EAST CANYON WATERSHED RESTORATION ACTION PLAN

September 1, 2004

Acknowledgments

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Introduction & Purpose

The East Canyon Watershed has been the focus of numerous water quality related studies over the last 10 years in response to significant water quality concerns. Many of these studies speak to various aspects of water quality issues and remedies proposed for this watershed. This Watershed Restoration Action Plan (WRAP) will bring together the previous studies and reports into a cohesive picture of the water quality issues and opportunities in the East Canyon Watershed. In addition, the WRAP will provide a cohesive strategy for implementing needed water quality improvements for the watershed such that state water quality standards are restored and maintained in East Canyon Creek and East Canyon Reservoir.

The prior reports have outlined point and non-point sources of pollution that are causing water quality impairment mostly in the upper East Canyon watershed. The problems listed in these reports include highly elevated phosphorus, high sediment loads, elevated water temperatures, and corresponding low dissolved oxygen in both East Canyon Creek and Reservoir. Sources for the water quality impairments come from both point and non-point sources of pollution in the watershed (Judd 1999). The U.S. Environmental Protection Agency (EPA) regulations require that states develop Total Maximum Daily Loads (TMDL) for those watersheds that have impaired beneficial uses. TMDL's for both East Canyon Creek and Reservoir addressing the upper East Canyon watershed were completed in April 2000 and approved by EPA in Sept. 2000.

The need to decrease the pollutant loads in the East Canyon watershed involves both point and non-point source load reductions. Point source pollution loads usually involve a relatively focused restoration area, whereas non-point sources usually require a broader restoration at the total watershed scale. The intent in producing this plan is to address all of the significant sources of pollution that are causing water quality impairment in the watershed and identify sound practices that once implemented, will restore and maintain water quality in the watershed.

1. WATERSHED DESCRIPTION AND SETTING

Location and Topography - The upper East Canyon Watershed is located in north central Utah approximately 20 miles east of Salt Lake City (figures 5 & 6). The watershed drains 144 square miles of mountainous terrain on the eastern slope of the Wasatch Mountains. The elevation of the watershed ranges from over 10,000 feet in the southern end to approximately 5,000 feet at the confluence of East Canyon Creek and the Weber River, near Morgan, Utah. The elevation at East Canyon Reservoir is approximately 5,600 feet. East Canyon Creek is the principal drainage flowing to the north into the East Canyon Reservoir. The principal drainage channel of the upper part of the watershed in the area of Park City is made up of McLeod Creek which turns into Kimball Creek and subsequently joins East Canyon Creek near the intersection of Interstate 80 and Kimball Creek.

Climate - Average annual precipitation in the watershed ranges from 44 inches in the southern highest elevations to approximately 19 inches in the lower portion of the watershed adjacent to the reservoir (Brooks and others 1998). Approximately 65 to 75% of the annual precipitation occurs during the winter months principally in the form of snow (Brooks 1998).

Soils - The soils found in the East Canyon Watershed exhibit a high amount of variability due to the dramatic topography. This watershed exhibits over 5000 feet of relief over a relatively small area. With the dramatic changes in relief also come changes in geology, climate, and vegetation. As a result, there is a wide range of soil types found within this watershed.

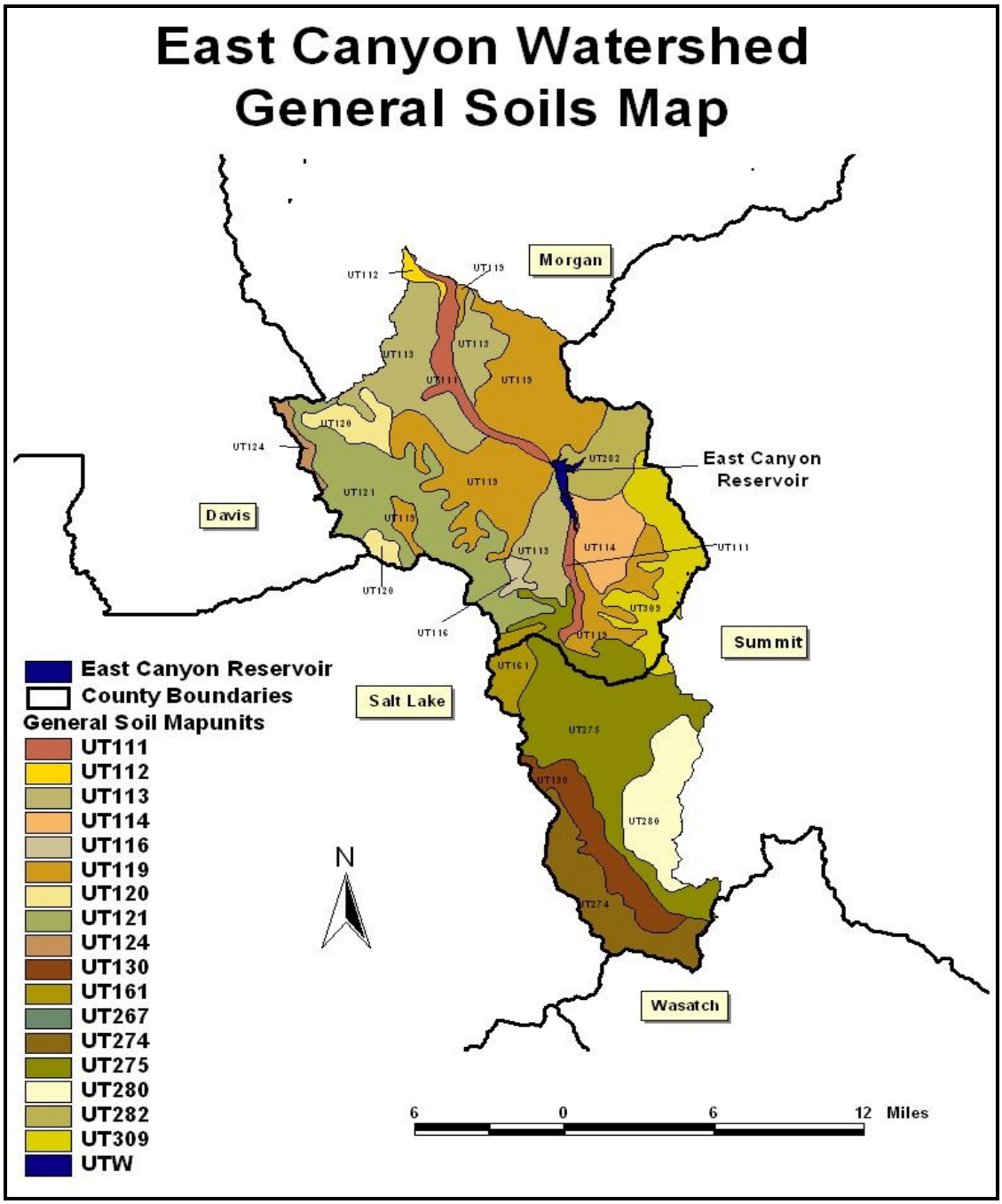
Soils found in the valley bottoms, on floodplains and on stream terraces are found at elevations ranging from 5000 to 5500 feet. These soils range in texture from sandy loam and loam to silty clay loam and clay loam and are somewhat poorly to well drained. They occur on 0-15% slopes and are deep to very deep. These soils are dominantly derived from alluvium derived from mixed sedimentary and igneous rocks. Runoff is low to negligible. These soils can have a seasonally high water table.

Soils located on lower mountain slopes, alluvial fans and foothills are found at elevations of 5500-6500 feet on 15-35% slopes. These soils range in texture range in texture from loam to clay loam and are sometimes gravelly or cobbly. These soils are well drained and are moderately deep to very deep. The soils are dominantly derived from slope alluvium and colluvium derived from mixed sedimentary and igneous rocks. Runoff is moderate to low.

Soils located on steep mountain slopes, high mountainsides and ridges are found at elevations of 6500-10000+ feet on slopes ranging from 35% to greater than 60%.

These soils have a wide range of textures depending on the parent material, but are commonly gravelly, cobbly or stony. These soils are well to somewhat excessively drained and are moderately deep to very deep. These soils formed from colluvium, alluvium, residuum derived from mixed sedimentary and igneous rocks. Some soils have formed from glacial till. Runoff is moderate to high. General soil descriptions are located in appendix A.

Figure 1. East Canyon Watershed Soils Map



Vegetation & Rangelands - Rangeland vegetation cover types were inventoried for the East Canyon Watershed using a remote sensing technique with Landsat infra red data and aerial photography. The resulting data delineated 15 different land cover types in the watershed.

The land cover types described in this inventory are summarized in Table 1. From this summary it is apparent that the dominant cover types in East Canyon are Gambel Oak and Sagebrush. Gambel Oak occupies the middle portions of the landscape bounded by sagebrush types below and aspen / conifer types above.

TABLE 1. EAST CANYON WATERSHED LAND COVER TYPE SUMMARY

LAND COVER	ACRES	PERCENTAGE
Aspen	24805.3	15.21%
Buildings	4174.1	2.56%
Conifers	8737.3	5.36%
Dry Cropland	860.9	0.53%
Gambel Oak / Sagebrush Mix	47440.3	29.10%
Gambel Oak > 50%	33248.9	20.39%
Irrigated Land	6971.7	4.28%
Juniper	31.2	0.02%
Mountain Shrubs	4387.1	2.69%
Riparian	1703.2	1.04%
Sagebrush 10% - 30%	6833.1	4.19%
Sagebrush < 10%	9673.1	5.93%
Sagebrush > 30%	12272.6	7.53%
Water	832.6	0.51%
Wet Meadow	1066.0	0.65%
Totals	163037.40	100%

Each of the range vegetation cover types is described below:

Gambel Oak

The Gambel Oak cover types correspond to the Mountain Loam (Oak), Mountain Stony Loam (Oak), and Mountain Very Steep Stony Loam (Oak) Ecological Sites. In excellent range condition, these plants are included:

(Grasses 25%)	(Forbs 10%)	(Shrubs 65%)
Slender wheatgrass	Peavine	*Gambel Oak
Dryland sedge	Sticky Geranium	Mountain snowberry
Bluebunch wheatgrass	Meadowrue	Serviceberry
Mountain Brome	Showy Goldeneye	*Mountain big sagebrush
Columbia needlegrass	Goldenrod	Birchleaf mahogany
Blue wildrye	Yarrow	*Low rabbitbrush
*Western wheatgrass	*Lupine	Chokecherry
*Kentucky bluegrass	*Little sunflower	

* These plants increase with grazing use, some will continue to dominate a site long after proper grazing use is established.

These sites are found on gentle to steep mountain slopes and occasionally on fan terraces. Slopes range from 15 to 60 % (and steeper). The site is found on all aspects, however it takes the higher elevations on south slopes and is found lower down on the north exposures. The elevation ranges from 5100 to 8500 feet above sea level.

The mean annual precipitation averages 16 to 25 inches. About 60% comes as snow October to March. The winters are cold and snowy, the summers are cool and dry. Plant growth begins about May 1st and last through June 15th. The plants go dormant or nearly so during the dry months. A second fall growth period is common if fall rain is available, this occurs about 1 year out of 3 years. The frost free period ranges from 50 to 100 days.

Over grazing causes Gambel Oak to become even more dominant leaving thick stands of Oak with a light scattering of Kentucky bluegrass on the ground. This condition is difficult and very expensive to correct. A grazing strategy that concentrates a lot of animals for a shorter time period will help to utilize more of the Oak itself and gradually open these stands up. Browsing type animals make better use of Gambel oak (i.e. sheep and goats).

These sites can burn quite easily during a dry summer even when the vegetation appears green. Gambel Oak and many other plants on these sites resprout very

quickly following a fire usually making seeding unnecessary for watershed protection following a wildfire. However, seeding following a fire can improve these sites for wildlife habitat and forage production values. Fire has been the mechanism that has historically 'rejuvenated' these sites by periodically removing the thick stands of oak and allowing the understory plants to dominate the site from time to time. This created diversity of vegetation structure and forage plants that benefited wildlife habitat. More recently these sites have suffered from the lack of fire due to removal of fine fuels through livestock grazing and fire suppression activities. As a result the majority of these sites in the watershed have suppressed understory growth with large stands of overmature Gambel Oak dominating.

Big Sagebrush

The Big Sagebrush cover types correspond to the Mountain Loam (Mountain Big Sagebrush), High Mountain Loam (Mountain Big Sagebrush), Mountain Gravelly Loam (Mountain Big Sagebrush), Mountain Stony Loam (Mountain Big Sagebrush), Mountain Shallow Loam (Mountain Big Sagebrush), Mountain Very Steep Stony Loam (Mountain Big Sagebrush), and Mountain Clay Loam (Mountain Big Sagebrush) Ecological Sites. In excellent range condition, these plants are included:

(Grasses 80%)	(Forbes 5%)	(Shrubs 15%)
Bluebunch Wheatgrass	*Yarrow	*Mountain Big Sagebrush
Basin Wildrye	Balsumroot	Mountain Snowberry
Mountain Brome	*Fleabane	Serviceberry
Nevada Bluegrass	Owlclover	*Low Rabbitbrush
Dryland Sedge	Peavine	Bitterbrush
Letterman Needlegrass	Little Sunflower	Elderberry
*Western Wheatgrass	*Lupine	Creeping Oregon Grape
Slender Wheatgrass	Sticky Geranium	Whitestem Gooseberry
Columbia Needlegrass	Peavine	
*Kentucky Bluegrass	*Butterweed	
Sheep Fescue	Mountain Aster	
Oniongrass	Sulphur Buckwheat	
Blue Wildrye	*Sneezeweed	
Nodding Brome	*Fleabane	
King Fescue	*Stickseed	
Nodding Bluegrass		

* These plants increase with grazing use, some will continue to dominate a site long after proper grazing use is established.

Soils on these sites are extremely variable in their amount of rock fragments, slope, and water supply capacity. They are usually deep soils. The erosion problem can vary from slight to severe based on slope and amount of plant cover.

These sites are found on all aspects from 5000 to 10000 feet in elevation. The high elevation sites are always mixed with Gambel Oak sites in the East Canyon Watershed. The mean annual precipitation averages 18 to 22 inches (22 to 40 for the high mountain sites). About 60% comes as snow October to March. The winters are cold and snowy, but the summers are hot and dry. Plant growth begins about May 1st. and last through July 1st, plants go dormant or nearly so during the hot dry months. A second fall growth period is common if fall rain is available, this occurs about 1 year out of 3 years. The frost free period ranges from 50 to 110 days.

Grazing is pretty much limited to mid summer through early fall due to the short growing season. Many of the preferred grasses found on this range are excellent forages, but they have growth points that are higher up on the stem than most grazing tolerant species, thus close cropping of forages may damage the best plants.

These sites are very important to Sage Grouse habitat, especially those around East Canyon Reservoir. The sage grouse populations near Silver Creek have disappeared in recent years and it is unknown whether any exist in the foothills near Morgan Valley. Optimum sagebrush cover for sage grouse habitat ranges from 10% to 30%.

Fire is historically an important component of these ecosystems. Sagebrush is killed by fires allowing understory species to dominate the site for a number of years until sagebrush gradually reestablishes its self from seed. This process can take anywhere from 20 to 40 years. The sagebrush types in the East Canyon watershed have been mapped into 3 canopy cover classes (see figure 2). The < 10% cover sites have had several types of disturbances in recent years. Some have burned, others have been treated mechanically or chemically to suppress the sagebrush, and others are old dry farms that have been planted to perennial grasses. The 10% to 30% cover sites are generally increasing in sagebrush cover following some disturbance from the past, and the > 30% cover sites have not been disturbed for a long time. Without the natural fire regime, sagebrush will continue to increase and suppress the understory vegetation until the sites become degraded for livestock forage or wildlife habitat values.

Aspen

The Aspen cover type corresponds to the High Mountain Loam (Aspen) Ecological Site Description. In excellent range condition, these plants are included:

(Grasses 35%)	(Forbs 15%)	(Shrubs 15%)	(Trees 35 %)
Mountain Brome	Aspen peavine	Mountain Snowberry	Quaking Aspen
Blue Wildrye	Tobacco Root	Oregon Grape	
Slender Wheatgrass	Sweetanice	Chokecherry	
Nodding Bluegrass	Meadowrue		
Elk Sedge	*Western Coneflower		
*Kentucky Bluegrass			
Columbia Needlegrass			

* These plants increase with grazing use, some will continue to dominate a site long after proper grazing use is established.

Soils on this site are deep well dark rich loam or clay loam soils. This soil has a rich organic layer on the surface and is very high in humus. The water holding capacity is high and this soil will supply about 25 inches of moisture for plant growth each year. Erosion is not a problem.

The site is found on mountain slopes of 5 to 40%. The site may be found on any aspect, but usually on north or east facing slopes. The elevation ranges from 6200 to 7500 feet above sea level.

The mean annual precipitation averages 25 to 35 inches. About 55% comes as snow October to April. The winters are cold and snowy, the summers are moderate and somewhat dry. Plant growth begins about May 10th and last through September 15th. The frost-free period ranges from 30 to 80 days.

This is an important and highly productive community. It is used for summer and fall grazing by either cattle or sheep. Proper use grazing and a rotation that allows for fall use only once every 3 to 4 years will preserve this area. Wildlife is another important use of this cover type. Deer, elk, moose and many other animals graze and shade-up in these Aspen stands. They are very popular during the hunting season and can be an added source of income. These sites are very important for their function in the watershed, the deep snow packs collected on this range will feed the streams below throughout the rest of the year.

Conifers

The Conifers cover type corresponds to the High Mountain Loam (Mixed Conifer) and High Mountain Stony Loam (Douglass Fir) Ecological Site Descriptions. In excellent range condition, these plants are included:

(Grasses 30%)	(Forbs 10%)	(Shrubs and Trees 20%)
Wheeler Bluegrass	Heartleaf Arnica	Mountain Snowberry
Blue Wildrye		Oregon Grape
Slender Wheatgrass		Subalpine fir
Elk Sedge		White fir
Spike Trisetum		Douglas fir
Columbia Needlegrass		Gooseberry Currant
		Bearberry
		Mountain Lover
		Ground Juniper
		Mallow Ninebark

The site is found on mountain tops and slopes of 8 to 60%. It is usually found on north or east facing slopes. The elevation ranges from 7000 to 8500 feet above sea level. Soils are moderately deep to deep, 40 to 60 inches of well drained loam soil. The soil is quite rocky, 35 to 50% stone in the profile. The water holding capacity is 1.7 inches per foot of soil depth. The hazard of water erosion is severe.

The mean annual precipitation averages 25 to 35 inches. About 55% comes as snow. Plant growth begins about May 10th and lasts through September 15th. The winters are cold and snowy, the summers are moderate and the frost free period ranges from 60 to 80 days.

This is not a highly productive plant community for grazing. It is, however, very important for wildlife in the region, it provides cover and bedding grounds for deer, elk, moose and many other animals common to the region. These forest stands are very popular during the hunting season and can be an added source of income. Watershed is another important use of this range type, the deep snow packs collected in these tree stands will feed the stream system below throughout the rest of the year. Wood production is also a consideration; this area can be used for saw timber, post and pole cutting or fire wood. Note: once the forest is opened up by wood cutting more forage will grow for use by livestock and wildlife.

Mountain Shrubs

These cover types correspond to the High Mountain Loam (Bigtooth Maple), High Mountain Loam (Silver Sagebrush), and Mountain Loam (Shrub) Ecological Sites. In excellent range condition, these plants are included:

(Grasses 65%)	(Forbs 10%)	(Shrubs 25)
Basin wildrye	Showy goldeneye	*Bigtooth maple
Bearded wheatgrass	Daisy (fleabane)	Birchleaf mountainmahogany
Bluebunch wheatgrass	*Lupine	*Oakbrush
Slender wheatgrass	*Mulesear dock	Serviceberry
Muttongrass	*Goldenrod	*Mountain snowberry
*Western wheatgrass	Arrowleaf balsamroot	*Yellowbrush
		Bitterbrush
		*Mountain big sagebrush
		*Rocky Mountain Juniper

* These plants increase with grazing use, some will continue to dominate a site long after proper grazing use is established.

The site is found on steep mountainsides or ridges. This forage type is usually found on north or east facing exposures, on slopes of 20 to 60%. The elevation ranges from 5000 to 9000 feet above sea level. Soils on this site are deep well drained loam soils, with a layer of gravel, lime or both at about 36 inches. This soil will supply about 14 to 19 inches of moisture for plant growth each year. The erosion problem is slight.

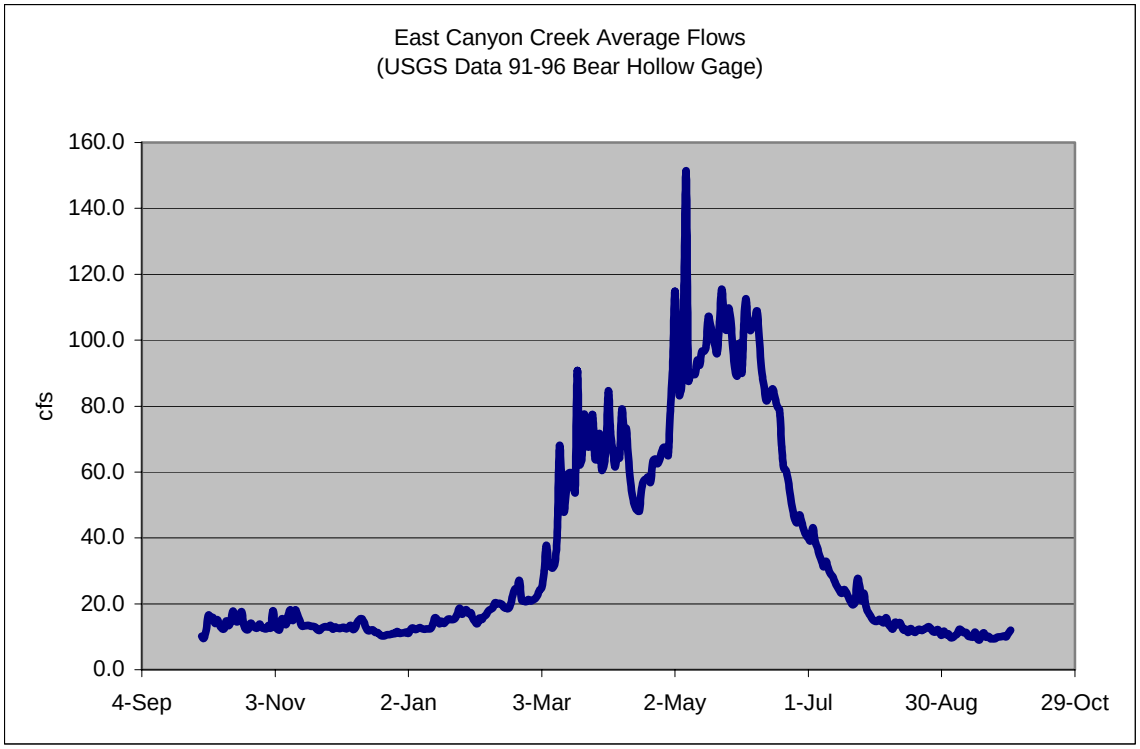
The mean annual precipitation averages 16 to 40 inches. About 60% comes as snow October to March. The winters are cold and snowy, but the summers are hot and dry. Plant growth begins about May 1st. and last through July 15th., plants go dormant or nearly so during the hot dry months. A second fall growth period is common if fall rain is available, this occurs about 1 year out of 3 years. The frost free period ranges from 70 to 130 days.

This area supports a well balanced and nutritious mix of plants for livestock use. the site is also somewhat tolerant of grazing abuse and will respond readily to proper management. This range type is popular with many types of wild animals especially deer and elk.

Geology - The geology in the East Canyon Watershed is complex and includes a series of faults, folds, and different water bearing units. A detailed presentation of the geology can be found in Ashland and others(1996). Brooks and others (1998) provide a good description of the hydrogeology including relationships between ground water and surface water flows.

Water Resources & Hydrology – Stream flows in the East Canyon Watershed are derived primarily from precipitation received during the winter months. Approximately 65 to 75% of the annual precipitation is received during the winter months, principally in the form of snow. Streamflows generally peak during the snow melt between March and June. Summer stream flows are mostly derived from ground water discharges. Figure 2 shows an average hydrograph for East Canyon Creek (USGS gage data;Bear Hollow;1991 through 1996).

Figure 2. Average Hydrograph for East Canyon Creek 1991-1996



The watershed includes the East Canyon Reservoir located at approximately the north south midpoint in the watershed. The reservoir stores spring snow melt flows for use later in the irrigation season. Accordingly, flows below the reservoir in lower East Canyon Creek are considerably buffered and do not exhibit the spring time peak flows typical of the upper watershed except for unusually high runoff years when the reservoir spillway is overflowing.

The reservoir has a capacity of just over 51,000 acre feet with a surface area of 684 acres. The mean depth in the reservoir is 75 feet with a maximum depth near the dam of 197 feet. Principal water right holders for water impounded in the reservoir are the Davis & Weber Canal Company and the Weber Basin Water Conservancy District.

Photo of East Canyon Reservoir

Land Use – The BioWest Non-point Source Water Quality Study (Olsen 2000) identified land use information for the portion of the East Canyon Watershed from the reservoir upstream to the headwaters. The major land use delineations are shown in Table 2.

Table 2. Bio-West Land Use Inventory 1999

Land Use Type	% of Upper Watershed
Forested/Semi-active Agriculture	57%
Forested/Inactive Agriculture	21%
Moderate Residential w/ Active Ag	5%
Ski Areas	5%
Golf Courses w/ high density residential	2%
Active Agriculture	2%
Active Construction	2%
Residential/Commercial	Approx 6%

Over 75% of the watershed above the reservoir is forested with either active or inactive agriculture, presumably grazing. Ski hills and golf courses comprised approximately 7% of the land use in 1999 when the study was completed. One new golf course has been constructed and another is planned in the next year or two.

Stantec completed a land use inventory of the Snyderville Basin, which includes the East Canyon Watershed from Jeremy Ranch Golf Course upstream and the upper portion of the Silver Creek Watershed from Atkinson upstream to the headwaters of Silver Creek (Stantec 2003). The results of this inventory were similar in many respects as shown on Table 3.

Table 3. Stantec Land Use Inventory – Snyderville Basin 2003

Land Use Type	% of Total Area	% Excluding Undeveloped Areas
Undeveloped (includes grazing lands)	73.6%	N/A
Residential Development	14.8%	56.1%
Ski Areas	7.6%	28.7%
Golf Courses	0.7%	2.7%
Agriculture	1.6%	5.9%
Commercial	0.9%	3.3%
Transportation	0.7%	2.8%

One significant item of interest is the large portion of the developed land that is residential land use. This suggests a potential source component that could be addressed with an information and education component aimed at residential home owners.

Water Use - (Check with Water Resources Report or Weber Basin annual report for stats; amounts used for irrigation, M&I, etc.). During the summer of 2003 a portion of the East Canyon Creek was dried up for part of a day resulting in a fish kill. The apparent cause was a water right diversion upstream. Water Right allocations for the upper East Canyon Watershed appear to be over-appropriated by a significant factor meaning that unless there are senior water rights dedicated to in stream flow augmentation, the stream could be dried up in most years

Demographics - The upper portion of the East Canyon Watershed has experienced explosive growth over the last 10+ years. Projections for growth compiled by the Mountainlands Association of Governments show projected population growth from the years 2000 to 2020 for the Park City area of 52% (6,750 to 10,246 residents). The Snyderville Basin area outside Park City boundaries is not specifically noted in the growth projections available. However, the same projections show un-incorporated portions of Summit County growing 103% between the years 2000 to 2020. Growth of this magnitude has significant implications on water quality and quantity for this watershed. More detail is provided in the Water Quality section of this plan.

2. WATER QUALITY ISSUES AND OPPORTUNITIES

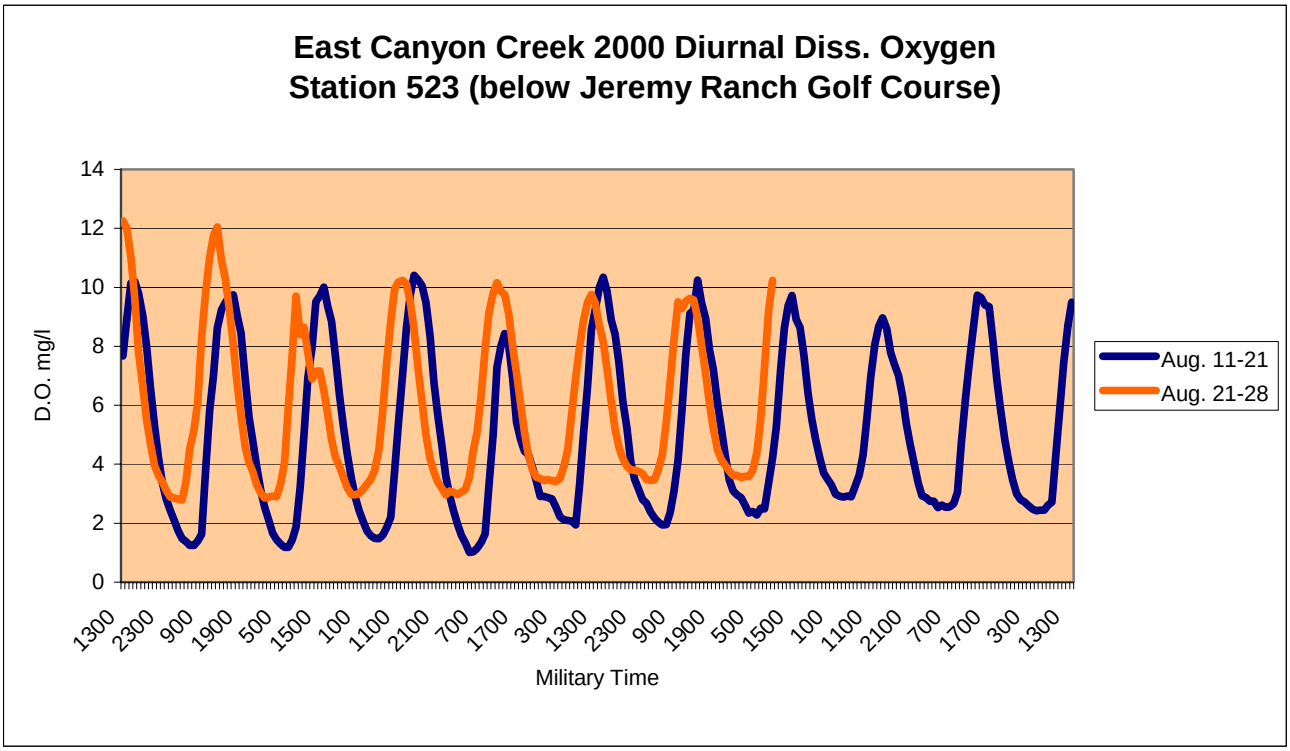
Known and Potential Pollutants – East Canyon Reservoir and East Canyon Creek from the reservoir to the headwaters have been listed on Utah's 303d list of impaired waterbodies for phosphorus and dissolved oxygen. Sediment and diminishing summertime flows have exacerbated these water quality impairments.

Nutrients – Numerous studies have documented the decline in water quality in East Canyon Creek and Reservoir. The Non-point Source Pollution Water Quality Study completed in 2000 documents nutrient loads and likely sources of non-point pollution in the East Canyon Watershed (Olsen 2000). The principal finding from the report is that non-point source pollution loads significantly affect water quality in East Canyon Creek and Reservoir. Elevated levels of phosphorus are evident in East Canyon Creek even above the East Canyon Wastewater Reclamation Facility. Using the 0.05 mg/l indicator value for streams, average annual values at stations 492537 and 492526, both above the East Canyon WWTP, exceed the indicator.

The Diagnostic Feasibility Clean Lake Study (Judd 1999) notes that an excessive total phosphorus load is responsible for a degradation of water quality and impairment for the cold water fishery in East Canyon Reservoir. The report notes that the average annual total phosphorus concentration in the water column was 117 ug/l from 1992-97. The Utah water quality indicator value for total phosphorus in lakes is 25 ug/l. Based on Trophic Status Index (TSI) analysis, East Canyon Reservoir is on the boundary between eutrophic and hyper-eutrophic conditions.

East Canyon Creek and Reservoir have been listed on Utah's 303(d) list of impaired waters since 1992. The specific impairments include excessive levels of total phosphorus and low levels of dissolved oxygen (D.O.). The dissolved oxygen impairments are most likely a result of high levels of nutrients in the water column resulting in excessive biological growth in the form of algae (periphyton) and rooted plants (macrophytes). Figure 3 depicts the daily fluctuation in DO values in the creek. During the daytime hours dissolved oxygen values are extremely high from photosynthesis while at night the reverse is true when plants and algae switch to respiration and actually consume dissolved oxygen. This can result in DO values falling to levels for stream biota such as fish and benthic invertebrates that can stress them and or be lethal.

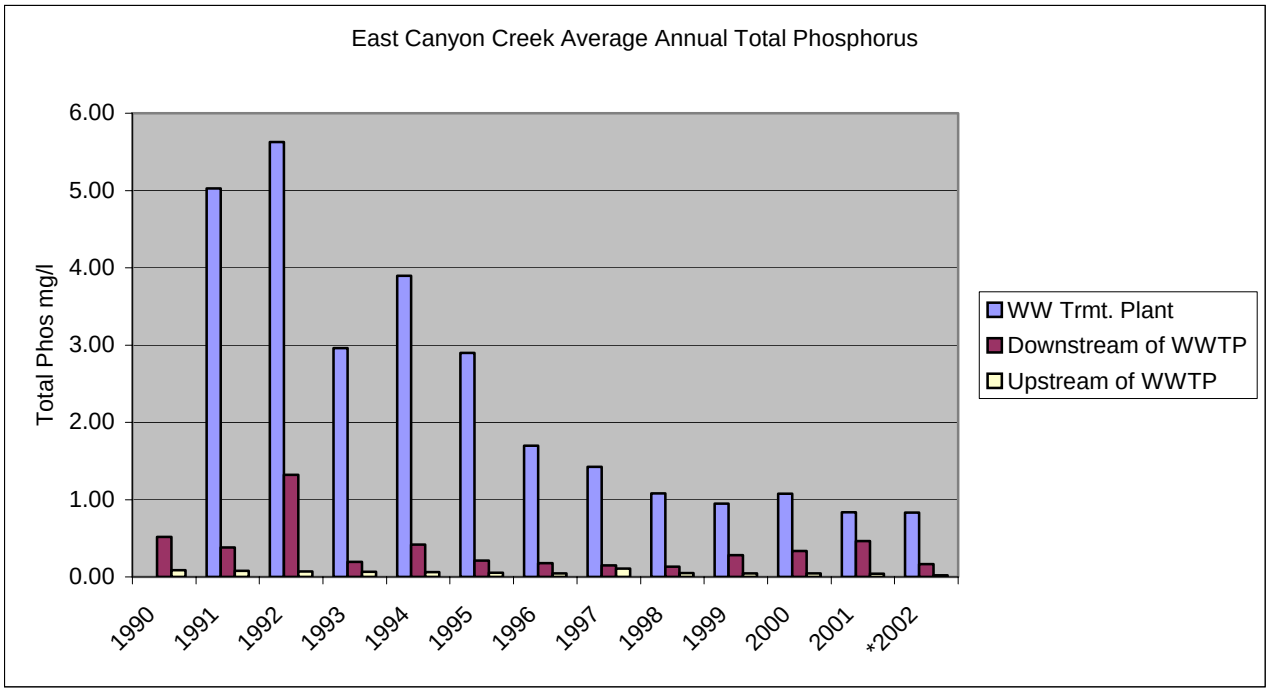
Figure 3. Diurnal dissolved oxygen values for station 523 on East Canyon Creek.



As is apparent from figure 4, the highest concentrations of phosphorus in the East Canyon Creek system emanated historically from the East Canyon Wastewater Treatment Plant. It is significant to note that the Snyderville Basin Water Reclamation District initiated biological treatment of phosphorus in the East Canyon Plant's treatment process in the summer of 1996. This action significantly reduced the phosphorus concentration from the plant from about 3 to 5 mg/l down to around 1 mg/l. In early 2003 the East Canyon WWTP started chemical phosphorus removal in its plant process. This process will be optimized by late 2004 and should result in another order of magnitude reduction in phosphorus concentrations in the plant effluent bringing phosphorus levels to below 0.1 mg/l.

The specific beneficial use that is impaired in East Canyon Creek and Reservoir is for cold water fisheries. East Canyon Reservoir and Creek historically supported an excellent cold water fishery including a Bonneville Cutthroat trout population along with a spawning population of Kokanee Salmon. The Kokanee are completely gone, and the trout fishery is marginal at best. The State Division of Wildlife Resources has curtailed stocking trout during the summer months in East Canyon Reservoir based on fingerling fatalities from temperature and dissolved oxygen problems (personal conversation; Craig Schaugaard, Division of Wildlife Resources)

Figure 4. Average annual total phosphorus concentration



Sediments – While not formally listed on the 303(d) list for sediment, most of the analysis for East Canyon Creek and Reservoir indicates sediment is a serious concern. Phosphorus is typically adsorbed to sediment particles, thus high sediment brings with it high phosphorus. Accordingly, one of the targets for addressing water quality concerns in East Canyon must include sediment. Additionally, one of the nutrient enrichment phenomenon in East Canyon Creek is the massive growths of rooted plants in the stream channel referred to as macrophytes. One of the factors that provides macrophytes with rooting zones is deposits of finer fraction sediments. The photo below shows a typical macrophyte infestation below the wastewater treatment facility during the summer months.

Photo of East Canyon Macrophyte Growth August 2002

Diminished Flows – Long term stream flow records for East Canyon Creek are difficult to establish. Several USGS gaging sites have been operated historically for periods of several years. Period of records and gages are listed in Table 4 for two of the currently operated USGS gages. In August of 2003 a portion of East Canyon Creek was de-watered with a significant fish kill. The apparent cause was an upstream water diversion. The water rights in the East Canyon drainage are over appropriated meaning that legitimate water right holders can dry up the stream. Low flows in July through September are the most critical season for water quality health in East Canyon. If stable summer flows can be maintained in the creek, there is hope for water quality improvements.

Table 4. USGS gages on East Canyon Creek and monthly stream flows

USGS 10133800 EAST CANYON CREEK NEAR JEREMY RANCH, UT

YEAR	Monthly mean streamflow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001										9.60	14.7	11.5
2002	11.2	13.3	30.5	67.5	56.6	25.2	8.06	4.50	8.20	11.9	12.4	12.0
2003	14.6	16.9	30.1	30.2	33.9	20.0	7.54	3.86	5.99			
Mean of monthly streamflows	12.9	15.1	30.3	48.9	45.3	22.6	7.80	4.18	7.10	10.8	13.6	11.8

USGS 10133650 E CANYON CR BL I-80 REST STOP NR PARK CITY, UT

YEAR	Monthly mean streamflow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002												8.27
2003	9.00	10.8	14.7	14.9	14.8	11.7	6.34	1.99	4.01			
Mean of monthly streamflows	9.00	10.8	14.7	14.9	14.8	11.7	6.34	1.99	4.01			8.27

Known & Potential Sources – Both non-point and point sources contribute to nutrient enrichment in East Canyon Watershed.

Point Source – There is only one point source discharger in the East Canyon Creek Watershed. The Snyderville Basin East Canyon Water Reclamation Facility is located adjacent to East Canyon Creek just upstream from the Jeremy Ranch Golf Course. The East Canyon TMDL calculated that the plant contributed approximately 7000 lbs./yr of phosphorus to the watershed prior to implementation of the chemical phosphorus removal process. This represented well over half the annual phosphorus load contributed to the East Canyon Creek at the time the TMDLs were completed. The plant has recently completed construction of chemical phosphorus removal facilities and will be reducing its annual phosphorus load to below 1,500 lbs./yr.

Non-point Sources - Without intensive sampling, including stormwater sampling, it is difficult to quantify non-point sources of pollution. The total amount of nutrient loading was estimated in the BioWest non-point source report (Olsen 2000) at several water quality monitoring sites. Table 4 is taken from the Bio-West Report. Loading for stations 492523 and 492519 include the phosphorus load from the East Canyon Plant.

Table 5. Total Phosphorus and Sediment Annual Loading
(BioWest report (Olsen 2000))

Storet Monitoring Station	Location Description	Drainage Area (Sq.miles)	Total Phosphorus Load lbs/yr.	Sediment Load lbs/yr.
492519	East Cyn Ck. @ inflow to E. Cyn Res.	113.3	10,560	1,720,000
492523	East Cyn Ck. Below Jeremy Golf Course	59.3	9,780	822,000
492526	East Cyn Ck. Above WWTP	51.3	2,280	655,600
492536	Kimball Ck. @ I-80	12	380	118,740
492537	East Cyn. Ck. Above confluence w/ Kimball	12.2	760	142,340
492544	McLeod Ck @ State 224	8.78	960	357,200

Several non-point sources were identified in the BioWest report although there is not adequate sampling data nor budget to quantify actual loads from specific non-point source sites. These source areas include:

- Winter Sports Venues
- Golf Courses
- Construction Stormwater Runoff
- Stream Channel erosion
- Road Drainage from dirt roads adjacent to the creek
- Agriculture – Animal Waste Management

One significant factor that affects several of the non-point source categories listed above is the growth and development that is occurring in the upper portion of the watershed. This is discussed in a prior section of this report under the Demographics heading.

Needed Load Reductions

The East Canyon TMDLs for the creek and reservoir and subsequent work have identified load targets as follows:

Table 6. Load reductions for point and non-point sources.

Source	Current Total Phos. Load	TMDL Target Load	Reduction lbs./yr	Percent Reduction Needed
East Canyon Plant	7,000 lbs./yr	1,462 lbs./yr	5,538 lbs./yr	79%
Non Point Sources	3,800 lbs./yr	1,895 lbs./yr	1,905 lbs./yr*	50%

*It should be noted that the estimated non-point source load is very likely understated due to the logistical and resource challenges associated with getting accurate storm runoff load estimates. Stantec Consulting has estimated average phosphorus concentrations in stormwater runoff for the Salt Lake County area to be about 1lb/acre of residential development per year. Using this data, the annual total phosphorus load for stormwater runoff could be 9000 lb per year. Accordingly, implementation activities for non-point sources should target load reductions that exceed 1,905 lbs/yr by at least a factor of two to three times. **Thus a target NPS reduction between 3,810 and 5,715 lbs. per year would be more appropriate**.

Further, as with many TMDL efforts, the actual biological response of the stream to nutrient reductions is difficult to predict. In addition, the effectiveness of various NPS implementation projects is difficult to predict. Accordingly, an iterative approach to NPS reductions should be undertaken. Ongoing monitoring should allow a feedback mechanism to assess if adequate NPS reductions have been achieved to bring East Canyon Creek and Reservoir into a fully supporting status of its beneficial uses.

3. WATERSHED IMPLEMENTATION STRATEGY

Goals and Objectives

To address the need described in the previous section, this action plan will achieve the following goals and their objectives.

GOAL 1: Control point source contributions of nutrients such that designated beneficial uses for East Canyon Creek and Reservoir are restored by achieving water quality standards for dissolved oxygen in both the reservoir and the creek.

Objective 1a: Effluent from the Snyderville Basin Water Reclamation District's East Canyon Wastewater Reclamation Plant will meet UPDES Permit effluent limits for total phosphorus concentration during the critical summer months of July through September.

Objective 1b: The annual total phosphorus load from the Snyderville Basin Water Reclamation District's East Canyon Reclamation Plant will meet UPDES Permit limits.

GOAL 2: Control non-point source contributions of nutrients such that designated beneficial uses for East Canyon Creek and Reservoir are restored by achieving water quality standards for dissolved oxygen in both the reservoir and the creek.

Objective 2a: Implement formal Storm Water programs in Park City and Summit County to minimize phosphorus and sediment contributions to East Canyon Creek and reservoir. Assure these programs meet the minimum requirements for the EPA Phase II standards.

Objective 2b: Compile and implement Watershed Restoration Action Plans (WRAP) for each ski and winter sports area in the upper watershed to minimize contributions of phosphorus and sediment.

Objective 2c: Implement stream channel restoration measures on East Canyon Creek and tributaries to minimize contributions of sediment and phosphorus from degraded segments. These efforts should include measures to restore natural shading along with narrowing and deepening of channel segments to promote cooler water temperatures as well as reduce light inputs and slow down algae and macrophyte growth.

Task 2c-1. Complete a stream channel inventory of East Canyon Creek and tributaries to inventory stream channel conditions and needed remedial measures.

Task 2c-2. Stabilize eroding segments of streambanks by working with private landowners to implement stream restoration BMPs. BMPs will include but are not limited to: willow plantings, rock barbs, vortex

weirs, installation of root wads, tree revetment, jetties, and re-shaping & re-vegetating vertical banks.

Task 2c-3. Implement site specific private land owner management plans such as fencing of riparian areas, rotational grazing, creation of vegetative buffer zones to protect streambank and riparian zones from erosion or degradation from excessive livestock grazing or other disturbances such as construction/development activities.

Task 2c-4. Re-vegetate segments of stream riparian areas with stabilizing woody vegetation in areas where this type of vegetation is practically non existent by working with private landowners on re-vegetation projects.

Objective 2d: Evaluate management practices for each golf course and other large turf management areas such as public parks to identify if BMPs are being implemented to minimize contributions of nutrients to the stream and ultimately the reservoir. Where needed, compile nutrient management plans to minimize contributions of nutrients. BMPs included in these plans will include but not be limited to: fertilizer types used, application rates and timing, buffer strips where no fertilizer is applied, "no mow zones", and irrigation practices.

Objective 2e: Inventory road drainage controls along dirt road segments that are impacting East Canyon Creek and tributaries. Develop and implement BMPs to address road drainage such that contributions of sediment and associated phosphorus are minimized.

Objective 2f: Develop and implement residential homeowner BMPs to minimize contributions of nutrients from residential land uses.

Objective 2G: Implement recommendations in the Snyderville Basin Recreation and Construction Industry Water Quality Improvements Project report prepared by Stantec Consulting Inc.

GOAL 3: Maintain summer season low flows in East Canyon Creek at a level that allows the water quality improvements included in this plan to restore the designated beneficial uses of the creek.

Objective 3a: Complete a detailed analysis of historical stream flows, precipitation records and water right diversions for East Canyon Creek to determine historical critical summer flows from July through September.

Correlate summer flows with precipitation records to distinguish flow reductions that are a result of climatic conditions versus reductions induced by up-stream water uses affecting in stream flows.

Objective 3b: Determine mechanisms, options, availability and cost to augment and maintain summer season flows in East Canyon Creek. Inventory existing water rights in the Snyderville Basin to determine feasibility of acquiring senior water rights that will insure summer season flows are maintained in East Canyon Creek. This analysis will include investigation of all reasonable means to acquire flow augmentation including purchase, lease, loans, donation, and other means to achieve the objective of maintaining summer flows in East Canyon Creek.

GOAL 4: Develop and implement an ongoing information and education program to reinforce objectives identified in Goal 2 (see I&E Plan; Section 4.0)

Objective 4a: Develop a Comprehensive Information and Education plan for the East Canyon Watershed utilizing the guidance and format in the EPA Getting In Step publication (EPA 2003).

Objective 4b: Ongoing implementation of the Information and Education plan.

GOAL 5: Implement a comprehensive ongoing water quality monitoring program that will evaluate the effectiveness of the implementation measures outlined in Goals 1 through 3 of this plan.

Objective 5a: Complete ongoing water quality monitoring in accordance with the plan included in section 5 of this plan.

GOAL 6: Enhance the management of agricultural animal feeding operations.

Objective 6a: Develop Comprehensive Nutrient Management Plans (CNMP) for landowners determined to have Animal Feeding Operations (AFO) or Confined Animal Feeding Operations (CAFO). Higher priority will be given to CAFO designations. Installation of conservation practices will meet USDA-NRCS criteria. A total of about 11 CNMP plans will be completed to address waste management issues in the watershed. All landowners with a CAFO/AFO will have an individual plan by (2008).

GOAL 7: Improve upland (rangeland) conditions to improve watershed functions and values

Objective 7a: Plan & complete conservation practices to treat targeted rangeland.

Brush Management :	6000 acres	$120,000
Prescribed Grazing :	50,000 acres	No cost
Fencing :	10 miles	$60,000
Livestock Water Developments	10 each	$40,000

Current Implementation Projects (Includes Anticipated Load Reductions)

Project Title	Major Objectives	Funds	Anticipated Load Reductions
East Canyon 319 Watershed Stream & Road Drainage Assessment PIP (Phase 1)	Develop stream channel inventories of degraded channel segments and compile recommendations and BMPs to address each segments. Identify road drainage areas that are adjacent to stream channels and that contribute sediment and nutrients to stream flow. Develop recommendations and BMPs to address these problem segments.	**Total Funds:** $91,000 **EPA 319 Funds:** $54,600 **Match:** $36,400	Load reductions will be realized after the inventories and resultant BMPs are implemented
East Canyon 319 Watershed Stream Restoration PIP (Phase 2)	Implement stream channel restoration measures and road drainage improvements on East Canyon Creek and adjacent dirt roadways	**Total Funds:** $260,000 **EPA 319 Funds:** $156,000 **Match**: $104,000	Approx 4,000 lbs of Phosphorus per year.
Silver Creek Estates 319 Ground Water Study	Determine if significant nutrient contributions are coming from septic systems in the Silver Creek Estates area of the East Canyon Watershed and quantify that load if appropriate.	**Total Funds:** $139,250 **EPA 319 Funds:** $95,590 **Match**: $43,660	This study determined that there is not a significant nutrient load coming from septic systems in the Silver Creek Estates area. Thus no load reductions achieved from this project.

Snyderville Basin Recreation & Construction Industries Water Quality Improvements	Identify NPS project work needed to achieve TMDL goals.	**Total Funds**: $154,118 **EPA Consolidated Funding:** $135,400 **Match**: $18,718	Project was designed to identify project opportunities; did not include on the ground project work except for a few pilot projects.
Summit County Storm Water Program development grant (2 Grants)	Develop Storm-water program for Summit County that meets Phase II requirements.	**Total Funds:** $243,645 **EPA One Stop & Consolidated Funding:** $183,145 ($84,620 & $98,525) **Match**: $60,500 ($35,500 & $25,000)	When fully implemented and staffed annual load reductions of phosphorus of 1,000 lbs. could be achieved.
Park City Municipal Storm Water Program development grant	Develop Storm-water program for Park City that meets Phase II requirements.	**Total Funds:** $85,878 **EPA One Stop Funding:** $65,400 **Match:** $20,478	When fully implemented and staffed annual load reductions of phosphorus of 500 lbs. could be achieved.
Snyderville Basin Water Reclamation Facility Plant Upgrade (chemical phosphorus removal)	Reduce total phosphorus load coming from the East Canyon Wastewater Treatment Plant	**Total Funds:** $5,000,000 **No EPA funds involved**	Load Reduction in Total Phosphorus of 6,100 lbs. per year. (Previous load of 7,600 lbs/yr to target of 1,462 lbs/yr.)
Upper Weber River Watershed Coordinator	Provide local on the ground supervision and facilitation of TMDL implementation activities.	**Total Funds**: $51,600 (annually) **EPA 319:** $34,800 **Consolidated Funding:** $16,800	Will provide on the ground assistance in project work. No direct load reduction.
East Canyon Watershed: In-stream Flow Feasibility & Alternatives Study	Determine mechanisms, options and feasibility of maintaining in-stream flows during the critical summer season in East Canyon Creek.	**Total Funds**: $125,000 **EPA 319:** $75,000 **Match:** $50,000	No direct load reduction associated with the study, except for the dilution effect with maintaining in-stream flows.

Future Funding Resources Needed for TMDL Implementation

Category	Description	Budget Needed	Sources for Funding
Point Source Chemical Phosphorus Removal	Operation of Snyderville Basin East Canyon Water Reclamation Facility's chemical phosphorus removal facilities	Ongoing O&M required $213,000/year	Local Sewer Revenues
Storm Water Programs	Ongoing implementation of the approved Storm Water Plans for Park City and Summit County	Annual Budget for Stormwater Implementation $250,000	Local Revenues & EPA grants
Ski Hill Watershed Restoration Action Strategies	Implementation of Ski Hill Watershed Plans including project work to address stream channel rehabilitation and drainage issues at: -Park City Mountain Resort -The Canyons Resort -Utah Olympic Park -Gorgoza Sledding Hill (PCMC)	Project work identified to date: $562,000	Individual Ski Hill Maintenance budgets 319 NPS Funding
Stream Channel Restoration and Rehabilitation Work	Based on SVAP survey information and prioritization, implement stream channel restoration work to reduce phosphorus loads from erosion	From East Canyon SVAP using Groups C,D,E,and F (less $260,000 already funded) $646,000	319 NPS Funding
Golf Course Nutrient Management Plans	Assure implementation of Golf Course Nutrient Management Plans to minimize nutrient contributions from each Golf Course: -Park City Municipal -The Canyons (under construction) -Glenwilde -Jeremy Ranch	Project work identified to date: $600,000	Course revenues 319 NPS Funding
Road Drainage Controls	Implement drainage controls on segments of dirt road adjacent to East Canyon Creek. Coordinate maintenance and grading with Summit and Morgan Counties	$105,000 construction and $10,000 annual maintenance	EPA 319 funding County Road Maintenance budget

Upland (rangeland) improvement	Plan & complete conservation practices to treat targeted rangeland. Brush Management : Prescribed Grazing : 50,000 acres Fencing : 10 miles Livestock Water Developments 10 each	 No cost $60,000 $40,000	 NRCS EQIP and/or 319 EPA funding
Animal Feeding Operations; Manure Management	Compile and implement approximately 11 Comprehensive Nutrient Management Plans for AFO and CAFO operations in the East Canyon Watershed	(Budget to be worked up with Ray Loveless)	NRCS EQIP and/or Dept. of Ag funding
Ongoing Monitoring	Implement an ongoing water quality monitoring program to assess if implementation activities are achieving TMDL goals	(Budget to be worked up with Monitoring Section of DWQ.)	319 EPA funding and DWQ match
Information and Education	Implement an ongoing I&E program targeted at homeowners to minimize contributions of nutrients from residential sources	$42,000 plan development $10,000 annually	319 EPA funding
Augment and maintain in-stream flows in East Canyon Creek.	Based on the recommendations of the in-stream flow feasibility & alternatives study obtain water rights to maintain in-stream flows in the critical low flow months.	$500,000	EPA 319 and possibly State Revolving Fund
Total Estimated Funding Need		**Over $3 million needed for all projects and programs**	

Technical Assistance Needed

Stream Rehab Project Planning – A combination of NRCS, Utah Div. Of Wildlife Resources and other private entities will be used to provide technical support for detailed project plans for stream rehabilitation work on East Canyon Creek and tributaries.

Road Drainage design and maintenance planning will be completed by Summit and Morgan Counties for their respective segments of a dirt road that is adjacent to the East Canyon Creek.

Information and Education –Technical expertise for the I&E program will have to be obtained via grant funding with some oversight provided by Mr. Jack Wilbur, Utah Dept. of Agriculture and Food.

Schedule for Implementation

Implementation Item	Responsible Party(s)	Target Date
Point Source Chemical Phos Removal	Snyderville Basin Water Reclamation District	July 1, 2004 for interim UPDES effluent limit of 0.1 mg/l
Storm Water Programs	Park City Municipal Corp. Summit County	Ongoing Ongoing
Ski Hill Watershed Restoration Action Strategies	Park City Mountain Resort The Canyons Resort Utah Olympic Park Gorgoza Sledding Resort	2005-2006
Stream Channel Restoration and Rehabilitation Work	Individual Landowners	Fall 2008
Golf Course Nutrient Management Plans	-Park City Municipal -The Canyons (under construction) -Glenwilde -Jeremy Ranch	Ongoing
Road Drainage Controls	Summit County Morgan County	Fall 2005
Water Quality Monitoring	Utah Division of Water Quality	Ongoing
Information and Education	Upper Weber Watershed Coordinator	Plan fully developed by March 2006 Plan fully implemented by January 2007
In-stream Flow Feasibility & Alternatives Study	Snyderville Basin Water Reclamation District	December 31, 2004

4. INFORMATION AND EDUCATION PLAN

A comprehensive Information and Education program for the East Canyon Watershed is being developed (an outline of this plan is included in this segment of the watershed plan). Significant effort to address some of the more obvious target audiences associated with non-point source pollution has been ongoing in the watershed. These include the following that have been accomplished to date:

March 2001 Two Erosion and Sediment Workshops held. - Training sessions for County and City staff and contractors and builders hosted jointly by Park City and Summit County on Phase 2 Storm Water Program requirements. Attendance of over 75 representatives from the Snyderville Basin, Park City area.

April 2001 Third Erosion and Sediment Workshop held. Training session for contractors and builders hosted jointly by Park City and Summit County.

April 2002 Summit County Stormwater Management Training – Half day workshop for developers and others involved in the construction business in Summit County.

May 2003 Erosion Control Seminar Construction Site Management – On the ground training session provided for contractors and builders hosted jointly by Park City and Summit County. Several erosion control approaches and BMPs were demonstrated by vendors to provide a hands on educational experience. Over 60 attended. (Part of the Snyderville Basin Recreation & Construction Industries Water Quality Improvements grant)

Construction Site Management training May 14, 2003

July 2003 Ski Area Erosion Control Seminar. Training session for winter sports facility managers and staff address appropriate BMPs for erosion control. Attended by over 20 key staff from four facilities in the Park City area. (Part of the Snyderville Basin Recreation & Construction Industries Water Quality Improvements grant)

Ski Hill Erosion Control Seminar July 2003

Information & Education Plan Development

A comprehensive Information and Education program will be developed utilizing the approach included in the Getting In Step guidance (EPA 841-B-03-002 December 2003). A 319 proposal has been submitted (Aug. 2004), that will determine current levels of knowledge, materials available, and other information that will assist in developing a comprehensive plan. An outline of the basic points of the I&E program to be developed are as follows:

1. Define the Driving Forces, Goals and Objectives

Some of the driving forces that are known are listed below; this list will be analyzed and modified as the comprehensive I&E plan is compiled:

-TMDL; violation of State Water Quality Standards
-Loss of cold water fishery
-Environmental Conscience of Residents

A detailed set of goals and objectives will be developed as the comprehensive I&E program is developed. A tentative set of goals has been developed and is included in this plan at the end of the I&E section.

2. Identify and Analyze the Target Audiences

A tentative list of target audiences includes the following entities. This list will be modified as needed as work on the comprehensive I&E plan continues.

-Contractors and Builders
-Residential Homeowners
-Recreational Industries (Golf, Winter Sports)

3. Create the Message

The appropriate message(s) for the identified target audiences will be developed as the comprehensive I&E plan is developed. The information obtained from the survey work to be completed to assess current levels of knowledge regarding water quality impairments will be utilized to develop the message(s).

4&5. Package and Distribute the Message

Research will be completed to determine the best means to package and distribute the developed message materials.

6. Evaluate the Outreach Program

An evaluation tool will be developed to determine the effectiveness of the I&E materials. This may be some sort of a questionnaire or survey, however details on this will be developed.

Tentative Goals to Date (a complete set of final goals and objectives will be developed in the comprehensive I&E program):

1. **Contractor Training**: Educate and train local contractors/builders and their employees on the storm-water control requirements for Summit County and Park City in accordance with the Storm Water Programs for these two entities.

   Objective 1: Conduct an annual mandatory training session in the spring of each year to educate local contractors/builders on the regulatory requirements of the Summit County and Park City Storm Water Programs.

2. **On Site Training:** Provide field based storm water controls training for local builders and contractors to ensure proper selection, installation and maintenance of BMPs for construction sites.

   Objective 2: Conduct a semi-annual "hands on" seminar hosted by vendors to demonstrate proper selection, installation and maintenance of storm water control methods for local contractors and builders

3. **Employee Training:** Provide storm water training for municipal personnel involved in plan review and inspection to insure a clear understanding of requirements and standards for the applicable storm water program they are involved in.

   Objective 3: Conduct an annual training session for municipal personnel involved in building permits issuance, inspections, or storm water compliance.

4. **Residential Outreach:** Develop a residential outreach program to educate homeowners on the best management practices for residential use of fertilizers in order to minimize nutrient contributions from residential areas.

5. **School Age education Program:** An age appropriate school curriculum will be developed to target 4th grade students in the watershed. This program will coordinate and support goal #4 in regard to homeowner practices.

6. **Winter Sports Supervisor Training:** Develop a training program for winter sports area supervisors to facilitate selection, installation and maintenance of appropriate BMPs for water quality improvement at each of the five winter sports venues in the East Canyon Watershed.

7. **Mountain Road Guidance Document:** Develop a guidance document for maintenance of roads on Winter Sports venues to minimize water quality impacts.

8. **Golf Industry Information:** Develop a newsletter/brochure to educate members, players, adjacent homeowners on the measures needed to minimize water quality impacts from Golf Courses.

9. **Web Site –** Develop and maintain an active and current web site for East Canyon to provide a source of information for BMPs, watershed events, and links to other helpful watershed web sites.

5. MONITORING PROGRAM

Interim Milestones – an Interim Water Quality Data Analysis will be prepared examining the Utah DWQ monitoring data and any other credible data sources for data collected from January 1, 1999 through December 31, 2004 (6 years). This will include two intensive monitoring cycles and should provide an opportunity to determine if the data shows any quantitative changes in water quality for East Canyon Creek and Reservoir. This will include examination of diurnal oxygen monitoring completed by UDWQ as well as benthic invertebrate and phytoplankton/periphyton data.

The Interim Water Quality Data Analysis report will be prepared by June 30, 2005.

Criteria for Success - The criteria for success of this watershed plan are as follows:

<u>East Canyon Creek</u>

1. **Non Point Source Criteria -** Total Phosphorus concentrations in East Canyon Creek above the East Canyon Water Reclamation Facility will have a 30 day mean equal to or less than 0.04 mg/l during the critical summer

months of July through September. This will be a measure of the effectiveness of non-point source controls in the upper watershed.

2. **Point Source Criteria** – The East Canyon Water Reclamation Facility will maintain compliance with the UPDES permit effluent limits established by UDWQ. This will entail a concentration based limit during the critical summer months of July through September and an overall load limit in order to be protective of the reservoir.
3. **Dissolved Oxygen Criteria** – The dissolved oxygen values in East Canyon Creek will meet UDWQ water quality standards of a 30 day average of not less than 5.0 mg/l during the critical summer season of July through September.

East Canyon Reservoir

1. **Annual Phosphorus Load** – The average annual load of phosphorus entering East Canyon Reservoir will be reduced to 5,647 pounds per year.
2. **In-Lake Phosphorus Concentration** – The average "in-lake" total phosphorus concentration will be equal to or less than 0.25 mg/l.
3. **Trophic State Index** – The seasonal trophic state index for the reservoir will be between 40 and 50.
4. **Algal Dominance** – The algal dominance in the reservoir will not be composed of blue green species.

Long Term Water Quality Monitoring Program

East Canyon Reservoir Monitoring

UDWQ will complete at least two lake profile monitoring events each year on East Canyon Reservoir during the summer months (June through September). This will include hydrolab readings for temperature, conductivity, pH, and dissolved oxygen at 1 meter intervals along with samples for phosphorus and phytoplankton.

East Canyon Creek:

Station	Storet No.	Frequency	No. of Samples	Parameters
EAST CAN CK AB RES AT SEC RD NR USGS GAGING STATION	492519	2004 - 2007 Schedule B; 2003 & 2008 Schedule A; Schedule C all years	Schedule A; 16 Schedule B; 9	Chem. Type 2; Nutrient Type 9
EAST CANYON CK O.5 MI AB CLAYTON HIST MARKER	492521	2003 & 2008 Schedule A	same as 492519	Chem. Type 2; Nutrient Type 9
EAST CANYON CK BL JEREMY RANCH GOLF COURSE	492523	same as 492519	same as 492519	Chem. Type 2; Nutrient Type 9
EAST CANYON WWTP	492525	same as 492519	same as 492519	Chem. Type 2; Nutrient Type 9
E CAN CK AB EAST CANYON WWTP	492526	same as 492519	same as 492519	Chem. Type 2; Nutrient Type 9
MURNIN CREEK AT I-80 XING	492532	2003 & 2008 Schedule A	same as 492519	Chem. Type 2; Nutrient Type 9
THREE MILE CK AB CNFL/ E CANYON CK @ I80 XING	492533	2003 & 2008 Schedule A	same as 492519	Chem. Type 2; Nutrient Type 9
KIMBLE CREEK AT I-80 XING	492536	same as 492519	same as 492519	Chem. Type 2; Nutrient Type 9
EAST CANYON CK AB KIMBALL CK	492537	2003 & 2008 Schedule A	same as 492519	Chem. Type 2; Nutrient Type 9
MCLEOD CREEK AT U-224 XING	492544	2003 & 2008 Schedule A	same as 492519	Chem. Type 2; Nutrient Type 9

Frequency

A. Biweekly March thru July; snowmelt to low flow (approx 9 events); monthly during low flow (approx August - Feb; 7 events.)

B. Monthly March through October w/ one sample in Dec. or Jan

C. Diurnal D.O. and Biological – Periphyton, benthic invertebrate, and diurnal dissolved oxygen in mid August each year

Parameters

Chemistry Type 2: Bicarbonate, Carbonate, Chloride, Hydroxide, pH, Specific Conductance, Sulfate, Total Alkalinity, Total Dissolved Solids, Total Hardness, Total Suspended Solids, and Turbidity**.**

Nutrient Type 9: Ammonia, Dissolved Nitrite & Nitrate, Total Phosphorus, Total Dissolved Phosphorus

Figure 5. Upper East Canyon Watershed map.

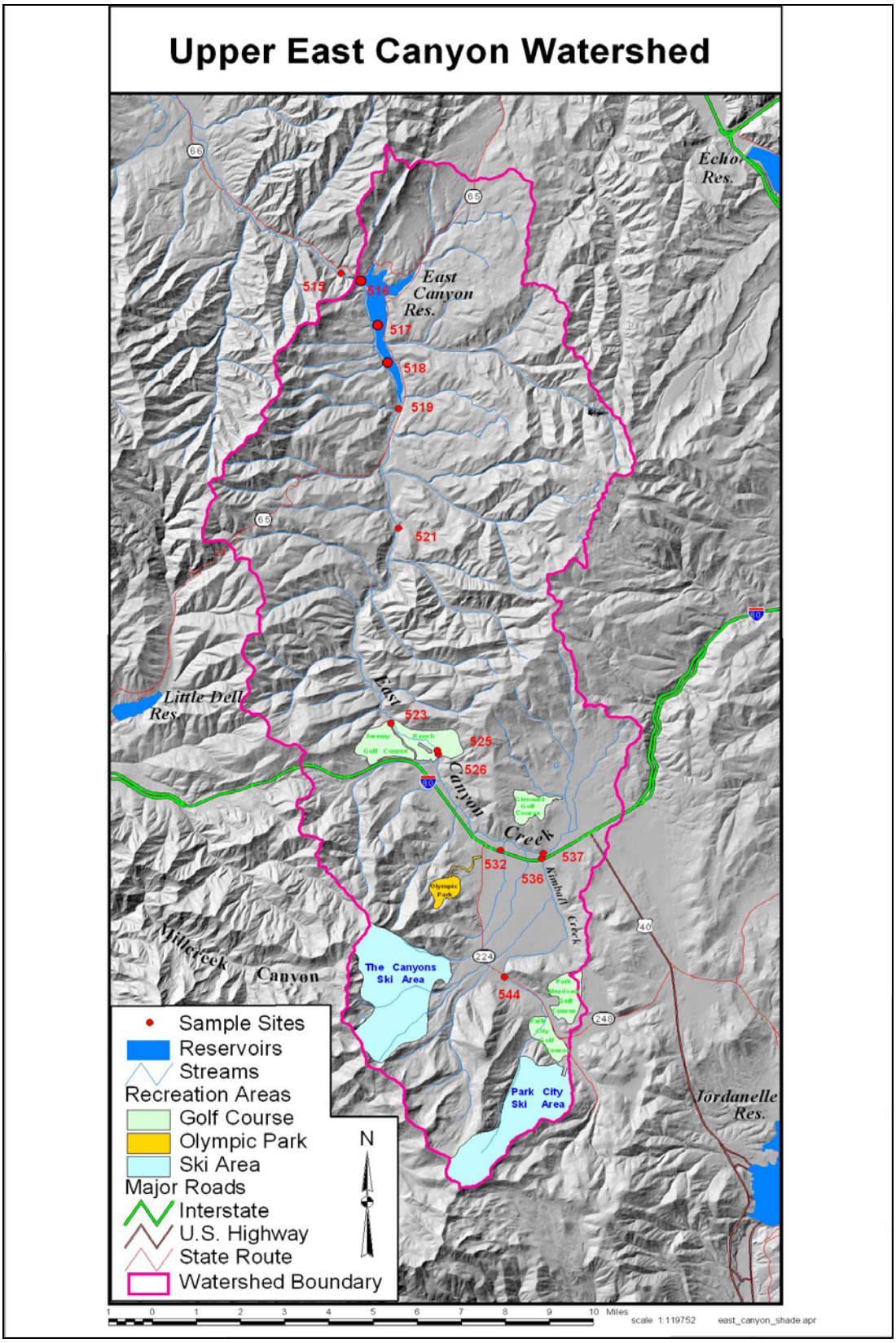
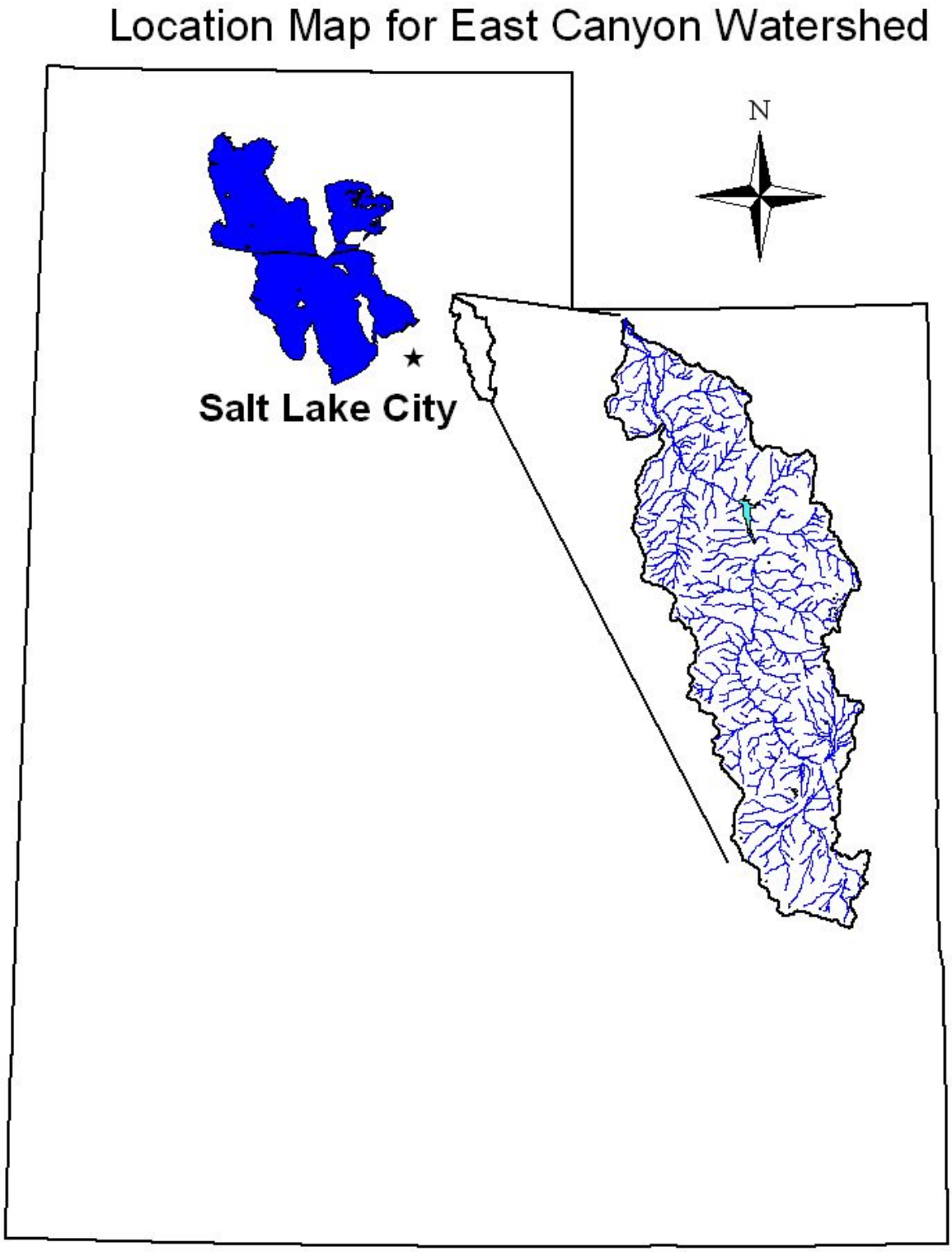


Figure 6. East Canyon Watershed location map.



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Utah Department of Environmental Quality, Division of Water Quality, 2000, East Canyon Creek Total Maximum Daily Load

Utah Department of Environmental Quality, Division of Water Quality, 2000, East Canyon Reservoir Total Maximum Daily Load

Appendix A: Soils Summary for the East Canyon Watershed.

Map Unit	Soil Association	General Description
UT111	UTABA-EASTCAN-PRINGLE	Very deep, well drained to poorly drained loam, silt loam, and gravelly sandy loam soils on valley bottoms alluvial fans, alluvial plains, and stream terraces.
UT112	MANILA-STODA-NEBEKER	Very deep, well drained, loam and clay loam soils on lake terraces, stream terraces, and alluvial fans.
UT113	HAWKINS-MANILA-OSTLER	Very deep or moderately deep, well drained loam and silty clay soils on foot hills, mountain footslopes, alluvial fans and mountainsides.
UT114	DURFEE-YEATES HOLLOW-LAMONDI	Very deep or deep, well drained, gravelly to very stony loam and clay loam soils on alluvial fans, mountain foot slopes, and mountainsides.
UT116	ISBELL-HADES-KILFOIL	Very deep to moderately deep, well drained loam soils on steep mountainsides and alluvial fans.
UT120	POLELINE-PATIO-SESSIONS	Deep and moderately deep, well drained, gravelly, cobbly, and stony loams on mountainsides and mountain tops.
UT121	LUCKY STAR-CHARCOL-FLYGARE	Very deep, well drained silt loams to gravelly or cobbly loams and fine sandy loams on high mountainsides.
UT124	NAGISTY-ROCK OUTCROP-BROAD CANYON	Moderately deep and very deep, well drained stony loam to gravelly loam soils on subalpine and high mountainsides and canyon walls.
UT130	ANT FLAT-HADES-PICAYUNE FAMILY	Very deep to moderately deep, well drained, cobbly silt loam and loam soils on mountainsides, benches, stream terraces, and alluvial fans.
UT161	HENEFER-GAPPMAYER-HARKERS	Deep and shallow, well drained, gravelly and cobbly loam and silt loam soils on mountainsides and alluvial fans.
UT267	ROUNDY-DAYBELL-FITZGERALD	Deep to very deep, well drained and somewhat excessively drained, gravelly and cobbly loams and sandy loams soils on high mountainsides and plateaus.
UT274	POLELINE-FITZGERALD-HAILMAN	Very deep and deep, somewhat excessively and well drained, loam and gravelly loam soils on mountainsides.
UT275	HENEFER-YEATES HOLLOW-MANILA	Very deep and deep, well drained, loam and stony or cobbly loam soils on mountain slopes and alluvial fans.
UT280	KOVICH-MOWEBA-MANILA	Very deep, poorly and well drained, loam and gravelly loam soils on alluvial fans, floodplains, and valley floors.

UT282	RICHSUM-AYOUB-CUTOFF FAMILY	Moderately deep to deep, well drained, gravelly or cobbly loam and silt loam soils on mountain slopes.
UT309	SKUTUM-LUCKY STAR-UINTA	Deep to very deep, well drained, loam, gravelly loam, and cobbly sandy loam soils on mountain slopes and till plains.