is characterized by a dendritic drainage pattern. Echo Creek and its tributaries, Sawmill and Heiners Creeks, maintain perennial flows. The remaining tributaries are intermittent and ephemeral streams. During winter low flow periods Echo Creek is the main water source for the Weber River below Echo Reservoir until the confluence with Lost Creek approximately 8 miles downstream.

There is only one stream flow gauge, located at the mouth of Rees Creek, and no weather stations located in the watershed and therefore hydrologic data are extremely limited and inconsistent. Stream flow data for the EPA STORET sampling location at Echo Creek above the confluence with the Weber River were typically recorded as water quality samples were taken. This limited data approximates the average annual daily stream flow at the mouth of Echo Canyon at approximately 14 cfs. Figure 1-4 below is a typical hydrograph from the flow gauge on Rees Creek for March through August. There is an initial increase in flow consistent with early snowmelt from low elevations and a subsequent spike associated with the remaining snowmelt from higher elevations. After the snowmelt, flows drop and become more consistent and fluctuate only during storm events. This same flow pattern is seen throughout the watershed. It is assumed the average annual flow increases from the top of the watershed to the outlet.

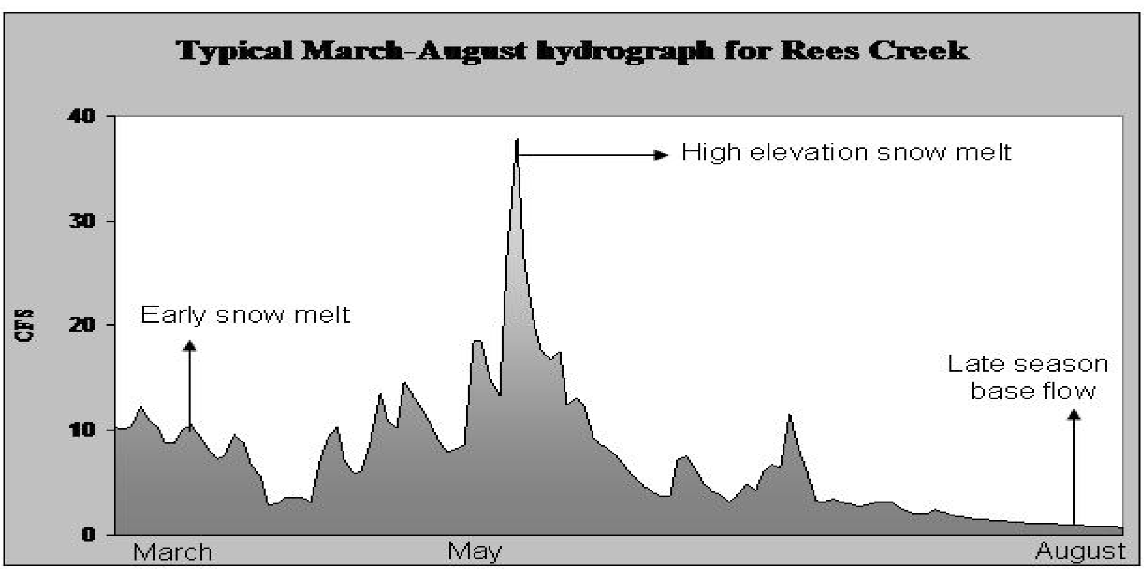

Figure 1-4. Typical March-August hydrograph for Rees Creek.

1.3 Geology

The geology of the Echo Creek Watershed consists of Tertiary and Cretaceous aged formations of sandstone, shale and quartzite conglomerates. The three dominant geologic units are the Wasatch formation, Echo Canyon conglomerate and the Henefer formation. The Wasatch formation (Figure 1-5) is comprised of red sandstone, siltstone, shale and conglomerate. The Echo Canyon conglomerate (Figure 1-6) is a red, massively bedded, pebble to boulder conglomerate. The conglomerate deposits of these two units are weakly cemented with highly erodible shale and sandstone lenses. The soils in the watershed are mostly rocky soils derived from these two conglomerates. The Henefer formation (Figure 1-7) is a tan and gray course-grained to conglomerate sandstone, inter-bedded with gray mudstone and shale. The Henefer formation also contributes erodible shale to the formation of clayey and loamy soils. Alluvium and colluvium deposits are found along the stream channels and valley bottoms that are susceptible to erosion and head cutting. The erodible nature of the geology of the watershed further exacerbates the sedimentation problem of Echo Creek and its tributaries.

In the lower part of the watershed the valley floor is flanked by massive red and tan colored cliffs formed by the Echo Canyon conglomerate and Henefer formation respectively. Mid way up the watershed the topography transitions into the red colored Wasatch formation forming less dramatic cliffs and rolling hills.

Figure 1-5. Wasatch Formation.

Figure 1-6. Echo Canyon Conglomerate formation.

Figure 1-7. Henefer Formation.

1.4 Soils and Range

According to a USDA NRCS range report on the area, the rangelands of the Echo Creek watershed are in relatively good condition. There has been a transition from a plant community dominated by grasses to one where sagebrush, oak brush and other less palatable species dominate. This is a common result of years of livestock grazing. However, there is still excellent forage and cover for livestock and wildlife throughout much of the area.

Brush dominated plant communities characteristically have patches of bare ground between plants that are a source of fine suspended particles due to sheet and rill erosion. This type of erosion occurs when rain drops and surface flows detach and transport soil, resulting in the loss of deposited seeds and the most fertile soil, reducing plant growth and impairing water quality.

The watershed consists primarily of loamy soils composed of sand, silt, clay and organic matter. This soil type generally contains more nutrients than sandy soils and is also better at retaining water. Plants common to the area include Utah juniper, basin wild rye, sedges and baltic rush. Invasive species are present and increasing; cheat grass, musk thistle, and tumble mustard are dominant in many locations and need to be addressed in a long term weed management plan.

1.5 Land Use History

Echo Canyon has a long history of human use. The earliest recorded use of the Echo Canyon watershed was by fur trappers harvesting beaver pelts from Echo Creek and its many small tributaries. As dams deteriorated and broke due to lack of constant maintenance by beavers, deep sediments laid down by years of beaver activity began to wash away. Next came wagon trains of pioneers on their way to Salt Lake City or points further west including California. The wagons left deep ruts on the canyon floor and livestock grazed and trampled the area as they passed through, leaving the stream vulnerable to erosion.

As settlers arrived in Utah a large sheep industry developed in Echo Canyon. It has been said that you could count the herds of sheep by the clouds of dust in the air. During the late 1800's a severe and prolonged drought combined with heavy overgrazing left the watershed bare and exposed to erosion.

During this same period construction of the Union Pacific railroad through Echo Canyon also left permanent scars. Large camps of men and livestock trampled the canyon and riparian areas, feeding on any vegetation to be found. The track crews created extensive cut and fill areas through hill sides in order to create the necessary grade for laying rails. Drainage systems constructed to move water away from the track caused many new gullies to form. The area was burned over many times due to the burning embers and sparks from the steam engines of the time.

The Echo Creek Watershed was heavily used between the turn of the century and the 1930's when the Soil Conservation Service and Soil Conservation Districts were formed. Since then ranchers have worked to improve this land. Livestock grazing is still the dominant use, but new techniques are being applied to reduce the effects. Oil and gas development is present in the watershed, but impacts from that activity appear to be minimal.

Construction of Interstate 80 through Echo Canyon began during the mid 1950's. The 4 lane divided highway required considerably more space than the train tracks, ultimately constricting the creek into a straight, narrow channel for much of its length.

1.5.1 Historic Photos

The following pictures were taken during the 1860-70's in Echo Canyon as the early pioneers came into Utah, first by wagon train and later by railroad. As early as 1869, construction of the railroad constricted the growth of riparian vegetation and the ability of Echo Creek to meander properly (Figures 1-8 and 1-9). Pioneers used willow to create a roadway on which the wagons could pass over a wetland area (Figure 1-10). This photo also illustrates the abundance of woody vegetation that was once present along the stream and valley floor. In Figure 1-11 a stand of large trees, most likely cottonwoods can be seen at the mouth of the canyon. Currently, only a few cottonwoods remain on Echo Creek. In the final photo (Figure 1-12) notice the extensive riparian vegetation throughout the valley bottom.

The purpose of these historic photos is to show that large woody riparian vegetation did flourish along Echo Creek. Presently, Echo Creek is devoid of this type of vegetation along most of its length. The absence of deep rooted woody vegetation has led in part to severe streambank erosion.

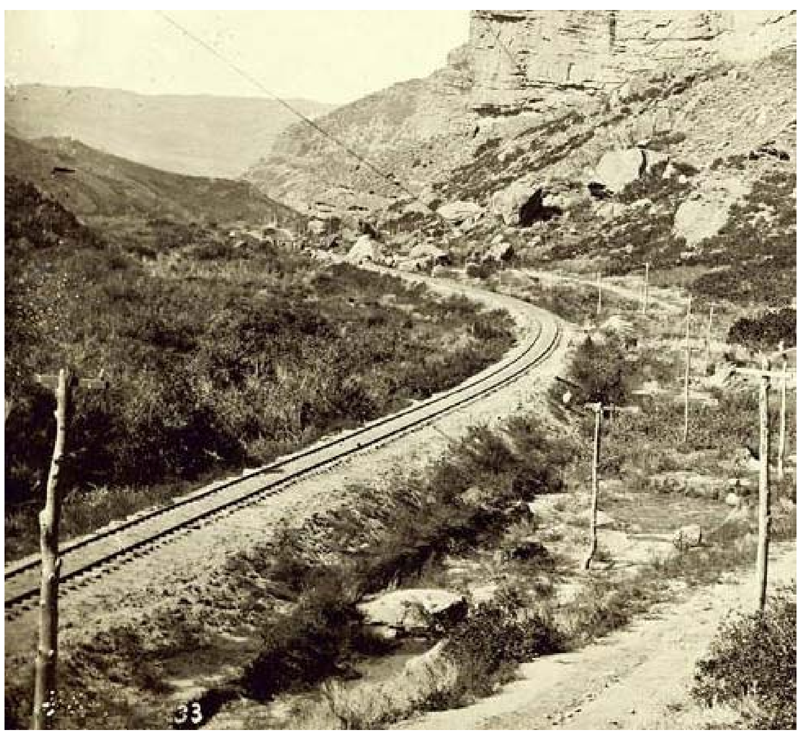

Figure 1-8: Picture of railroad in Echo Canyon in 1869. Echo Creek is confined to the left side of the railroad.

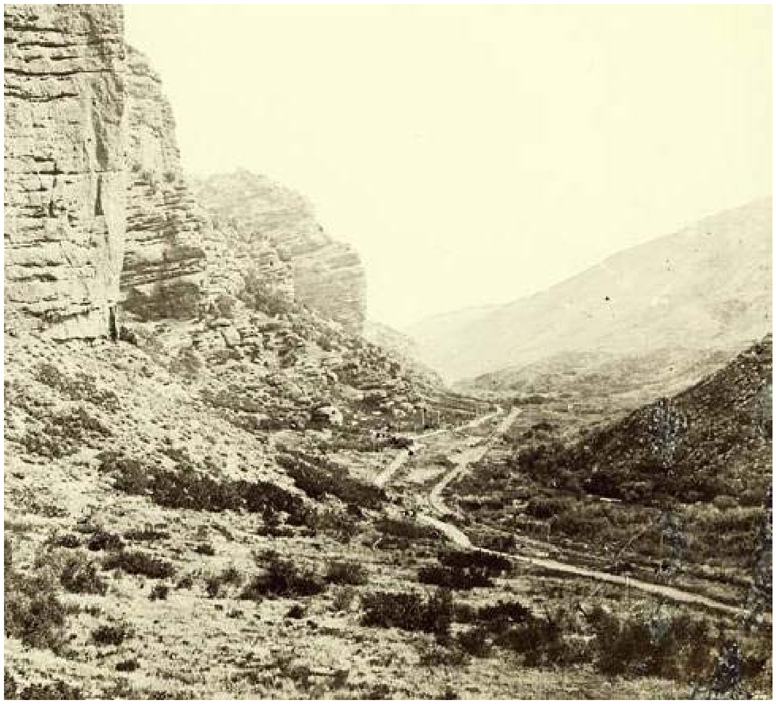

Figure 1-9: Looking up Echo Canyon in 1872.

Figure 1-10: Wagon train in Echo Canyon in the 1860's. Willows were used to create a roadway for the wagons.

Figure 1-11: Settlement at the mouth of Echo Canyon. A large stand of cottonwoods can be seen along the stream.

Figure 1-12: Echo Canyon 1872. Note the riparian vegetation covering the valley floor.

2.0 WATER QUALITY STANDARDS

2.1 Water quality impairments

Under the Federal Clean Water Act, states are required to protect, maintain, and improve the conditions of the nation's waters by adopting water quality standards. Utah's water quality standards consist of three different components: beneficial uses, numeric criteria, and the antidegradation policy.

Beneficial uses are the desired uses that water quality should support. Utah's beneficial uses include drinking water supply, recreation, fishery and aquatic life support, and agriculture (irrigation and stock watering). Each beneficial use has specific water quality requirements or numeric criteria that must be met for the use to be supported. A water body is considered impaired when it does not meet the water quality standards needed to support its beneficial uses.

The antidegradation policy specifies the conditions under which water quality may be lowered in surface waters. Existing beneficial uses must be maintained and protected. Water quality better than that needed to protect existing beneficial uses must be maintained unless lower quality is deemed necessary to allow important economic or social development. Echo Creek is designated as a Category 2 High Quality Water.

Echo Creek is protected for the following four beneficial uses:

1C- Drinking Water

2B- Recreation

3A- Cold Water Fishery

4- Irrigation and Agriculture

Echo Creek was listed as a high priority for TMDL development in the State of Utah's 2004 303(d) list of impaired waters. The pollutant of concern in Echo Creek is sediment, which is partially impairing its cold water fisheries beneficial use. Sediment in surface waters is typically measured by its concentration of total suspended solids (TSS) and turbidity. However, there is not a numeric water quality standard for TSS, the standard for turbidity is relative to background levels of an increase no greater than 10 NTUs (Nephelometric Turbidity Units).

Sediment in streams negatively impacts aquatic life by burying aquatic habitat, spawning areas, fish eggs, and bottom dwelling macroinvertebrates, a primary food source for fish. Increased sediment in surface waters also causes the water to be cloudy which reduces light penetration and beneficial plant growth, as well as impairs fish visibility making it more difficult for them to locate and capture prey.

Excess sediment can also impair other beneficial uses of our water resources. Nutrients, metals and bacteria are often bound to sediment particles that when washed into surface waters degrade water quality downstream, threatening municipal, industrial and recreational uses of Utah's water resources.

Natural erosion and overland flow during storm events contribute some amount of TSS into all streams. In highly erodible watersheds such as Echo Creek, background TSS concentrations and turbidity can be very high, especially following spring runoff and rain storm events.

Echo Creek was listed as impaired based on its narrative criteria stating that waters should be free of suspended or deposited sediments at levels detrimental to designated uses. Echo Creek is a major tributary to the Weber River, which supplies drinking water to the growing populations of Weber and Davis Counties. The increased load of sediment from Echo Creek results in increased expenditures for maintenance and filtration of culinary water. Up to 23% of the sediment in the lower Weber River originates from the Echo Creek drainage. The Weber Basin Water Conservancy District estimates that increased treatment costs of $120,000 per year can be directly attributable to sediment from Echo Creek. Much of the Weber River is eventually used for irrigation and livestock watering, uses also impacted by high sediment concentrations.

Total suspended solids and turbidity data is sparse throughout the watershed. The impairment is based more on an abundance of qualitative visual evidence than on quantitative data. However, the *State of Utah Water Quality Report of 1986* noted that Echo Creek contributes to the Weber River "…in excess of 270 tons/day of TSS with associated turbidities of 1700 NTU during spring runoff."

Figure 2-1: Echo Creek (right) flowing into the Weber River, March 2002.

3.0 WATER QUALITY TARGETS

3.1 Introduction

One of the goals of a TMDL is to establish water quality endpoints that can be used to determine when water quality has improved sufficiently to support beneficial uses. The primary beneficial use of concern in Echo Creek is the protection of cold-water fish and the organisms upon which they depend (Class 3A). Aquatic biota have been shown to be negatively impacted by excessive sediment inputs in numerous studies (see Cordone and Kelley 1961, Berry et al. 2003 for reviews). The primary objective of the indicators and targets in this TMDL is to ensure that sediment inputs are sufficiently controlled to maintain a healthy stream ecosystem.

TMDL endpoints are often based on numeric criteria defined in water quality standards for the pollutant of concern, however there is no water quality standard for TSS. Although sampling has taken place for several years at several sites throughout the watershed and TSS and turbidity data are available, the data does not provide an accurate representation of sediment loading into Echo Creek. The majority of measured TSS and turbidity values are near or less than the detection limit because most of the sampling was conducted on days with fair weather. Therefore, an endpoint for this TMDL based upon representative data for turbidity or TSS concentrations can not be established.

Due to the lack of representative TSS and turbidity data for Echo Creek, biological indictors will serve as the primary water quality targets for this TMDL. Biological indicators are appropriate for measuring water quality improvements for a couple of reasons. First, measures of biological integrity directly quantify the extent to which aquatic life beneficial uses are met. Second, biological organisms integrate the effects of stressors through time, which will better capture the effects of the episodic sediment loads into Echo Creek.

3.2 Benthic Macroinvertebrates

As noted by Zweig and Rabeni (2001) benthic macroinvertebrates are ideal candidates for monitoring the effects of human-caused sediment inputs, because substrate is one of the primary factors regulating their distribution and abundance. Macroinvertebrate populations are altered by sediment deposition because habitat is reduced by a loss of interstitial spaces (Cummins and Lauff 1969). In addition, pulses of sediment such as those observed at Echo Creek have been shown to alter the composition of benthic invertebrate assemblages (Shaw and Richardson 2001). These alterations in the composition of benthic macroinvertebrate assemblages are likely to be detectable by both general measures of biotic integrity and measures of biota specifically designed to detect the effects of sediment deposition (i.e., Relyea et al. 2000, Zweig and Rabeni 2001).

3.2.1 General Measures of Biotic Condition

Macroinvertebrate samples have been collected in 2004 and 2005 from a number of stream reaches throughout the watershed (see Technical Analysis section). The taxonomic composition of these samples can be used to calculate numerous measures of general biotic condition. However, this TMDL recommends, at a minimum, the following:

<u>Percent EPT</u>
An index that is frequently used to assess the overall condition of streams is the percent of individuals in a sample that are in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). In general, species within these Orders are more sensitive to anthropogenic stressors than species from other Orders of macroinvertebrates.

<u>Modified Hilsenhoff Biotic Index (HBI)</u>
HBI is an index that summarizes the relative tolerance of an assemblage to human-caused nutrient enrichment. HBI calculations for this TMDL are based on the tolerance values for individual taxa given in Appendix B (Northwest Idaho data) of Barbour et al. (1999). This index was calculated as a density-weighted average of the tolerance values for individual taxa such that lower HBI values are indicative of higher quality waters.

<u>Taxa Richness</u>
Taxa richness is a metric that describes the total number of individuals in a sample. Taxa richness decreases in concert with the magnitude or frequency of human-caused stressors.

<u>Multi-Metric Index (MMI)</u>
A MMI is a combination of indices that together quantify important compositional and functional traits of the macroinvertebrate assemblage (Karr and Chu 1999). Expected MMI values are estimated from measures obtained from a number of physically and geographically similar reference sites. These expected conditions can then be compared against values obtained from a new site to quantify the magnitude of biological impairment. A MMI is currently under development for Utah’s streams and, once complete, will be used to evaluate Echo Creek samples.

<u>O/E</u>
O/E is another measure of biological integrity that is derived from RIVPACS-type empirical models (Wright et al. 1984). These models use geographical and physical watershed characteristics from reference sites to predict the number of taxa that are expected to occur in the absence of human-caused disturbance (E). These predictions are then compared with those taxa observed at a site that the model predicted to occur (O). The ratio O/E describes the percent of taxa lost because of anthropogenic stressors. RIVPACS-type models are currently under development and O/E scores will be used to evaluate Echo Creek samples.

3.2.2 Sediment-specific Measures of Biotic Condition

In addition to the more general measures of biological condition, indices that are generated from sediment-specific relations to alterations of macroinvertebrate assemblages will be explored. Sediment-specific measures of biological condition have been found to be more sensitive to the sediment inputs than more general measures of biological condition (Zweig and Rabeni 2001, Rinella et al. 2002). Relyea et al. (2000) used macroinvertebrate and fine sediment data compiled from 562 stream segments throughout western states to develop sediment tolerance scores for 83 widely-occurring macroinvertebrate taxa (see Appendix B). These tolerance scores were then used to create 3 tolerance categories and associated scores (Figure 3-1).

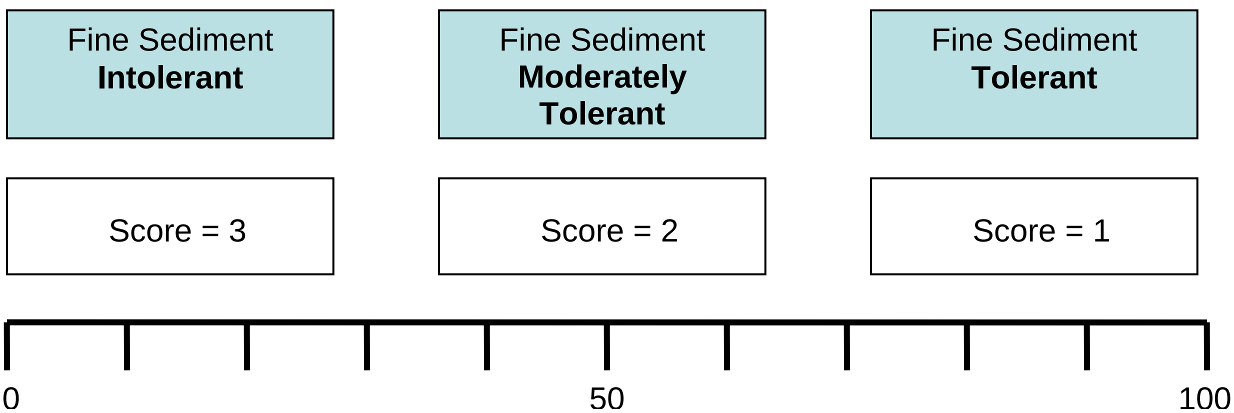

Figure 3-1: **Benthic macroinvertebrate classification into 3 tolerance classes. Taxa that Relyea et al. (2000) found to occur in streams with 0-40% fines were placed in the intolerant category and scored 3. Those taxa found in streams with 41-70% fines were placed in the moderately tolerant category and scored a 2. Those taxa found in streams with 71-100% fines were placed into the tolerant category and scored a 1.**

These fine sediment tolerance scores were then used to generate the following sediment-specific measures of biotic condition:

<u>Sediment-weighted EPT</u>
Sediment-weighted EPT is a modification of EPT that uses empirically-derived sediment tolerance values to give higher weight to those EPT taxa that are sensitive to fine sediment. This metric was calculated as:

$$\text{Sediment-weighted EPT} = \sum (N_i a_i)/N_{EPT}$$

where N_i is the total number of individuals in an EPT taxon, a_i is the tolerance value for taxon i, and N is the total number of EPT taxa.

Sediment-weighted diversity
Measures of diversity combine estimates of richness with the relative abundance of each taxon. Empirically-derived measures of sediment tolerance were used to calculate a measure of diversity that gives a higher weight to sediment-sensitive tolerance as follows:

$$\text{Sediment-weighted diversity} = \sum (N_i a_i)$$

where N_i is the total number of individuals in a taxon, and a_i is the tolerance value for taxon i. A tolerance of 1 was assigned to taxa where the tolerance values are not assigned.

The tolerance values used to generate these metrics will be refined with collections made throughout Utah as the data are made available.

3.3 Defining Endpoints

Effective use of biological indicators as endpoints, or targets, for the implementation of this TMDL will require that naturally-occurring spatial and temporal variability in the composition of macroinvertebrate assemblages is accounted for. Spatial variability will be accounted for in a couple of ways. First, 2-3 sites will be selected on Echo Creek to help tease out differences in macroinvertebrate assemblages associated with local characteristics (i.e., in-stream habitat and riparian conditions) instead of human-caused stressors. Second, data collected at Echo Creek will be compared against other physically and geographically similar reference streams to better understand the range of biological conditions encountered in unimpaired stream ecosystems. Temporal variability will be estimated by comparing measures of biological condition obtained from samples collected within the same season for >3 years.

Once quantified, measures of spatial and temporal variability will be used to help determine whether TMDL implementations have resulted in improved biological conditions. Remediation efforts will continue at Echo Creek until measures of biological condition for 3 consecutive samples falls within 80% of values observed at comparable reference sites. These conditions will continually be reevaluated with the most robust indicators of biological condition available, so that the biological assessment tools under development can be utilized.

4.0 SOURCE ASSESSMENT

There are several potential sources of sediment in the Echo Creek watershed. As mentioned earlier, the geology and soils of the area are highly erodible. Prior to anthropogenic disturbance Echo Creek received large amounts of sediment from the surrounding landscape. It is anticipated that even after implementation of projects to decrease sediment loads to the creek, much sediment will still be transported to the creek.

4.1.1 Agricultural Uses

Livestock grazing is currently the most prominent land use within the watershed. The type of livestock has shifted over time from sheep to cattle. It has been shown that one of the major effects of grazing, besides reduced species richness and disrupted ecosystem function, is alteration of ecosystem structure, resulting in soil erosion. Cattle are often attracted to the lush riparian areas where vegetation is thick and water is easily accessible. Efforts are underway to install off stream watering facilities for livestock in order to reduce the amount of time spent within the stream corridor. There are no defined animal feeding or concentrated animal feeding operations in the watershed.

Although crop farming is not a significant use of this watershed, historically there were a few irrigated fields within the flood plain of Echo Creek until the freeway was constructed. Today only a few small plots remain. Oil exploration and extraction developments are taking place, and recreation and hunting are present, but it appears that cattle ranching will remain the dominate enterprise in Echo canyon for the foreseeable future.

4.1.2 Oil/Gas Fields

There are 22 gas/oil pads within the Echo Creek Watershed (see Figure 4-1). Of these, 15 are plugged and abandoned, 1 is an active service well, 1 is an inactive service well, 3 are shut-in and 2 are producing. Plugged and abandoned wells have been plugged in accordance with the Utah Division of Oil, Gas and Mining approved plugging procedures and well site reclamation has been conducted in accordance with surface landowner agreements. Shut-in wells are wells that have been completed and have shown to be capable of production in paying quantities, and are not presently being operated. The active service well is a water disposal well. Water disposal wells are wells into which salt water is pumped into a zone (with confining zones above and below the zone to prevent fluid migration) to dispose of the salt water. The inactive service well is a gas injection well. These are wells into which gas is injected for the purpose of maintaining or supplementing pressure in an oil reservoir.

The majority of the pads are located in the headwaters of Rees Creek and Cache Cave Creek and all but 1 pad are located in headwater areas. There are typically small areas of disturbance associated with the pads themselves but access roads are a more significant potential source of sediment. A site management plan and surface restoration/reclamation plan are required within the Application for Permit to Drill Statement of Basis and On-Site Evaluation. These plans include disposal procedures for on-site garbage, refuse and human waste and best management practices for containing and controlling runoff and erosion. Also included in the permit application is an environmental parameters section. This section addresses impacts to floodplain and/or wetlands and fauna and flora. It also describes the soil types, surface formations and erosion/sedimentation potential and stability of the site. According to the Utah Division of Oil, Gas and Mining there have not been any environmental violations for any of the wells within the watershed in recent years. The gas/oil pads do not seem to be significant sources of sediment within the watershed, but there is always potential for runoff and erosion from the sites.

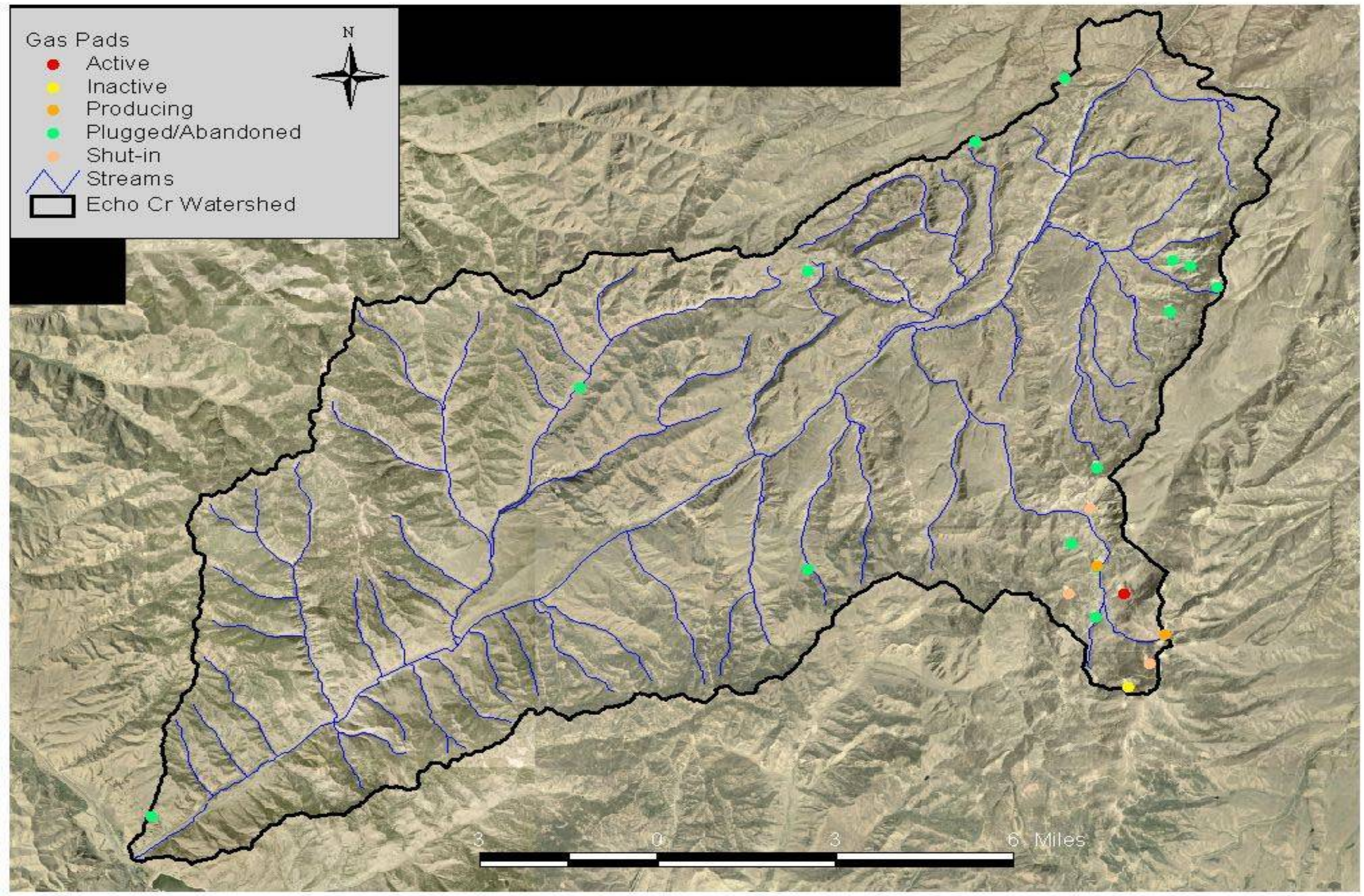

Figure 4-1: Map of Echo Creek watershed gas pads.

4.1.3 Transportation Impacts

Prior to settlement Echo Creek meandered along the valley floor, lined with cottonwoods, willows and many other riparian species. Today it has been straightened and is lined for much of its length by Interstate 80 and the railroad. Only a small number of areas exist where it can access its original floodplain which is critical during high water events like spring runoff. Most of the natural behavior of Echo Creek has been suppressed to provide space for these transportation corridors. The creek is piped under the railroad and the interstate many times on its way down the canyon. Echo Creek gains significant velocity in some areas because there are no meanders, leading to increased erosion potential.

4.2 PSIAC

In November of 2004 a sediment delivery study for Echo Creek was conducted to quantify potential and active erosion sources within the watershed. The study was conducted by the NRCS using the Pacific Southwest Interagency Committee procedure (PSIAC). A field reconnaissance of the entire watershed was performed from existing roads and trails along with reviewing previous studies of the watershed. The field reconnaissance resulted in a comprehensive view of the existing conditions within the various sub-watersheds of Echo Creek. The most notable observation was that the watershed is in good to excellent management, hydrologic, land use and sediment yield condition, with the exception of three severely and critically eroding areas. Focus will be placed on these areas for project implementation. Most major and minor sub-watershed outlets have good vegetative cover and these areas act as filters for sediment being transported through the system. The PSIAC values of this study compare well with a previous study done in 1987.

4.2.1 Sediment Yield from Rees Creek

Rees Creek is located in the upper portion of Echo Creek's watershed. Rees Creek was identified as a major sediment contributor. The sediment yield from Rees Creek has been estimated to be approximately 2000 tons per year. The severely eroding areas in the upper watershed were mostly controlled by the NRCS in cooperation with landowners during the 1990's although channel erosion was not addressed.

A small landslide is currently active in the upper reaches of the drainage. The only method of mitigating this natural phenomenon is to create catch basins for the sediment yield, maintain periodic inspections and perform cleanout work as needed. It is possible that there could be a major enlargement of the landslide.

There is also some channel bank erosion in the main creek channel. It was estimated from previous studies in the area that the sediment yield rate could be approximately 2000 tons of sediment per mile of channel. About 2 miles of channel are actively eroding. It is expected that the lower flood plain area of Rees Creek should be able to handle this sediment by baffling and deposition. If not, then some conservation or mitigation measures may be necessary. Possible measures include spreading the flow out over the flood plain, stilling basins, riprap or other appropriate measures.

Figure 4-2: Confluence of Echo Creek (clear) and Rees Creek (turbid). Rees Creek has long been a major contributor of sediment to Echo Creek.

4.2.2 Sediment Yield from Lower Robinson Creek

Robinson Creek is the next major drainage south and downstream of Rees Creek. It has been estimated to provide approximately 800 tons per year of sediment to Echo Creek. The primary source of sediment in this subwatershed is sheet and rill erosion on a relatively un-vegetated area on the north side of the outlet of Robinson Creek. There are about 160 acres providing sediment directly to the stream. The remainder of the watershed is controlled by a series of dams.

4.2.3 Sediment Yield from I-80 Borrow Area

Little Saw Mill Canyon has been identified as a significant source of sediment in the lower reaches of Echo Creek. It has been conservatively estimated to yield approximately 13,500 tons per year of sediment. Little Saw Mill Canyon serves as a road maintenance borrow area located on the south side of the interstate. This borrow area is in the lower reaches of a small tributary to Echo Creek. Borrow materials have been taken from both sides of the valley and from the main channel area. The valley configuration has been considerably widened by the process. The gradient is moderately steep for the lower 2,500 feet of the channel. Sediment is derived from exposed masses of poorly cemented deeply weathered, loose fines, sand and gravel.

The outlet of the borrow area is a large sized box culvert that is an efficient transporter of sediment. The lower 1,000 feet of the valley is a highly erodible area. It has active gullies and sheet/rill erosion. There was previously a pond in the flat area next to the interstate at the outlet of the canyon in which the flow from the canyon was directed. This pond was probably a sediment trap for the borrow area. That pond has filled and is no longer functioning. The area has been reworked for vehicle parking.

This borrow area was treated for sediment control with multiple, in-channel, ascending, terrace-like small basins. This mitigation functioned successfully until the small basins filled. The present situation is that the terraces are acting like hydrologic drop structures and undergoing classic channel erosion processes. The terraces are in an active gully erosion phase and yield large masses of fine grained material and sand to the lower watershed of Echo Creek. None of the eroding terraces have a gully that has reached the upper end of the terrace and joined with the one draining into it. Depending on the number and intensity of storms, these terrace gullies will merge. Then, the sediment yield from this area could increase by a factor of 7 to 10 in the next year or two.

Erosion control treatment of this area should be a high priority for water quality mitigation. It is equally important that this area be inspected annually for maintenance and after every major usage of the borrow area in order to maintain erosion control.

4.2.4 Sediment Yield from Echo Creek

The NRCS direct volume channel erosion model (1983) was used to estimate sediment yield from Echo Creek. The annual sediment yield was estimated to be approximately 12,800 tons per year. Approximately 60% of the creek banks and bottom are undergoing erosion. The eroding bank heights vary from 1 foot to greater than 10 feet. The average eroding bank height is 6 feet. The total channel length is about 20 miles of which 10 miles are actively undergoing channel erosion. All significant sediment delivery is coming from the portion of Echo Creek downstream of the confluence with Rees Creek. The area upstream of Rees Creek has some eroding areas but has a very low gradient, a well vegetated, grassed flood plain and a dam that catches most water and settles the fine grained materials. Should this situation change, this area could contribute significant amounts of sediment to the Weber River.

Echo Creek is heavily impacted by the constriction of the interstate and the railroad. Prior to settlement and development it was an aggrading, meandering stream flowing over alluvial deposits aided by many beaver dams and a diverse riparian habitat. Now it is a straightened, degrading channel constrained within a small corridor. Echo Creek’s channel is in need of intense coordinated planning to mitigate sediment related water quality problems.

The total sediment yield from severely eroding areas equals approximately 29,100 tons while the natural average annual sediment yield is 40,000 tons so that the total sediment yield for the watershed in its present condition is 69,100 tons. The severely eroding areas represent a 73% increase in sediment yield compared to the natural back ground erosion. If the severely eroding areas are treated, then there will be a 42% reduction in sediment yield from the present condition.

4.3 SVAP

During July 14–18 2003 the NRCS and the Summit Soil Conservation District assembled a team of volunteers from the Echo Creek Watershed Steering Committee and conducted an inventory on Echo Creek following the Stream Visual Assessment Protocol (SVAP). In addition to the SVAP inventory a Stream Erosion Condition Inventory (SECI) developed by the Idaho NRCS was conducted at the same time. Forty-four miles of Echo Creek and its 3 main tributaries were inventoried using these methods. The stream was divided into 37 different reaches based on various criteria such as geographic location, kind, types and amounts of vegetation, impacts and stream type. A table containing reach scores can be found in the Appendix A.

The criteria examined for the SECI were:

1. Bank Erosion Evidence
2. Bank Stability Condition
3. Bank Cover / Vegetation
4. Lateral Channel Stability
5. Channel Bottom Stability
6. In Channel Deposition

The SECI results indicate a total of 33,042 feet of actively eroding banks which represents approximately 14% of the stream banks surveyed. Actively eroding banks were defined as banks that should be treated in the evaluator's opinion. A total of 4,405 tons of sediment are eroding from these stream banks annually. These numbers are considered conservative due to the fact 6 reaches were dry at the time and were not surveyed. The largest sediment contributing reaches are located on the tributaries of Rees Creek in the headwaters of the watershed and Heiners Creek. Additional eroding reaches are located just above the confluence with the Weber River, just below the confluence of Heiners Creek and below the confluence of Rees Creek. These reaches are characterized by highly incised channels with 6 ft average height vertical cut banks.

The Echo Creek SVAP makes reach specific recommendations for restoration and implementation of BMP's to improve stream and watershed conditions. The following practices and BMP's are listed within the SVAP report:

- Grade Stabilization Structures
- Pest Management
- Prescribed Grazing
- Riparian Corridor Fencing
- Stream Bank Protection
- Tree/Shrub Establishment

5.0 TECHNICAL ANALYSIS

The listing of Echo Creek is based primarily on visual observations of high sediment loads during storm events. As a result, most of the technical analyses for this TMDL are focused on establishing baseline biological conditions on sites throughout the Echo Creek watershed. This section of the document provides a brief description of how these data were collected and summarizes the study results. However, there are not a sufficient number of samples to adequately characterize the variability around our estimates of biological condition. A much clearer picture of the biological condition of Echo Creek will undoubtedly emerge as additional data are collected to evaluate the efficacy of ongoing remediation efforts occurring throughout the watershed.

5.1 Study Sites

Macroinvertebrate collections were made at Echo creek in late summer and early autumn of 2004 and 2005 (see site locations on figure 1-3). In 2005, 3 additional sites were added and sampled on the same dates to help better characterize the range of conditions found in the watershed and to better define reference conditions. Gray (2005) provides the following descriptions of these sites:

5.1.1 Echo Creek, STORET 4926070

The Echo Creek site is located approximately 70 m upstream from the creek's confluence with the Weber River. The riparian vegetation is mainly grasses and forbs. Some small willows are present. In some places, the banks of the creek have slumped, but these areas are generally stabilized by grasses. Stream substrates are primarily gravel with some larger (>15 cm diameter) rocks. In 2005, nearly the entire channel was covered with growths of *Potamogeton*, and filamentous algae. Some portions of the channel had a greater amount of silts and muds present than previous, whereas other portions showed evidence of scouring by high flows.

5.1.2 Echo Creek (Canyon), STORET 4926072

The additional site on Echo Creek established in 2005 is located upstream in the narrow canyon section. This reach has a higher gradient and more confined flow than the lower reach, and its substrates were mainly cobble and gravel overlying compacted, finer sediments. Some filamentous algae were present on larger rocks, but the reach lacked macrophytes. Riparian vegetation consists of grasses and sagebrush.

5.1.3 Heiners Creek, STORET 4926082

Heiners Creek was added as a sampling site this year. The sampling reach is in an open pasture used for livestock grazing. The riparian vegetation was made up of grasses and sedges. Stream substrates consist of sand and gravel with few large cobbles. Filamentous algae (both green algae and blue-greens) and macrophytes (*Rorippa, Myriophyllum*, and mosses) covered about 20% of the stream channel.

5.1.4 Sawmill Canyon Stream, STORET 4926045

The small stream in Sawmill Canyon was sampled this year as a potential reference site for the Echo Creek drainage basin. In the sampling reach, the stream is shaded by large trees and receives extensive inputs of leaf and woody debris enhanced by remnants of a beaver dam. Inorganic substrates consist of cobble and gravel overlying uncompacted, finer sediments. Filamentous algae were relatively rare and covered less than 10% of the stream bottom. The drainage basin of this stream is used for some livestock grazing and limited recreation. However, impacts to the stream were minimal at the collection site.

5.2 Macroinvertebrates

Macroinvertebrates at all sites were collected with a 1 foot square Surber sampler (0.25-mm mesh). Three Surber samples were taken in riffle/run portions of the creek at each sampling site on each date. Macroinvertebrates from each sample were hand picked, counted, and identified to the lowest possible level of taxonomic resolution. Sample counts were then used to generate 400 count subsamples to standardize collection efforts (Ostermiller and Hawkins 2004). The subsamples were then used to calculate a number of measures that describe biological condition (see Section 3.0).

5.2.1 Results and Discussion

Table 5.1. Measure of biological condition from the Echo Creek watershed

STORET	Site Name	Date	Richness	EPT Richness	Percent EPT	HBI	Sediment-weighted Diversity	Sediment-weighted EPT
4926070	Lower Echo Ck	8/11/04	14	6	20.6	6.8	487	0.87
4926070	Lower Echo Ck	10/02/04	12	4	7.8	6.9	516	1.41
4926070	Lower Echo Ck	8/02/05	16	5	24.6	6.2	620	1.98
4926070	Lower Echo Ck	10/01/05	13	4	12.4	6.9	544	1.71
4926072	Echo Ck (Canyon)	8/02/05	20	6	46.8	6.2	717	1.93
4926072	Echo Ck (Canyon)	10/01/05	17	6	59.6	5.3	714	1.80
4926082	Heiners Ck	8/27/05	13	3	20.4	6.0	600	1.98
4926045	Sawmill Canyon	8/27/05	24	10	73.1	4.3	855	1.98
4926045	Sawmill Canyon	10/01/05	21	11	83.8	3.9	857	1.84

5.2.2 General Measures of Biological Condition

In general, measures of overall biological condition suggest that both Echo Creek and Heiners Creek are biologically impaired relative to the reference site on Sawmill Creek (Table 5.1). Relative to Sawmill Creek, all other sites in the watershed show declines in both total richness and the number of EPT taxa. The percent of EPT individuals is also depressed at other sites. Finally, modified HBI values would generally categorize the condition of sites within the watershed as “fairly poor” or “poor”, whereas Sawmill Creek would be classified in “good” condition (Resh et al. 1996).

Interestingly, many measures suggest that the Echo Creek canyon site (4926070) is in slightly better condition than other streams in the watershed, although measures of biological condition are lower than Sawmill Creek (Table 5.1). In fact, virtually all measures of biotic condition at the Echo Ck. Canyon site were intermittent between the Lower Echo Creek site and values obtained from Sawmill Ck. One possible reason for the improved condition of the Echo Ck. Canyon site is the higher gradient of this section, which may prevent sediment deposition during the episodic sediment inputs observed on Echo Creek. However, additional data collection is necessary to more clearly evaluate these differences.

5.2.3 Sediment-specific Measures of Biological Condition

Trends were less clear when sediment-specific tolerance values were used to adjust biotic condition metrics (Table 5.1). Sediment-weighted diversity followed similar trends as total richness, suggesting that the sediment tolerance values did not provide additional information. In addition, strong differences were not observed among measures of sediment-weighted EPT.

The inability of sediment tolerance to improve assessments at Echo Creek is in contrast to a couple of studies that found sediment tolerance values to strongly improve the ability of macroinvertebrates to detect the effects of human-caused sediment inputs (Relyea et al. 2000, Zweig and Rabeni 2001). There are at least two possible explanations for these differences. First, given that all sites were located in watersheds with highly erodible soils it is possible that the macroinvertebrates were adapted to the effects of sediment inputs. Indeed, few taxa identified as ‘sensitive’ were found at Sawmill Creek. A second related possibility is that because the tolerance values were empirically derived from streams throughout the western USA they do not adequately capture the relative sensitivity of taxa that naturally occur in streams with high sediment inputs.

5.2.4 Future Research

Given that many watersheds in Utah are found in watersheds with highly erodible soils, future research needs to focus on which measures of biological condition are most sensitive to human-caused sediment inputs in these conditions. These relations are currently being explored as part of the development of RIVPACS-type empirical models and MMIs. Insights gained through the exploration of these relations will undoubtedly help ensure that the final measures used to measure improvements in the biological integrity at Echo Creek are as sensitive as possible.

5.3 Linkages Between Controls and Biological Endpoints

An all-inclusive theory of all effects of deposited or suspended sediments on benthic macroinvertebrate assemblages is difficult to formulate due to differences in study objectives, methods, and evaluations of biological responses (Zweig and Rabeni 2001). Nonetheless, a few generalizations are possible. Sediment pulses such as those that occur at Echo Creek have been shown to increase the drift of macroinvertebrates, which in turn reduces total density and diversity (Shaw and Richardson 2001). As sediment settles, interstitial spaces are filled and the quality of macroinvertebrate habitat is diminished (Cummins and Lauff 1969). In addition, sediment input alters distributions of substrate size classes, which are an important determinant of macroinvertebrate distributions (Minshall 1984). All of these effects of sediment should lead to alterations of the composition and function of macroinvertebrates in Echo Creek. Indeed, preliminary analyses suggest that Echo Creek is biologically impaired relative to a physically comparable reference site (see Technical Analysis section). Measures of biological condition obtained from continued monitoring of macroinvertebrates at Echo Creek should allow us to evaluate the success of the remediation projects described in this TMDL.

5.4 Water Chemistry Sampling Results

The Utah Division of Water Quality has five monitoring sites within the Echo Creek watershed. These were sampled on a monthly basis from July of 2002 through June of 2004. Physical parameters including temperature, pH, specific conductance, dissolved oxygen, and flow were recorded at the time of sample collection. Analyzed chemical parameters included total and dissolved nutrients, TSS, and total dissolved solids (TDS). On several winter season visits the streams were frozen and no flow data was measured. A small amount of TSS data was collected at 2 of those 5 sites previous to the 2002-2004 intensive sampling.

The Weber Basin Water Conservancy District is responsible for delivering culinary, industrial and irrigation water to residents of Davis, Weber, Summit, and Box Elder counties. They are very interested in Echo Creek due to its impacts on the Weber River. For the past 3 years they have sampled Rees Creek and Heiners Creek, two significant tributaries to Echo Creek. A flow gage was installed on Rees Creek which helps to better correlate flow values and TSS concentrations.

Several samples showed high TSS concentrations. Climatic data from a nearby weather station in Coalville, Utah was used to look for correlations between the high TSS values and rainfall. It was evident that when a spike in precipitation occurred it was often followed by a spike in TSS concentration.

Table 5-2 shows several dates with the amount of precipitation and TSS values for Echo Creek above the confluence with the Weber River.

Table 5-2: Precipitation driven TSS concentrations

Date	Precipitation (in.)	Echo Creek above Weber River (TSS in mg/L)
9/30/1998	0.03	14.4
10/28/1998	0	12
1/21/1999	0.35	77.4
2/17/1999	0.33	138
7/16/2002	0.1	None detected
7/9/2003	0	None detected
6/2/2004	0	None detected

High TSS values were also observed on dates with no precipitation. These occurred in the spring months and were likely the result of snow melt runoff. Table 5-3 shows values from these instances.

Table 5-3: Snowmelt driven TSS concentrations

Date	Precipitation (in.)	Echo Creek above Weber River (TSS in mg/L)	Heiners Creek (TSS in mg/L)	Sawmill Creek (TSS in mg/L)
3/25/1999	0	395	9	NA
3/24/2004	0	47	41	52
5/5/2004	0	33	26	81

Based on data and observation, the majority of sediment loading into Echo Creek occurs during spring runoff and summer convective storms. After a storm event, the tributaries often run very turbid. Winter months generally show very low TSS values. Sediment loading comes from all tributaries in the watershed. The major contributor varies from year to year according to the data we have available. The following tables show what percent of the load comes from each tributary.

Figure 5-1 shows the load to Echo Creek in 2003 in pounds per year. The load was determined by calculating the product of TSS concentration, flow, conversion factor of 5.39, and 365 days per year. Samples were collected monthly excluding September.

Figure 5-2 shows spring TSS load to Echo Creek based on DWQ sampling data. It is difficult to interpret data from year to year as the variability is high. DWQ sampling is conducted on a set schedule so it is difficult to capture the events that result in significant loading.

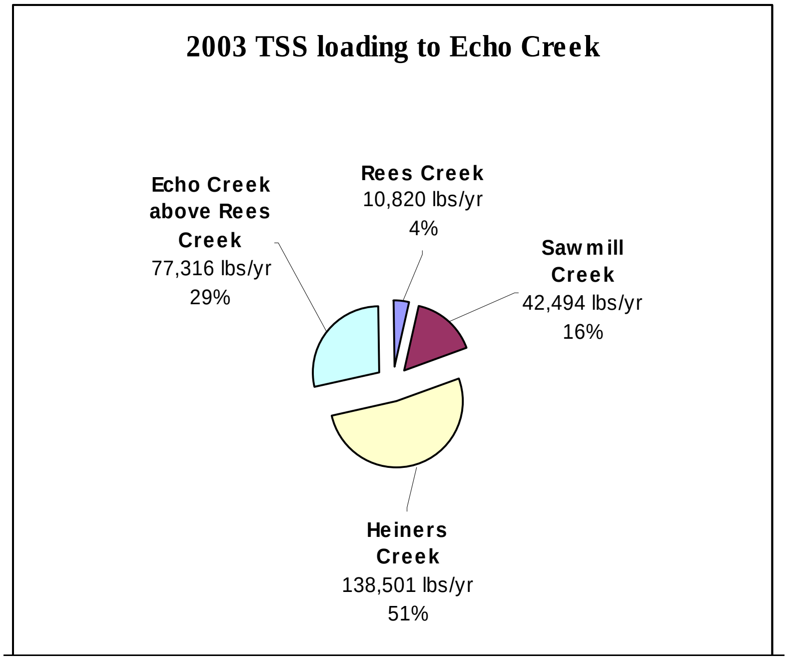

Figure 5-1: 2003 TSS loading to Echo Creek.

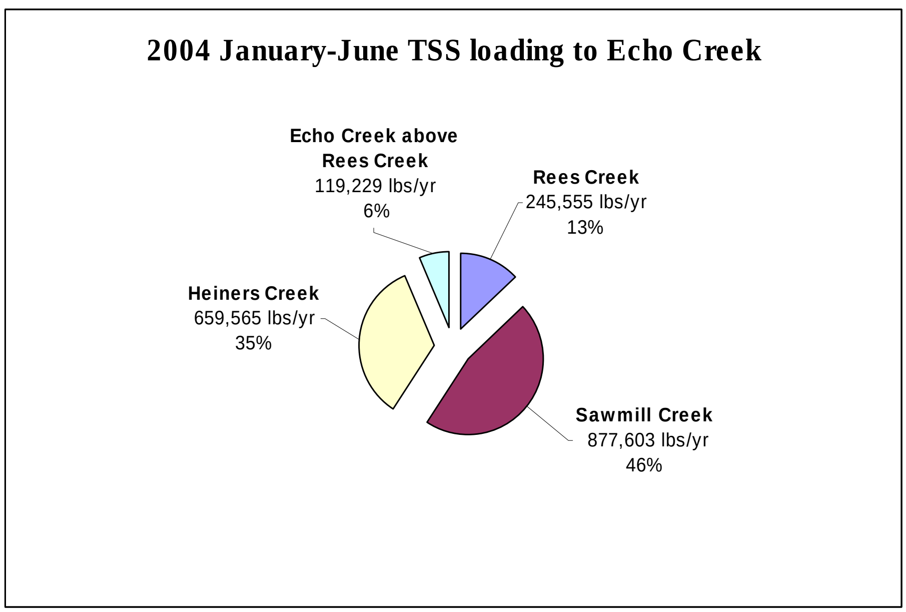

Figure 5-2: 2004 January-June TSS loading to Echo Creek.

Although these data contradict what the SVAP and PSIAC concluded, they are still useful. Each of those studies identified Rees Creek as one of the primary sources of sediment in the watershed, yet in Figure 5-1 it is only 4% of the 2003 load. Rees Creek is often dry or has a minimal flow, so data indicate a lack of sediment contribution. Throughout most of the year sediment loads in Echo Creek are not problematic. It is just a small percent of the time that large episodic loading events occur, resulting in tons of sediment entering the system at one time. An attempt to collect samples during and after storm events must be made to determine the extent of storm related contributions.

6.0 MARGIN OF SAFETY

According to the Federal Clean Water Act, TMDLs require a margin of safety (MOS) component that accounts for the uncertainty about the relationship between the pollutant loads and the receiving waterbody. The MOS can be implicit or explicit. An explicit MOS is often accounted for in the allocation section as a percentage of the overall allocation, but we are not setting a percentage reduction in turbidity or TSS values. For this study the MOS will be addressed implicitly by using conservative methods of measuring macroinvertebrate response.

There is some capacity for growth in the Echo Creek watershed. Many rural areas of Summit County are being developed at a rapid rate. However, Interstate 80 and the railroad limit development activities along the main stem of Echo Creek and most of the land along the tributaries is privately owned in large parcels.

7.0 IMPLEMENTATION

7.1 Proposed Measures

The following implementation measures should be undertaken to successfully achieve the endpoints identified in this TMDL:

7.1.1 Rees Creek Sediment Detention Basin Demonstration Project

In 2004, seven sediment detention basins were installed on Rees Creek. Rees Creek is a major contributor of sediment to Echo Creek. The project involved constructing detention basins within the incised channel of Rees Creek. New channels were created to connect the basins. These channels were created using proper channel dimensions based on bank full discharge. The proper meander patterns were also recreated. The channels have been reconnected to the historic floodplain. In order to deal with high flow events spillways were constructed on the detention basins using geotextile fabric, cement blocks and compacted soil. These spillways were then re-seeded to further stabilize them. This project has been successful in trapping sediment and not allowing it to enter the main channel of Echo Creek. Sampling of TSS was conducted by Weber Basin Water Conservancy District (WBWCD) above and below the project (see Table 7-1). As shown in Table 7-1 there were dramatic reductions in TSS below the project location.

Table 7-1: TSS values above and below Rees Creek demonstration project

Date	Rees Creek above project (TSS in mg/L)	Rees Creek below project (TSS in mg/L)	Rees Creek above Echo Cr (TSS in mg/L)	Echo Creek above Weber R (TSS in mg/L)
3/25/05	**270.4**	**12**	32.8	68.8
4/1/05	**398**	**7.5**	35	9.5
4/8/05	**596**	**78.5**	95	40.5
4/21/05	**120**	**8.7**	71.5	32.5
5/2/05	**59**	**7.7**	74	42.5
5/6/05	**1274**	**72**	228	82
5/13/05	**1196**	**18.9**	169	102.4
5/20/05	**167.5**	**22.4**	57	60
5/27/05	**87.2**	**8.4**	11.5	17.6

7.1.2 Rees Creek Sediment Detention Phase II Project

As shown by the above data there is an increase in TSS from below the demonstration project to the confluence with Echo Creek. Therefore, an additional series of sediment detention basins will be installed upstream from the confluence. These sediment detention basins will be constructed using the same design as the demonstration project. The WBWCD will conduct sampling on this project to monitor success.

7.1.3 Dennis Wright Sediment Detention Basin Project

This project will involve constructing 2 or 3 detention basins on the main channel of Echo Creek. A design similar to the Rees Creek Project will be used but some modifications will be made to provide fish passage and larger perennial flows. Landowner permission for the project has been granted. This section of Echo Creek is one of the few sections that would allow for the installation of these types of basins due to the constriction of the creek in most places by the railroad and interstate highway. The Natural Resources Conservation Service (NRCS) will provide the engineering design for the project while the WBWCD will conduct sampling.

7.1.4 Utah Department of Transportation Borrow Pit Project

As identified in the 2004 Echo Watershed PSIAC Report, the UDOT I-80 borrow pit area is a significant contributor of sediment to Echo Creek. As stated in the report this area should be a high priority for water quality mitigation. Stabilizing gully erosion and head cutting, along with sediment detention and fencing, should be implemented in this area. Riparian and upland re-vegetation will further stabilize the eroded areas and decrease sediment contributions from rill and sheet erosion. Implementation efforts in this area should be inspected and maintained in order to sustain effective erosion control.

7.1.5 Re-establishment of Woody Riparian Vegetation

As identified in the Echo Creek Stream Visual Assessment Protocol report (SVAP) the main channel of Echo Creek has marginal to poor riparian habitat conditions. Marginal riparian habitat conditions are located on reaches that encompass much of the mid and lower sections of Echo Creek down to its confluence with the Weber River. This portion of the stream corridor has been impacted by stream alteration and weed spraying resulting in a loss of woody riparian vegetation typically associated with this type of stream. Poor riparian habitat is common along the main stem of Echo Creek. In a number of these areas stream alteration has virtually eliminated all the riparian habitat. The stream has been channelized into a cement canal to facilitate the construction of Interstate 80. Woody riparian vegetation should be re-established along the majority of the main channel of Echo Creek. The SVAP will be used to identify specific locations. The Summit Soil Conservation District, whose district includes the Echo Watershed, has a water jet stinger available for use. The water jet stinger is a tool for planting dormant non-rooted plant cuttings, such as willows. The stinger uses a jet of water to bore a hole into the stream bank in which the cutting is planted. The stinger also allows the cutting to be planted into the water table in order to maximize growing success of the cuttings.

Figure 7-1: Natural re-establishment of willows on Sawmill Creek.

7.1.6 Elimination of Broadcast Weed Spraying

Broadcast spraying of weeds has historically been used by landowners, UDOT and the railroad to control weeds in the Echo Creek Watershed. In order to maximize success of any planting project, along with protecting established riparian vegetation, the practice of broadcast spraying should be eliminated within the riparian corridors of Echo Creek and its tributaries. Working with the Summit County Weed Supervisor, BMP's for weed control within these sensitive areas will be established. Landowners and land managers will be educated on these BMP's and agreements to implement them in replacement of broadcast spraying will be sought.

7.1.7 Installation of Grade Stabilization Structures

The straightening and confinement of Echo Creek and the nature of the channel's material has incised the channel on average 6 to 10 feet. The location of the railroad and interstate will never allow for the stream to meander properly to control flow velocities and bank erosion due to channel alteration. In order to slow flow velocities and aggrade the stream channel to reconnect it to the floodplain, drop structures should be installed. The Echo SVAP identifies specific reaches for installation of these structures. It states that approximately 340 drop structures are needed. Landowner agreements to install these structures will be sought along with funding.

7.1.8 Riparian Corridor Fencing

The SVAP recommends fencing 89,110 feet of riparian corridor. These riparian areas are very sensitive to impacts from livestock. By excluding livestock access to these sensitive areas the riparian areas can function properly by protecting the stream banks and buffering the streams from overland erosion. The SVAP will be used to identify specific fencing locations.

7.1.9 Prescribed Grazing (Riparian)

Proper grazing management and Best Management Practices (BMP's) should be implemented in the areas where grazing has negatively impacted the stream and riparian area. The SVAP recommends a total of 476 acres in which to implement prescribed grazing practices. The NRCS will evaluate site specific locations identified in the SVAP and make recommendations for grazing practices.

7.1.10 Stream Bank Protection

The SVAP identifies a total of 16,743 feet of stream bank which should be treated to control erosion. A variety of bank stabilization practices should be used including hard structures, bioengineering and geotextiles depending on site specific considerations. The SVAP will be used to determine site specific bank protection projects.

7.1.11 Upland Watershed Projects

The vast majority of the Echo Creek Watershed is used for grazing purposes and is further impacted by wildlife. In order to address the impacts from livestock and wildlife, upland watershed projects should be implemented. These projects should include but not be limited to the following:

Spring Developments
Develop springs in upland areas to provide off-stream water and keep livestock and wildlife out of the main stream channels.

Upland Seeding/Brush Management
Approximately 30% brush management should be implemented within the watershed. The brush should be managed to increase forage and increase soil stability. This will decrease sheet and rill erosion and provide livestock and wildlife alternatives to forage other than in riparian areas.

The Echo Creek Watershed is considered a high priority watershed for receipt of section 319 non-point source program funding. It is the Utah Division of Water Quality's intent to facilitate and support project proposals for 319 funding for implementation projects in concert with this TMDL. Estimates for project costs and anticipated sources of funding are located in Appendix C.

7.2 Expected Load Reductions from Proposed Measures

The following load reduction estimates are based on numbers from the PSIAC.

Table 7-2: Expected Load Reductions from Proposed Measures

Proposed Measures	Expected Load Reductions (tons/year)
Rees Creek Demonstration Project and Rees Creek Sediment Detention Phase II Project*	2000
UDOT Borrow Pit Project	12,000
Stream Bank Protection along with Grade Control Structures and Dennis Wright Sediment Detention Basins Project*	12,000
Establishment of Woody Riparian Vegetation, Riparian Corridor Fencing, Prescribed Grazing, Upland Watershed Projects	5000
Total Expected Load Reductions	31,000

*Over time the detention basins will fill in completely with sediment, so the reduction estimate can be expected to decline after a few years. However, even after the basins fill in, the creek will have better access to the floodplain, which will act as a sediment filter and continue to contribute to a reduction in sediment to Echo Creek.

8.0 MONITORING

Analysis of the water quality data for the Echo Creek watershed has revealed several data gaps. Long term monitoring has taken place at only one site, Echo Creek above the Weber River (4926070), since 1983, but no TSS or turbidity data were collected until 1993.

The Utah DWQ has several established sites, as noted earlier, but the data is minimal. Utah DWQ collected physical and chemical data for 5 sites beginning in July of 2002 as part of its basin intensive monitoring cycle. Those sites were sampled once per month through July 2003. They include:

4926040: Sawmill Creek above Echo Creek
4926050: Rees Creek above Echo Creek
4926060: Echo Creek above Rees Creek
4926070: Echo Creek above Weber River
4926080: Heiners Creek above Echo Creek

Macroinvertebrate data has been collected by DWQ for several years from Echo Creek above the Weber River (4926070). Additionally, Larry Gray, with Utah Valley State College, has collected samples at the following locations:

4926045: Sawmill Creek 2.5 miles above Echo Creek (reference site)
4926072: Echo Creek 1 mile above Weber River
4926082: Heiners Creek 2 miles above Echo Creek
4926090: Echo Creek 2 miles above confluence with Heiners Creek

Recommendations for monitoring within the Echo Creek watershed are listed below.

1. Continue monitoring chemical and physical parameters at the 5 intensive sites at a minimum of once every 5 years.

2. Increase the number of macroinvertebrate sampling sites. Collect samples on Echo Creek above and below the proposed detention pond project site to gather baseline data. Continue to collect at sites where samples have already been taken. The data set is very limited at this point. Any additional data will help to increase understanding of a dynamic system.

3. Identifying exact sources of sediment impairment is difficult. Sediment in streams can originate from several possible sources, including upland erosion, channel scouring, and bank erosion. Bank erosion pins are a fairly simple and inexpensive way to measure areas of eroding bank and how much sediment results from that process. It is recommended that bank erosion pins be installed in several places to more accurately quantify the load from this source.

4. Collect and analyze photo points. Provide annual photo documentation to visually evaluate the success of restoration activities in maintaining stable channel and banks and establishing riparian vegetation.

5. Conduct follow up PSIAC and SVAP studies throughout the watershed at least once every 10 years, but possibly more often to track changes in erodible areas, as well as potential improvements in areas where projects have been implemented.

6. The Echo Creek watershed will be an ideal area to apply the new EPA WARSSS model (Watershed Assessment of River Stability and Sediment Supply). According to the EPA website, WARSSS is a watershed approach to sediment assessment that focuses on:

   - natural variability in sediment dynamics
   - geologic versus anthropogenic sediment sources
   - erosional and depositional processes
   - prediction of sediment loads
   - streamflow changes, and
   - stream channel stability and departure from reference condition.

9.0 PUBLIC PARTICIPATION

Public participation is fundamental to the success of any TMDL. Agencies, landowners and other stakeholders must be clear about the objectives, who will be involved, and how the goals are going to be met.

Due to broad local support to address the issues within the watershed the Echo Creek Steering Committee was formed in June of 2002. Many meeting have been held since and attended by local, state and federal cooperators. Meeting dates include 6/13/02, 9/12/02, 5/15/03, 6/19/03, 9/9/03, 3/10/05, and 4/22/05.

An Echo Creek Steering Committee meeting was held on January 19 at the Coalville County Building at 7 PM. The objective of this meeting was to discuss the draft and address comments or suggestions committee members had about it.

Public comment period was from January 30th-March 3rd, 2006. Notice of the TMDL was published in the Salt Lake Tribune, The Deseret News, and the Summit County Bee.
No public comments were received.

10.0 REFERENCES

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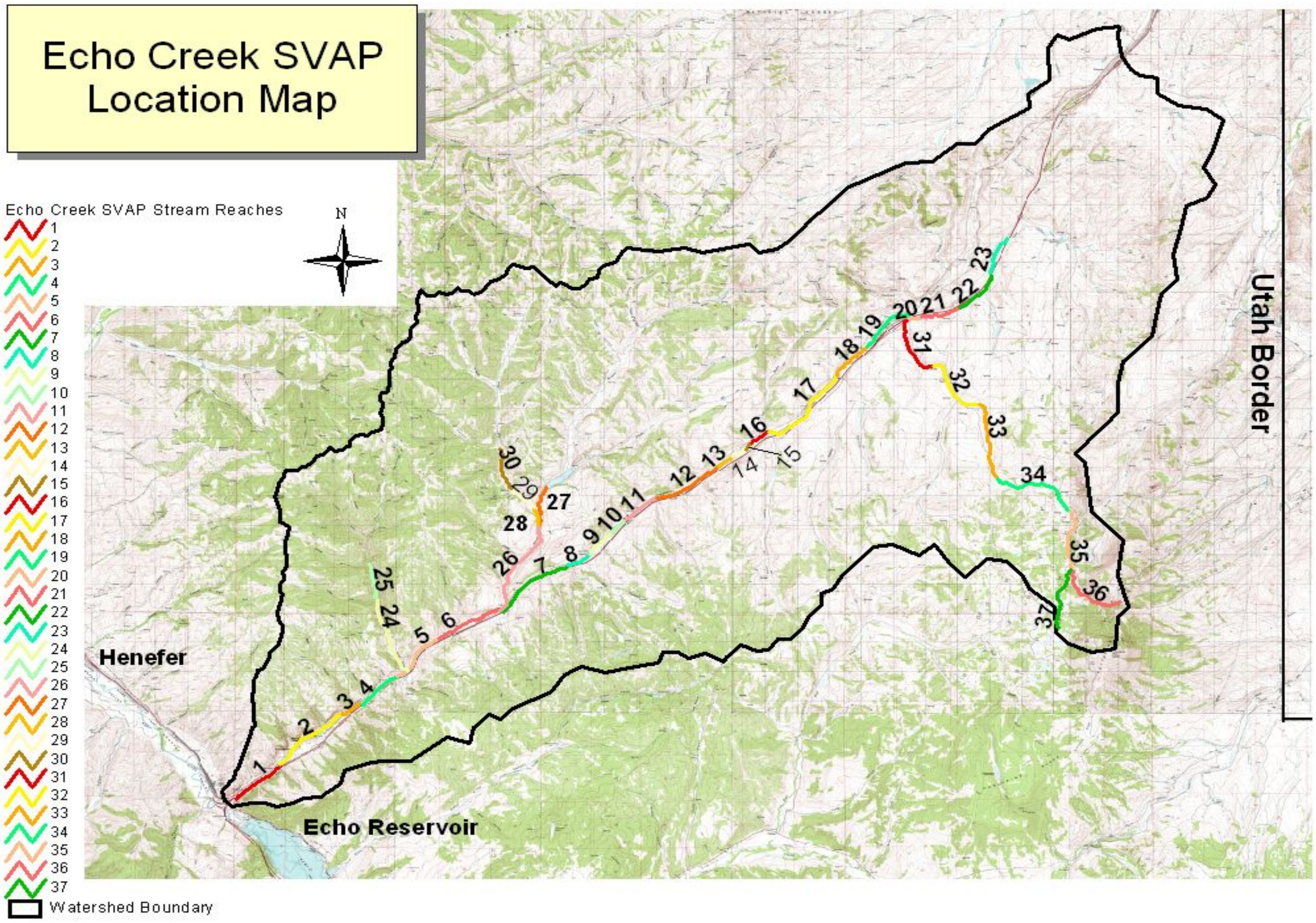
Appendix A: Echo Creek SVAP results



Thirteen different criteria were evaluated in the SVAP for the 37 different reaches. The scale for all of the ratings is 1 through 10, except for the Macroinvertibrates Observed category which was rated between –3 through 15. A score of 10 would indicate the best possible observable conditions and a 1 would indicate the worst. The Manure Presence category was only rated on those reaches where manure was present, otherwise it was not rated (hence the empty cells for this criteria on some reaches). The low ratings for the Canopy Cover and Riparian Zone categories indicate the lack of woody riparian vegetation and other riparian species. The presence of this type of vegetation is vital for stabilizing stream banks and buffering the stream from upland sediment sources. Poor to moderate conditions for these criteria are present on the entire main stem of Echo Creek.

Low to moderate ratings for the Channel Condition and Hydrologic Alteration categories indicate the loss of natural channel function. This loss is partly due to the constricting of the stream by transportation routes, mainly the railroad and Interstate 80, and the loss of riparian habitat. This increases stream velocities and increases bank erosion as the stream tries to adjust and re-establish a new floodplain. The highly incised condition of the stream channel produces large amounts of sediment as the stream adjusts.

Echo Creek SVAP Results													
Reach Number	Channel Condition	Hydrologic Alteration	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrichment	Fish Barriers	Fish Cover	Pools	Invertebrate Habitat	Canopy Cover	Manure Presence	Macro-invertebrates
1	6	5	8	3	7	6	1	10	7	10	3		14
2	8	10	10	8	7	6	10	10	8	10	2	2	12
3	1	1	7	10	7	6	10	3	1	5	1	5	12
4	4	6	9	10	7	4	10	7	4	7	1		12
5	1	1	8	10	7	5	10	5	1	7	1		9
6	5	5	5.5	4	5	4	5	8	7.5	3	2		10
7	3	3	4.5	5	6	7	5	6.5	8	5.5	1	5	6
8	6	7	8	6.5	8	7	10	3	5	5.5	1	5	7
9	8	8	8.5	6	8	7	10	5	8.5	7.5	2	5	11
10	2	1	8	9	7.5	8	5	5	5	5	2		9
11	2	3	7	7.5	7	7.5	5	5	4	5	1.5		7
12	1	3	1	9	7	6	1	6.5	6.5	5.5	1	10	4
13	4	8	3	7	5	5	10	3	6	2	1		2
14	7	8	4	9	5	5	9	5	10	2	1		2
15	7	9	9	10	5	4	1	4	7	2	1		10
16	4	8	3	9	6	5	1	4	7	2	1		-2
17	4	7	4	7	3	4	10	2	2	1	1	4	-3
18	5	4	1	5	4	5	1	2	3	3	1	5	-2
19	2	5	1	8	3	6	1	2	2	3	1	3	-2
20	dry	“	“	“	“	“	“	“	“	“	“	“	“
21	9	7	10	9	5	4	1	2	2	1	1	5	0
22	dry	“	“	“	“	“	“	“	“	“	“	“	“
23	dry	“	“	“	“	“	“	“	“	“	“	“	“
24	7	5	8	6	8	8	10	6	1	5	4	3	10
25	9	8	10	9	9	9	10	9	1	10	10	4	12
26	6	6	8	8	8.5	8	8	7	6	8	5	5	11
27	dry	“	“	“	“	“	“	“	“	“	“	“	“
28	8.5	6	9	7.5	8	9	10	7	3	9	7	5	12
29	5	2	5.5	3.5	10	9	10	4	2	3	3	5	11
30	8.5	9	10	7.5	10	9.5	10	6	3	4	7		12
31	dry	“	“	“	“	“	“	“	“	“	“	“	“
32	dry	“	“	“	“	“	“	“	“	“	“	“	“
33	5	4	8	3	5	5	6	5	3	3	2	5	4
34	5	3	7	3	5	4.5	1	3	3	10	1	5	8
35	8	7	9	3	7	7	1	5	3	10	1	5	9
36	10	10	10	8	10	9	1	8	3	10	10	5	13
37	7	10	10	10	7	7	1	3	1	7	10	5	8

Appendix B: Sediment tolerance values (FSBI) and modifications obtained from Relyea et al. 2000.

Order	Taxon	FSBI	Modified FSBI
Coleoptera	*Cleptelmis ornata*	2	1
Coleoptera	*Cleptelmis spp.*	2	1
Coleoptera	*Lara avara*	2	1
Coleoptera	*Optioservus spp.*	3	1
Diptera	*Chelifera spp.*	2	1
Diptera	*Dicranota spp.*	2	1
Diptera	*Dixa spp.*	1	1
Diptera	*Hexatoma spp.*	3	1
Diptera	*Limnophila spp.*	2	1
Diptera	*Simulium spp.*	3	1
Diptera	*Tipula spp.*	3	1
Ephemeroptera	*Cinygma spp.*	2	1
Ephemeroptera	*Heptagenia/Nixe spp.*	2	1
Ephemeroptera	*Paraleptophlebia spp*	2	1
Megaloptera	*Sialis spp.*	1	1
Plecoptera	*Isoperla spp.*	2	1
Plecoptera	*Malenka spp.*	2	1
Plecoptera	*Zapada cinctipes*	3	1
Plecoptera	*Zapada columbiana*	3	1
Trichoptera	*Cheumatopsyche spp.*	2	1
Trichoptera	*Lepidostoma* - panel case larvae	2	1
Trichoptera	*Lepidostoma spp.*	2	1
Trichoptera	*Psychoglypha spp.*	3	1
Trichoptera	*Rhyacophila Sibirica grp.*	3	1
Trichoptera	*Wormaldia spp.*	2	1
Coleoptera	*Heterlimnius corpulentus*	5	2
Coleoptera	*Heterlimnius spp.*	5	2
Coleoptera	*Narpus concolor*	5	2
Coleoptera	*Narpus spp.*	5	2
Coleoptera	*Zaitzevia spp.*	5	2
Diptera	*Antocha spp.*	6	2
Diptera	*Atherix spp.*	6	2
Diptera	*Clinocera spp.*	5	2
Diptera	*Glutops spp.*	5	2

Order	Taxon	FSBI	Modified FSBI
Diptera	*Hemerodromia spp.*	5	2
Diptera	*Pericoma spp.*	5	2
Ephemeroptera	*Acentrella spp.*	6	2
Ephemeroptera	*Ameletus spp.*	4	2
Ephemeroptera	*Baetis bicaudatus*	5	2
Ephemeroptera	*Baetis bicaudatus/tricaudatus*	5	2
Ephemeroptera	*Baetis spp.*	4	2
Ephemeroptera	*Baetis tricaudatus*	5	2
Ephemeroptera	*Cinygmula spp.*	6	2
Ephemeroptera	*Diphetor hageni*	4	2
Ephemeroptera	*Epeorus albertae*	6	2
Ephemeroptera	*Epeorus longimanus*	6	2
Ephemeroptera	*Epeorus spp.*	6	2
Ephemeroptera	*Ephemerella inermis/infrequens*	4	2
Ephemeroptera	*Ephemerella spp.*	4	2
Ephemeroptera	*Paraleptophlebia bicornuta*	5	2
Ephemeroptera	*Rhithrogena spp.*	6	2
Ephemeroptera	*Serratella spp.*	5	2
Ephemeroptera	*Serratella tibialis*	5	2
Ephemeroptera	*Tricorythodes minutus*	4	2
Ephemeroptera	*Tricorythodes spp.*	4	2
Plecoptera	*Calineuria californica*	5	2
Plecoptera	*Pteronarcys spp*	6	2
Plecoptera	*Skwala spp.*	5	2
Plecoptera	*Sweltsa spp.*	4	2
Plecoptera	*Visoka cataractae*	5	2
Plecoptera	*Yoraperla spp.*	5	2
Plecoptera	*Zapada oregonensis*	6	2
Plecoptera	*Zapada spp.*	4	2
Trichoptera	*Brachycentrus occidentalis*	6	2
Trichoptera	*Brachycentrus spp.*	6	2
Trichoptera	*Dicosmoecus spp.*	6	2
Trichoptera	*Glossosoma spp.*	6	2
Trichoptera	*Hydropsyche spp.*	5	2
Trichoptera	*Hydroptila spp.*	5	2
Trichoptera	*Lepidostoma* – sand case larvae	5	2
Trichoptera	*Micrasema spp.*	4	2
Trichoptera	*Neophylax spp.*	6	2
Trichoptera	*Parapsyche elsis*	4	2

Order	Taxon	FSBI	Modified FSBI
Trichoptera	*Parapsyche spp.*	4	2
Trichoptera	*Rhyacophila Betteni grp.*	6	2
Trichoptera	*Rhyacophila Brunnea grp.*	5	2
Trichoptera	*Rhyacophila Coloradensis grp.*	4	2
Trichoptera	*Rhyacophila spp.*	5	2
Ephemeroptera	*Attenella spp.*	7	3
Ephemeroptera	*Caudatella spp*	8	3
Ephemeroptera	*Drunella coloradensis/flavilinea*	7	3
Ephemeroptera	*Drunella doddsi*	7	3
Ephemeroptera	*Drunella grandis*	7	3
Ephemeroptera	*Drunella grandis/spinifera*	7	3
Ephemeroptera	*Drunella spinifera*	7	3
Ephemeroptera	*Drunella spp.*	7	3
Ephemeroptera	*Epeorus grandis*	8	3
Plecoptera	*Cultus spp*	7	3
Plecoptera	*Doroneuria spp*	7	3
Plecoptera	*Hesperoperla pacifica*	7	3
Plecoptera	*Megarcys spp*	8	3
Trichoptera	*Apatania spp*	7	3
Trichoptera	*Arctopsyche grandis*	8	3
Trichoptera	*Arctopsyche spp*	8	3
Trichoptera	*Brachycentrus americanus*	7	3
Trichoptera	*Ecclisomyia spp*	8	3
Trichoptera	*Oligophlebodes spp*	8	3
Trichoptera	*Rhyacophila Hyalinata grp.*	7	3

Appendix C: Costs for proposed implementation projects

Current Implementation Projects

Project	Description	Cost
Rees Cr Demo Project	Installation of 7 sediment detention basins. Detain sediment in Upper Rees Cr. Create new channel using proper channel dimensions and reconnect channel to floodplain. Implemented in 2004	Total - $120,000 319 funding and landowner match
Rees Cr Phase II Project	Installation of 4 or 5 sediment detention basins. Detain sediment in Rees Cr and decrease the amount of sediment entering Echo Cr. Create new channel using proper channel dimensions and reconnect channel to floodplain. To be implemented in 2006	Total - $40,000 Approved for funding in 2005 319 funds and landowner match
Dennis Wright Sediment Detention Basins Project	Installation of 2 or 3 sediment detention basins on the main channel of Echo Cr. Detain sediment in Echo Cr. Reduce the amount of sediment entering the Weber River. Create new channel using proper channel dimensions and reconnect channel to floodplain. To be implemented in 2006	Total - $39,400. $23,333 from Utah Watershed Coordinating Council $7,000 from Weber Basin Water Conservancy District for water quality monitoring $10,000 from US Fish and Wildlife Service

Costs for Proposed Measures – The following costs were determined using the NRCS cost list for Best Management Practices.

Practice	Description	Budget Needed
UDOT Borrow Pit Project	Stabilize eroding gullies and headcuts. Detain sediment in borrow pit area.	To be determined
Establishment of Woody Riparian Vegetation	Plant approximately 594 acres of woody riparian vegetation.	\$750 per acre Total cost - \$445,500
Grade Control Structures	Install 375 grade control structures, such as log and rock drop structures and Rosgen cross vanes, in order to slow stream velocities and aggrade the stream channel. Several dry washes should also be treated to minimize their sediment contributions during storm events.	\$360 per structure Total cost - \$135,000
Riparian Corridor Fencing	Build 16.9 miles of fencing to exclude livestock from riparian areas.	\$1.50 per foot Total cost - \$133,665
Prescribed Grazing for Riparian areas	The NRCS will evaluate site specific location identified in the SVAP and make recommendations for grazing practices on 476 acres.	No cost associated with these practices
Stream Bank Protection	Stabilize 3.2 miles of stream banks.	\$20 per foot Total cost - \$334,860
Pest Management	Eliminate broadcast spraying in riparian corridor areas. Control weeds on 396 acres.	\$100 per acre Total cost - \$39,600
Spring/Pond Developments	Develop 20 springs and create 8 ponds to provide watering facilities for livestock and wildlife in order to keep them out of stream channels. Install 25 troughs along with 8 miles of pipeline.	Spring/Pond Development – To Be Determined (NRCS cost list – As Bid) Troughs - \$1,000 each Pipeline - \$2.40 per foot Total Cost of Troughs and Pipeline - \$126,376
Brush Management/Seeding	Treat 15,000 acres of the Echo Watershed with brush management and reseed 1000 acres.	Reseeding - \$70 per acre Brush Management - \$25 per acre Total cost - \$420,000