Criteria Support Document

12/19/2018

Use and Value Assessment and Site-specific Criteria for Total Dissolved Soils (TDS): Silver Creek, Version 2.2

Contents

EXECUTIVE SUMMARY

A Use and Value Assessment was conducted for total dissolved solids (TDS) criterion to protect the agricultural designated use for Silver Creek, Summit County. Based on the use and value of the water, a maximum TDS criterion of 1,900 mg/L is proposed for Silver Creek and tributaries from Tollgate Creek to headwaters.

Road salting in the Park City area is impacting the water quality of Silver Creek by increasing the concentrations of TDS. The water quality of Silver Creek is also adversely impacted by water diversions and metals contamination from the historic mining activities in the Park City area.

The TDS criterion protects the agricultural uses of Silver Creek water. After determining that road salt was the primary source of man-caused portion of TDS to Silver Creek, local and state road maintenance agencies were contacted and their best management practices (BMPs) reviewed. BMPs are currently being implemented (primarily liquid potassium chloride pre-treatment of roads, sweeping and metered application) but salt application on private properties remains unregulated. This road salting is essential to protect human life and health resulting in an irreversible human-caused condition.

After considering all of the current and likely future irrigation practices with Silver Creek water and researching the salt tolerances of the irrigated crops, the higher criterion will protect the agricultural uses. The irrigation uses in this upper reach are primarily moderately salt-tolerant pasture grasses. Agriculture is more intensive downstream and includes alfalfa and grains. The TDS criterion for upper Silver Creek from the existing criterion of 1,200 mg/L to 1,900 mg/L is proposed. The 1,900 mg/L criterion in upper Silver Creek will be protective of the existing agricultural uses and will support the continued attainment of the 1,200 mg/L criterion downstream.

The following changes to R317-2-13.4 Weber River Basin are recommended.

(a) Weber River Drainage

Weber River and tributaries, from Stoddard diversion to Headwaters<u>, except as listed below</u>

1C 2B 3A 4

<u>Silver Creek and tributaries, from confluence with Weber River to</u>

<u>below the confluence with Tollgate Creek 1C 2B 3A 4</u>

<u>Silver Creek and tributaries, from confluence with Tollgate Creek</u>

<u>to Headwaters 1C 2B 3A 4*</u>

R317-2-14. Numeric Criteria Table 2.14.1

FOOTNOTE: (4)

<u>Silver Creek and tributaries, Summit County, from confluence with Tollgate Creek to headwaters: maximum 1,900 mg/L.</u>

LIST OF ACRONYMS

-A-		**-N-**	
AGRC	Automated Geographic Reference Center	NRCS	Natural Resources Conservation Service
AMRP	Abandoned Mine Reclamation Program	**-P-**	
ASOC	Administrative Settlement and Order on Consent	PCMC	Park City Municipal Corporation
AU	Assessment Unit	**-S-**	
-B-		SBWRD	Snyderville Basin Water Reclamation District
BMPs	Best Management Practices	SCO	Stipulated Compliance Order
-C-		SCWRF	Silver Creek Water Reclamation Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (aka Superfund)	**-T-**	
CFR	Code of Federal Regulations	TDS	Total Dissolved Solids
CWA	Clean Water Act (FKA Federal Water Pollution Control Act)	TMDL	Total Maximum Daily Load
-D-		**-U-**	
DDW	(Utah) Division of Drinking Water	UGS	Utah Geological Survey
DEQ	(Utah) Department of Environmental Quality	UHP	Utah Highway Patrol
DWQ	(Utah) Division of Water Quality	UPCM	United Park City Mines
-E-		USGS	United States Geological Survey
EPA	Environmental Protection Agency	**-W-**	
-K-		WQS	Water Quality Standard
KVCD	Kamas Valley Conservation District	WWTP	Wastewater Treatment Plant
-L-			
LDC	Load Duration Curve		
-M-			
MLID	Monitoring Location ID		
MS4	Municipal Separate Storm Sewer Systems		

INTRODUCTION

Purpose of Document

The purpose of this document is to present supporting documentation for a revised TDS criterion in Silver Creek. Data for this study were collected and analyzed according to the Sampling and Analysis Plan for TDS (DWQ, 2016) and the Silver Creek and East Canyon Creek TDS Study Work Plan (DWQ, 2017).

Regulatory Basis

As specified by UAC R317-2-7.1, site-specific standards may be adopted by rulemaking where biomonitoring data, bioassays, or other scientific analyses indicate that the statewide criterion is over or under protective of the designated uses or where natural or un-alterable conditions or other factors as defined in 40 CFR 131.10(g) prevent the attainment of the statewide criteria as prescribed in Subsections R317-2-7.2, and R317-2-7.3, and Section R317-2-14. As documented herein, the proposed criterion is protective of the uses.

The applicable federal requirements are specified in 40 CFR 131.10(a) "Each State must specify appropriate water uses to be achieved and protected. The classification of the waters of the State must take into consideration the use and value of water for public water supplies, protection and propagation of fish, shellfish and wildlife, recreation in and on the water, agricultural, industrial, and other purposes including navigation. If adopting new or revised designated uses other than the uses specified in section 101(a)(2) of the Act, or removing designated uses, States must submit documentation justifying how their consideration of the use and value of water for those uses listed in this paragraph appropriately supports the State's action. A use attainability analysis may be used to satisfy this requirement."

DWQ is proposing to revise the magnitude and duration of the water quality criterion for TDS for the Class 4 beneficial use in the upper Silver Creek watershed because of irreparable human-caused conditions. This requires splitting the Silver Creek Assessment Unit 16020101-020_00 into Silver Creek-1 (16020101-020_01) and Silver Creek-2 (16020101-020_02). A higher criterion in (Upper) Silver Creek-2 will continue to protect the existing Class 4 Agricultural uses because the irrigated pastures have a medium tolerance for salinity (USU, 1999; USDA, 2018). The salinity tolerances of crops are also affected by soil type, specific ions present and irrigation practices (USU, 1999). If sufficient irrigation water is applied at 1,900 mg/L (2,289 µS/cm) so that 15% is available for percolation through the root zone, predicted reductions in alfalfa yields are 15% (USU,1999).

Downstream agricultural uses for Silver Creek-1 include crops such as alfalfa that are more sensitive to TDS than the pastures but alfalfa is still classified as having medium salinity tolerance (USDA, 2018). No change to the TDS criterion is proposed for Silver Creek-1.

Watershed Description

The Silver Creek watershed is located in north-central Utah approximately 20 miles east of Salt Lake City (Figure 1). It is part of what has been defined by the Utah Geological Survey as the Snyderville Basin, which contains all of the East Canyon Creek drainage within Summit County and includes Silver Creek from its headwaters to the confluence with Tollgate Canyon (Figure 2) (Brooks et al., 1998). The headwaters for both Silver Creek and East Canyon Creek are in the Park City Municipal area.

Silver Creek flows east from its headwaters in Park City, then north through meadows along Highway 40, and finally through Silver Creek Canyon to the confluence with the Weber River downstream of Rockport Reservoir. The watershed drains approximately 48 square miles, and elevations range from >9,900 feet at the headwaters to 5,825 feet in the lower watershed (DWQ, 2013). The majority of Silver Creek's flow occurs during spring runoff, and the stream reach between Highway 40 and the USGS Gage at Atkinson often has little to no streamflow at other times of the year.

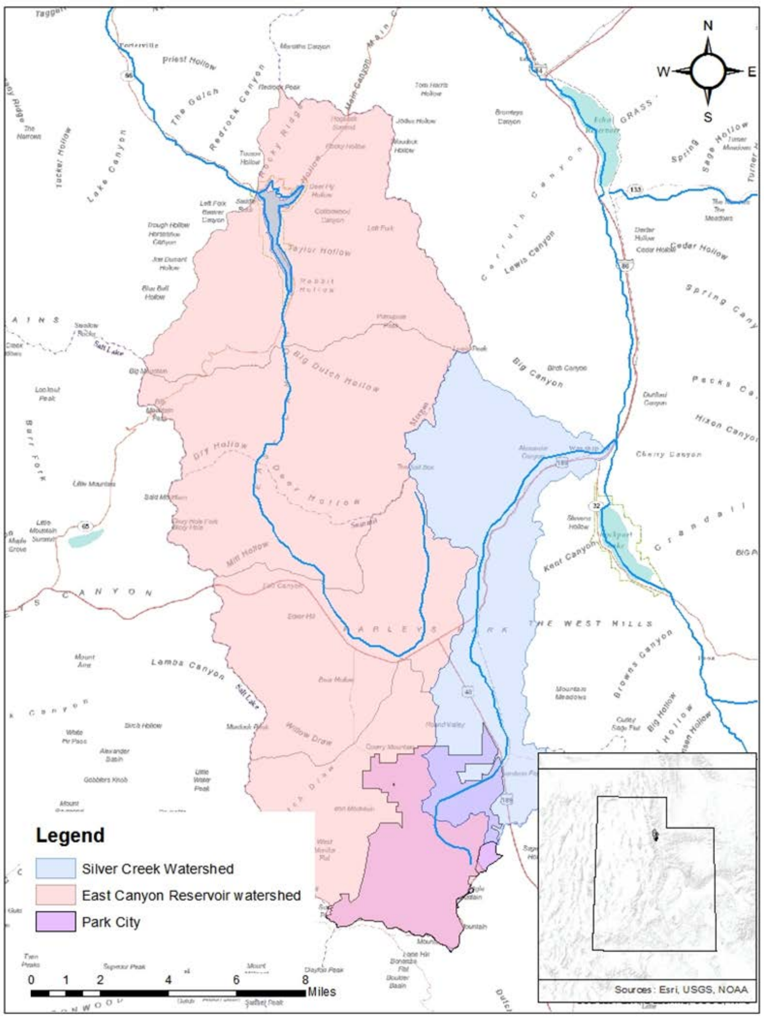

FIGURE 1. LOCATION OF SILVER CREEK WATERSHED (BLUE). PARK CITY'S BOUNDARIES ARE IN PURPLE. SILVER CREEK'S HEADWATERS ARE LOCATED IN PARK CITY.

Geology

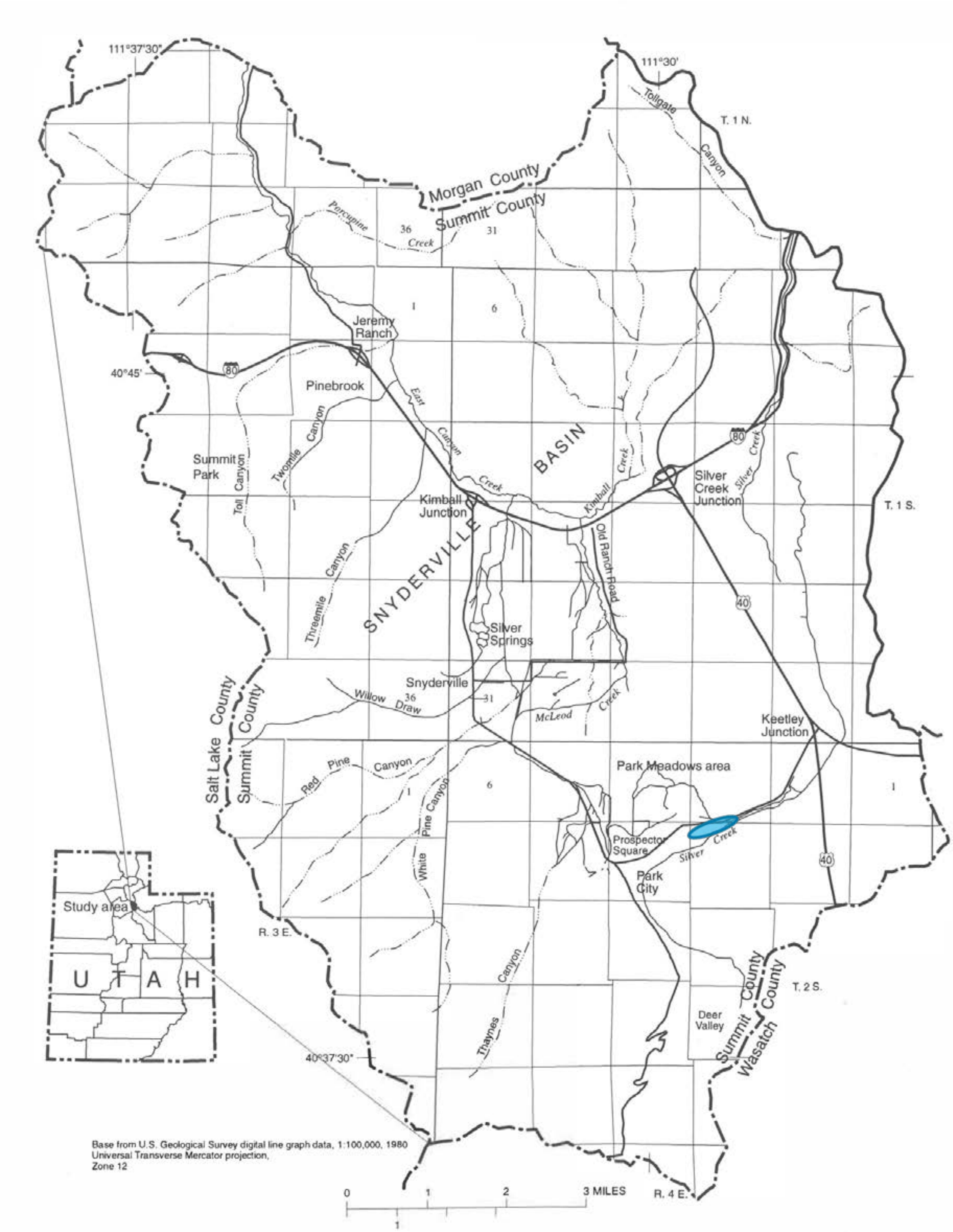

FIGURE 2. HYDROLOGIC BOUNDARY OF THE SNYDERVILLE BASIN, SUMMIT COUNTY, UTAH (MODIFIED FROM BROOKS ET AL., 1998). ORANGE OVAL MARKS THE APPROXIMATE LOCATION OF THE SINKHOLES THAT APPEARED IN 1982 AND 2008.

Figure 2 shows the boundary of the Snyderville Basin, which includes all of East Canyon Creek within Summit County and Silver Creek from the headwaters to the confluence with Toll Creek Canyon

(Brooks et al., 1998). This area has been studied by the United States Geological Survey (USGS), Utah Geological Survey (UGS), and the Utah Division of Water Rights since the 1990s due to increasing development and the need to characterize available groundwater resources.

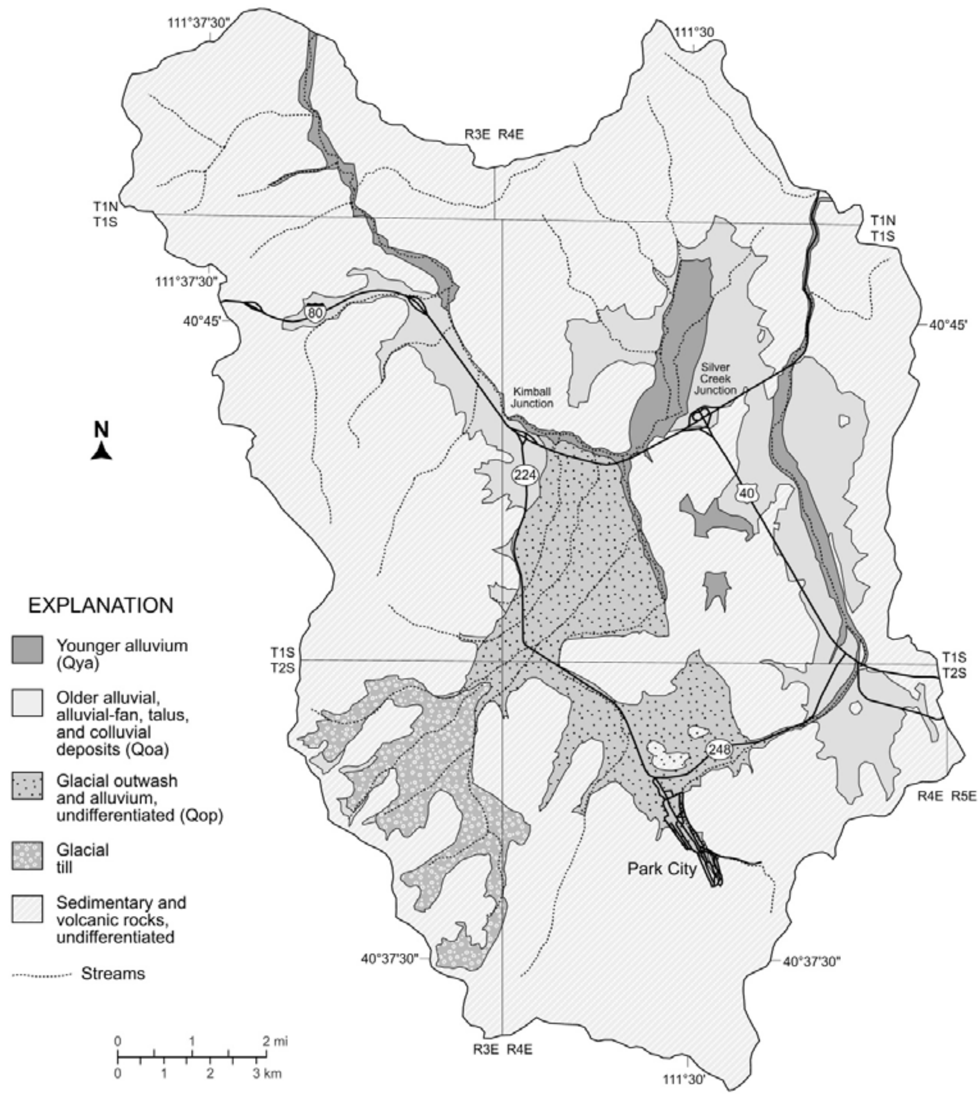

FIGURE 3. GEOLOGIC MAP OF THE SNYDERVILLE BASIN (MODIFIED FROM ASHLAND, ET AL, 2001). ORANGE OVAL MARKS THE APPROXIMATE LOCATION OF THE SINKHOLES THAT APPEARED IN 1982 AND 2008.

Figure 3 is a simplified geologic map of the Snyderville Basin. Groundwater in the basin is present in consolidated bedrock and in the unconsolidated valley fill. The principal water bearing formations consist of folded and fractured sandstone, limestone, shale, and quartzite in the northwest and central portions of the valley; volcanic rocks in the northeast and east; and siltstone, conglomerate, and sandstone in the north. The valley fill aquifers comprise alluvium, glacial outwash and glacial till (Brooks et al., 1998).

Groundwater in the study area is primarily influenced by the consolidated bedrock. Weathering of limestone and sandstone yield calcium, magnesium, bicarbonate and sulfate, which result in high hardness (>400 mg/L on average [DWQ 2004]). According to Brooks et al. and Susong et al. (1998), groundwater TDS concentrations in the Snyderville Basin range from 200 – 600 mg/L in the unconsolidated deposits. TDS concentrations in the unconsolidated aquifer may influence sodium and chloride concentrations in the underlying consolidated bedrock aquifer. Chloride in wells and springs near Park City, and in the creek near I-80, was attributed to road salt application (1998).

Headwater streams in the Snyderville Basin originate in the Wasatch Range, which constitute the southern and western borders of the basin. The canyons are a source of surface water, which flows north, and a recharge area for the consolidated bedrock and the unconsolidated valley fill aquifers (Brooks et al., 1998). Groundwater is discharged near Kimball Junction and in Park Meadows (Figure 2). The rapid response of streamflow to snowmelt conditions indicates limited groundwater storage capacity, such that streamflow is highly variable depending upon the amount of precipitation available (Susong et al., 1998).

Tunnels from legacy mining in the Park City area are also a source of surface water. Flow from the Judge and Spiro Tunnels is used for drinking, and any excess water flows to Silver Creek (or Mcleod Creek in the East Canyon Watershed).

SINKHOLES

Sinkholes formed in faulted limestone, quartzite and shale during May and June of 2008 in the reach of Silver Creek approximately 0.6 miles east-northeast of the trail gate at Wyatt Earp Way and South of U-248 (SBWRD, 2009) (Figures 2 and 3). This was approximately 200 feet west of a sinkhole that appeared in May 1982. The sinkholes captured the entire flow of Silver Creek and were subsequently plugged to restore streamflow. There is disagreement between USGS and the Abandoned Mine Reclamation Program (AMRP) and Loughlin Water Associates as to how they formed – USGS and AMRP contend that they were an abandoned adit while Loughlin Water Associates argue that they developed naturally (2009). Regardless, the geology in that stream reach is not well understood, and the reach can alternate between gaining and losing streamflow.

LEGACY MINING

Silver mining occurred in Park City from approximately 1868 to 1949 (http://historicparkcityutah.com). This history has resulted in metals contamination in soil, sediment, and surface water from Silver Creek's confluence with Tollgate Creek to the headwaters. Most of the mining activity occurred within the headwaters, particularly in Empire Canyon. Tailings from the mines were typically stored onsite or sluiced downstream. Several downstream locations were used to further reduce and process the discarded mine tailings in an attempt to recover additional metals. The middle reaches of the stream have significant amounts of mine tailings, including Silver Maple Claims, Richardson Flats, Flood Plain Tailings and the Meadow area (Figure 4). The ground water table is high and appears to exchange freely with water in Silver Creek, so contamination pathways are generally attributed to surface or ground water contact with mine tailings contaminated with metals. The Prospector Drain, a shallow groundwater drain installed to lower the water table in a portion of Prospector Square, is also a significant source of metals (and TDS) to the creek. The stream reach in Silver Creek Canyon between

Atkinson (MLID 492674 on figure) and Wanship has no tailings or other sources of metals other than existing sediment loads.

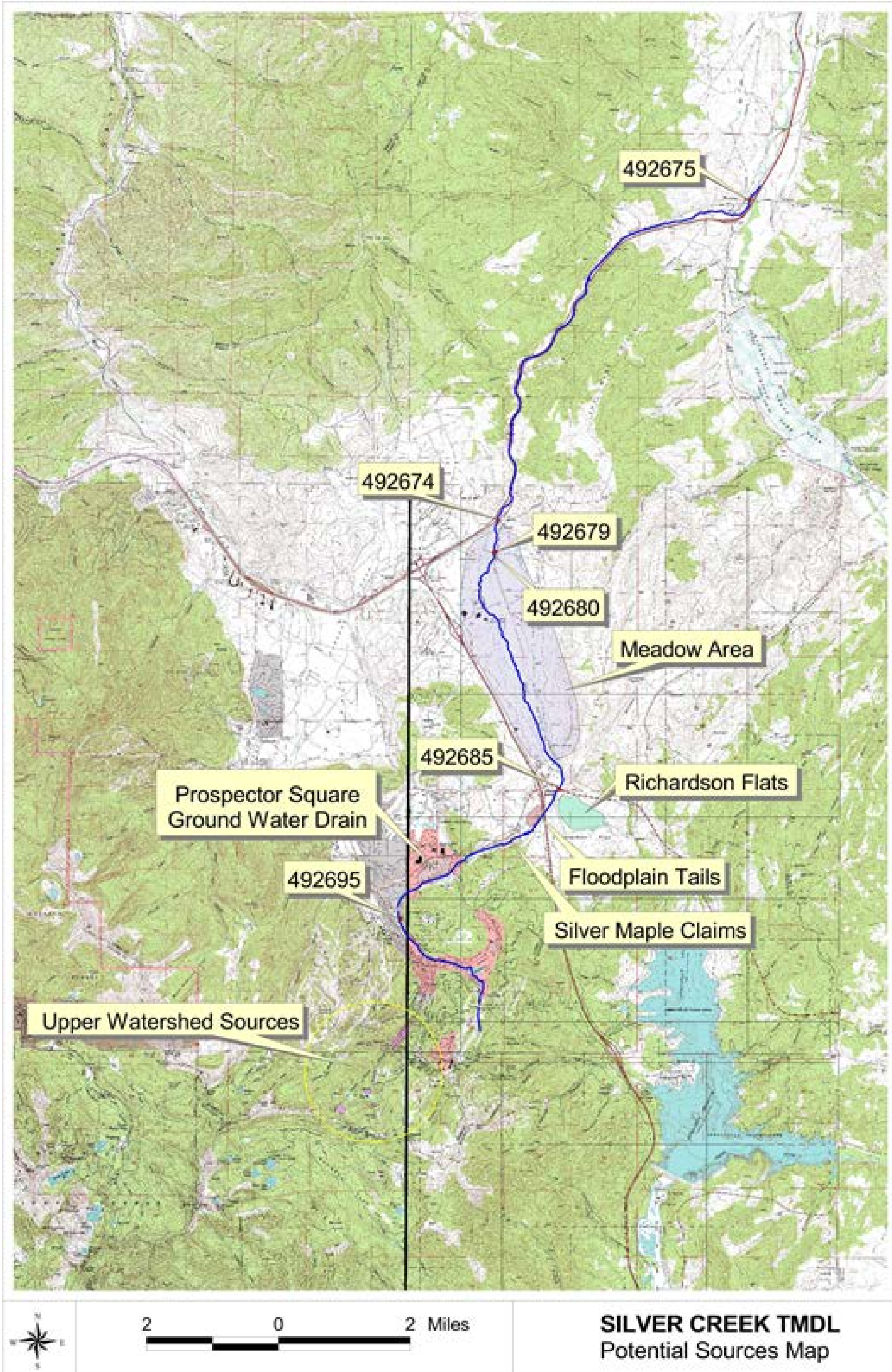

FIGURE 4. MAP OF POTENTIAL SOURCES FROM THE 2004 SILVER CREEK TMDL. MINE TAILING LOCATIONS AND MLIDS IN THE SILVER CREEK WATERSHED ARE ACCURATE, BUT THE LOCATION OF THE PROSPECTOR DRAIN IS APPROXIMATE. NOTE: ZEROS HAVE BEEN ADDED TO MLID SINCE 2004. FOR EXAMPLE, 492674 IS NOW 4926740.

Land Use

Based on the most recent water related land use information (AGRC, 2018), land use in the Silver Creek watershed is approximately 13% agricultural, 86% urban, and 1% riparian. Of the agricultural uses, approximately 10% are pasture, 1% alfalfa, 1% grass hay, and less than 1% idle (Table 1, Figure 5).

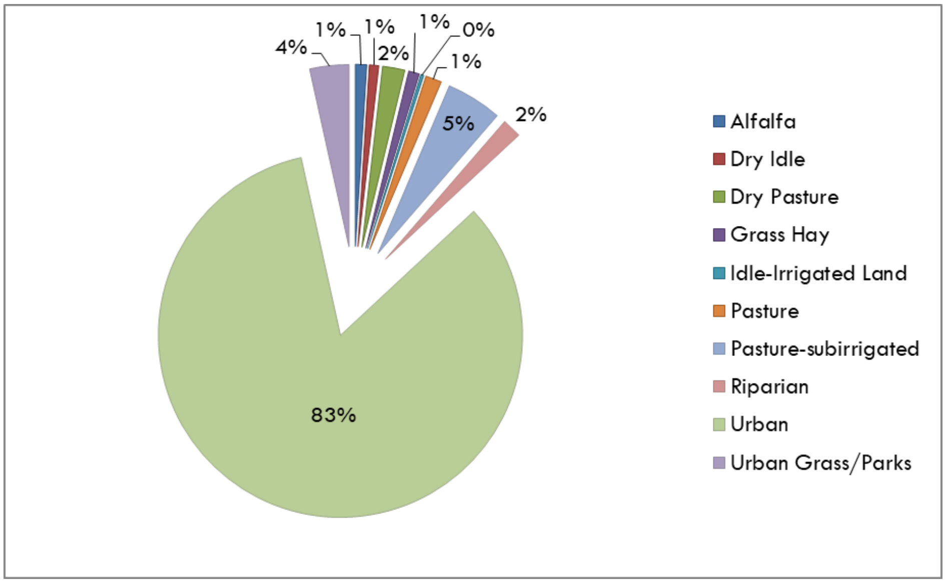

FIGURE 5. PROPORTIONAL LAND USE IN THE SILVER CREEK WATERSHED BY SUBCATEGORY (E.G. URBAN & URBAN GRASS AND PARKS). DATA IS FROM WATER RELATED LAND USE INFORMATION COMPILED BY THE UTAH DIVISION OF WATER RESOURCES – SURVEY YEAR 2007 (AGRC 2018).

According to NRCS, agricultural irrigation uses are primarily in Wanship, and crops include wheat, oats, and barley rotated with alfalfa (K.Lundeen, personal communication with NRCS 5/2/2016).

TABLE 1. LAND USE IN THE SILVER CREEK WATERSHED (DATA FROM AGRC, 2018).

Water Related Land Use	# of Acres	% Acres
Irrigated		
Alfalfa	21.37	1.04%
Grass Hay	20.48	1.27%
Pasture	30.65	2.84%
Total Irrigated:	**72.5**	**5.15%**
Not Irrigated		
Dry Idle	17.78	0.23%
Dry Pasture	42.12	1.98%
Idle-Irrigated Land	5.38	0.08%
Total Not Irrigated:	**65.28**	**2.29%**
Riparian		1.21%
Total Riparian:	**36.72**	**1.21%**
Sub-Irrigated		
Pasture-Sub-Irrigated	106.35	5.60%
Total Sub-Irrigated:	**106.35**	**5.60%**
Urban		
Urban	1,793.81	83.29%
Urban Grass/Parks	74.59	2.47%
Total Urban:	**1,868.4**	**85.75%**
Grand Total	**2,149.25**	**100.00%**

Figure 6 shows the land uses within the Silver Creek watershed. According to data from AGRC and the NRCS Resource Assessment for Summit County, Utah (2005), nearly all land is privately owned (i.e. city, county, or private citizens). Approximately 3% of land is federally or state owned (1.4% Bureau of Land Management, 0.2% Army Corps of Engineers/Department of Defense, and 0.3% owned by Utah School and Institutional Trust Lands Administration.

Irrigation

As discussed above, a limited (13%) quantity of agricultural land use is present in the Silver Creek watershed. Water rights to support new irrigation are unavailable and arable land is limited by ongoing growth. Irrigation is primarily used for pastures, grass hay and alfalfa which is rotated with wheat, barley or oats. Of the irrigated crops in the Silver Creek watershed, alfalfa is likely the most sensitive to TDS. However, alfalfa is primarily grown near the town of Wanship where no changes to the TDS criterion are proposed. There is one exception in the Park City area (Figure 7). This is the only plot of alfalfa in the Upper Silver Creek watershed, and it is irrigated using water from a private well. Since the water rights are limited to that source, this particular alfalfa field is not using and will not use water from Silver Creek (K. Lundeen, personal communication with Park City Municipal Corporation [PCMC], 7/26/2018). Pace Homer ditch, the other major irrigation diversion, collects water from Dorrity Spring, Spiro Tunnel, Mcleod Creek, and groundwater seepage (Brooks et al., 1998). Water from these sources is also below 1,200 mg/L TDS.

USU (1999), USDA (2018) and the Canadian Alberta Ag-info Center (AA, 2001) classify all of these crops as having a high- or medium salt tolerance. Based on the data presented in these sources, the 1,900 mg/L TDS criterion will not adversely affect the existing agricultural uses of water. If alfalfa crops were irrigated with TDS concentrations of 1,900 mg/L in the future, yields could be by reduced 15% (USU, 1999).

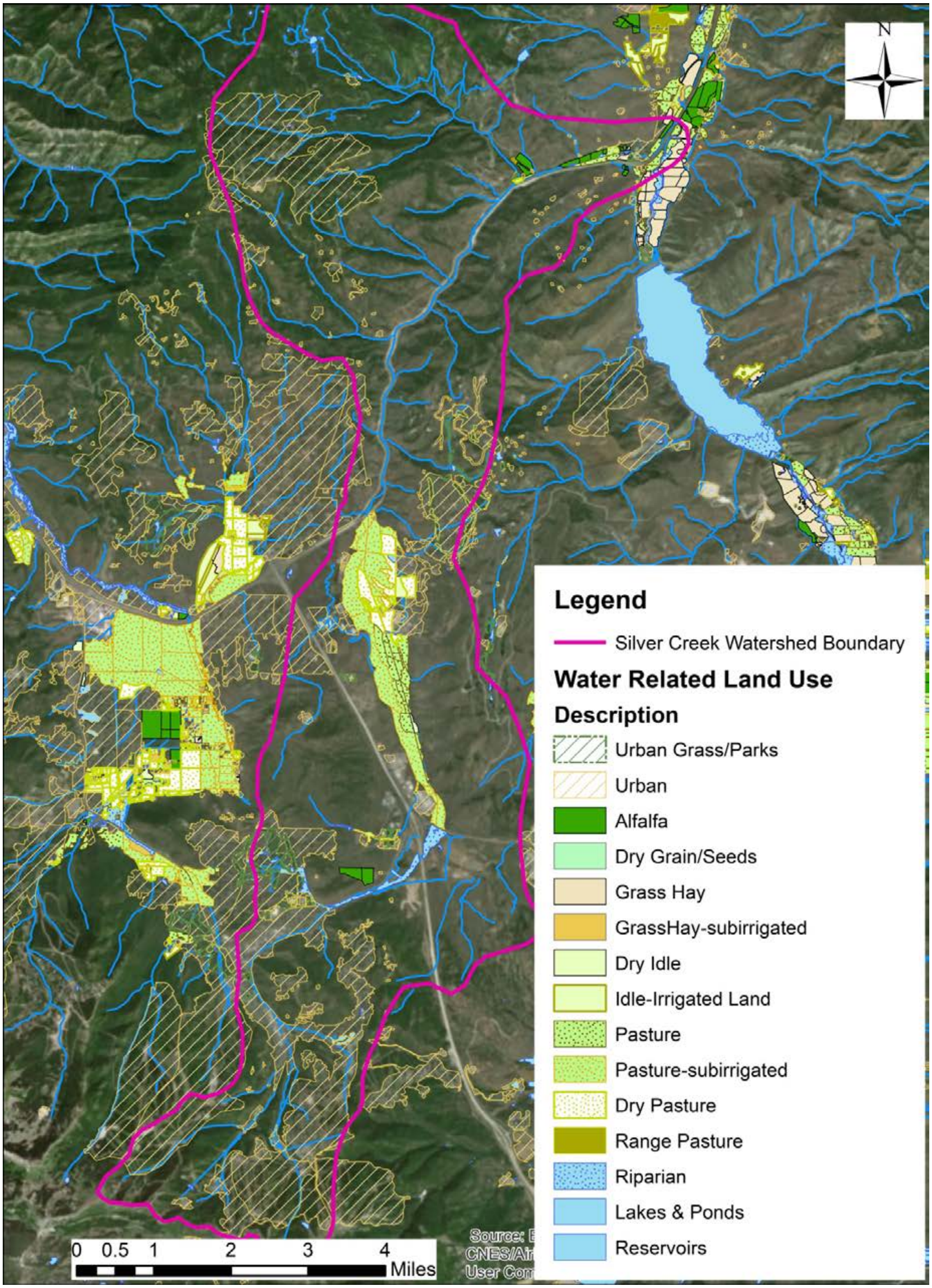

FIGURE 6. MAP OF LAND USES IN THE SILVER CREEK WATERSHED. (WATER RELATED LAND USE DATA COMPILED BY THE UTAH DIVISION OF WATER RESOURCES – SURVEY YEAR 2007 [AGRC 2018])

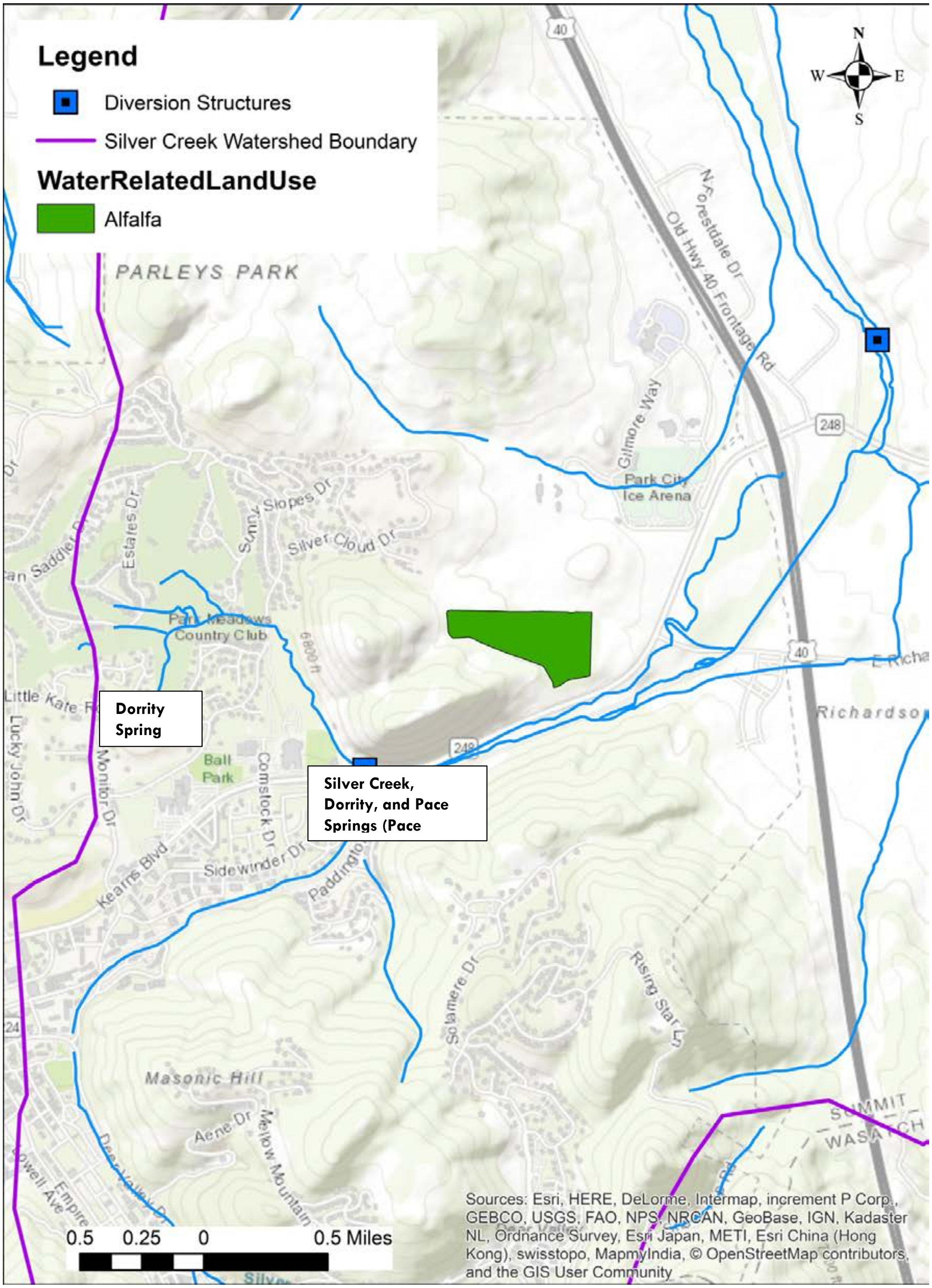

FIGURE 7. IRRIGATION DIVERSIONS IN THE SILVER CREEK WATERSHED AS THEY PERTAIN TO IRRIGATED LAND USE (DIVERSION DATA PROVIDED BY TROUT UNLIMITED). ALFALFA GROWN IN THIS LOCATION IS IRRIGATED BY A PRIVATE WELL.

Beneficial Uses

Silver Creek is protected for the following designated uses:

1C Protected for domestic purposes with prior treatment by processes required by the Utah Division of Drinking Water.

2B Protected for infrequent primary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water, such as boating, wading, or similar uses.

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

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

DISCUSSION OF IMPAIRMENTS

1C - Domestic

The water quality of Silver Creek is not meeting its 1C beneficial use criteria for arsenic, nitrate, and pH. The nitrate impairments have been addressed through the Rockport and Echo Reservoir TMDL (2014). Arsenic will be addressed by a Stipulated Compliance Order (SCO) between DWQ and PCMC.

2B - Recreation

According to the 2016 Integrated Report, the water quality of Silver Creek is not meeting its 2B beneficial use criteria for pH.

3A - Aquatic Life

As described in the table, the water quality of Silver Creek is not meeting the Class 3A cold-water fishery beneficial use based on cadmium, zinc, arsenic, DO, pH, and biological assessments.

The stream channel between Silver Creek Canyon and the headwaters has high in-stream metal concentrations due to legacy mine tailings. DWQ completed TMDLs for cadmium and zinc in 2004. The 2004 TMDL recommended best management practices (BMPs) to reduce metals loading, including removal of the mine tailings, slope protection, proper routing of storm runoff, isolation measures, soil ordinances, temporary erosion controls, and water treatment such as water and sediment separators and treatment wetlands. Remediation was completed in Empire Canyon in 2007 and in part of Richardson Flat in 2012. EPA continues to oversee remediation under Administrative Orders on Consent (AOCs) with PCMC and United Park City Mines (EPA 2013 and 2014). Completed and planned remedial actions are expected to address all metal impairments.

DWQ addressed the DO impairment in the 2014 TMDL for Rockport and Echo Reservoirs. However, DWQ does not expect to attain the 3A use until the remedial actions are complete due to the tailings in the stream channel that degrade aquatic habitat.

4 - Agricultural Water Uses

The water quality of Silver Creek exceeds the Class 4 beneficial use criteria of 1,200 mg/L TDS for irrigation and stock watering (Utah Administrative Code R317-2-14). As such, Silver Creek was included on Utah's 303(d) list of impaired waters in 2014 for TDS. Data indicates that TDS concentrations are higher in Silver Creek during the winter when road salt is applied with concentrations higher at the upstream sites.

TABLE 2. DESCRIPTION OF BENEFICIAL USES, IMPAIRMENTS, AND TMDL STATUS.

Name	Assessment Unit	Impaired Beneficial Use	2016 Assessment	TMDL Status
Silver Creek	UT16020101-020	1C	Arsenic	4B*
		1C	Cadmium	Approved 2004
		1C	pH, nitrate	Approved 2014
		3A	OE Bioassessment	4B*
		3A	Cadmium, Zinc	Approved 2004
		3A	Arsenic	4B*
		3A	Temperature	4B*
		3A	Dissolved oxygen, pH	Approved 2014
		4	Total Dissolved Solids	2015-2018

**Pending submission to and approval by EPA, Category 4B is a listing category indicating that a plan is in place to address this parameter (currently in development).*

SOURCE ASSESSMENT

Conceptual Site Model

DWQ has developed a conceptual model for sources of TDS impairment in the Silver Creek watershed based on examination of existing data, discussions with stakeholders, and comparisons with similar TDS impaired waterbodies (Figure 8).

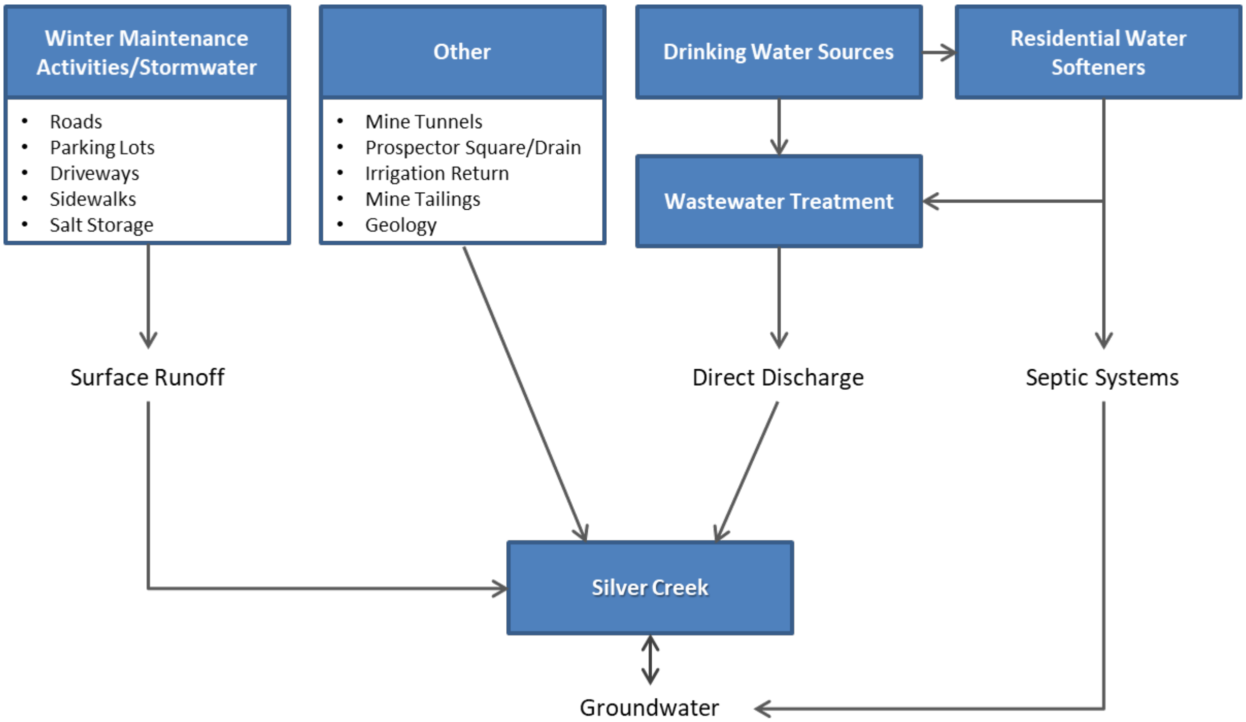

FIGURE 8. CONCEPTUAL SITE MODEL.

Winter Maintenance Activities

Park City is a tourist destination with steep mountain roads and receives an average of 340" of snowfall during the winter. Road salt is used so that residents and tourists may safely access home, work, two ski resorts, the Sundance Film Festival, and other winter activities. Figure 9 shows three photographs of road salt applied in the Park City area during a snowstorm in February 2018. In addition to applying salt to roads, snow is removed from areas of that do not have sufficient space for stockpiling. Summit County and PCMC are restricted in where they may store snow, but private contractors pile snow in various locations throughout Park City and Summit County, and sites are selected solely based on landowner willingness to accept the snow piles (K.Lundeen, personal communication with Kamas Valley Conservation District [KVCD], 5/1/2018).

FIGURE 9. SUMMIT PARK EXIT, I-80, PARK CITY AREA, FEBRUARY 22, 2018. PHOTOS SUBMITTED BY MIKE LUERS.

JURISDICTIONS AND REGULATORY OVERSIGHT

There are three different jurisdictions for road salt application in the Park City area - the Utah Department of Transportation – Region 2 (UDOT), Summit County, and Park City Municipal Corporation. All three entities are designated Municipal Separate Storm Sewer Systems (MS4s) and are subject to stormwater permitting, which requires that they keep and update stormwater management plans. Summit County was designated as of July 1, 2015 and Park City was designated as of July 1, 2016.

Multiple private contractors within the watershed remove snow and apply salt to parking lots, driveways, and sidewalks. No regulatory oversight exists for their application rates or snow disposal methods.

EXISTING BEST MANAGEMENT PRACTICES

Salt Storage and Truck Maintenance

UDOT stores salt at various locations throughout the state. Most of the sheds are covered; all of them will be covered by June of 2019. Additional salt storage BMPs include sweeping excess salt back into covered storage areas, washing trucks in contained areas that divert the water to retention ponds, and regular pumping and proper disposal of retention pond water. UDOT is investigating ways they can prevent excess water from entering their retention ponds to enhance storage capacity. Summit County and PCMC have fully covered salt storage, including clay-lined holding ponds and improved truck maintenance procedures.

Truck Calibration and Salt Application

UDOT trucks are maintained regularly and are calibrated in the fall to prepare for the winter season. Mechanics check the hydraulics, chains, and salt spreaders. The mechanics are given control of the spreader, and truck drivers are locked out of the controls so that the standard rate of 250 pounds/lane mile is maintained. The truck drivers are still able to get in the back of the truck and adjust the gate, but UDOT discourages this through training. The standard application rate of 250 pounds/lane mile has been developed based on experience with salt effectiveness on Utah roads and cost. Summit County and

PCMC use 300 pounds/lane mile at 20 miles per hour. Summit County also uses a brine solution with the salt that enhances snow melting.

PCMC has made a concerted effort over the last several years to optimize salt application and reduce the overall amount applied to roads (Figure 10). They have achieved some reductions, particularly since 2016.

While PCMC and Summit County have made efforts to reduce salt application, local contractors are incentivized to apply as much salt as possible. Contractors are paid a bonus for the amount of salt applied on top of the pay they receive for clearing snow (K.Lundeen, personal communication with KVCD, 5/1/2018).

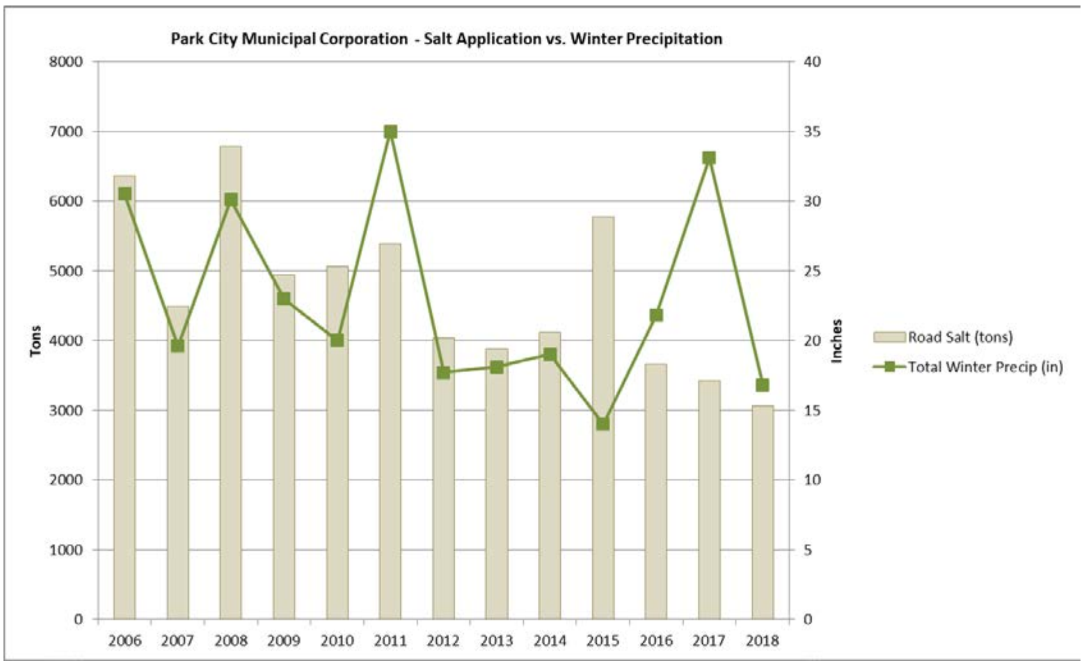

FIGURE 10. ROAD SALT APPLIED IN PARK CITY IN TONS PER WINTER SEASON

COMPARED TO SNOW PRECIPITATION TOTALS IN EQUIVALENT INCHES OF WATER FOR THAT SEASON (SOURCE – PCMC AND NRCS SNOTEL DATA).

Road Maintenance

Each entity works to maintain roads to ensure effective drainage, prevent icy spots, and reduce the need for salt. UDOT sweeps the roads in their jurisdiction on days that it is not snowing while Summit County and PCMC sweep in the spring.

Education and Training

Each entity trains drivers annually on truck maintenance, truck calibration, and salt application rates. Challenges lie in retaining drivers and in finding new drivers during the winter season.

Frequently, extra salt is added to roads at the request of the Utah Highway Patrol (UHP) or local law enforcement. UDOT has equipped their trucks with GPS so that when they receive a request for additional salt they can respond more efficiently – if the truck has already visited a location they can convey that to UHP, or they could send a driver if the area has not been salted yet. PCMC has invited local law enforcement to the training for their drivers so that they understand the logistics involved in clearing the roads and the desire to be as judicious as possible with salt application.

FUTURE BEST MANAGEMENT PRACTICES

Each entity is developing BMPs as part of their MS4 permits. Below is a list of recommended and planned BMPs.

- Recommended Education and Training
  - Provide annual education and training to private contractors responsible for snow removal (all)
  - Actively discourage excessive salt application (through ordinances or permitting requirements) (all)
  - Invite state highway patrol and other law enforcement to trainings (all)
  - Send mailers to the public in their utility bills to educate them on the need for optimized salt use
  - Provide incentives to operators for optimizing salt use

- Planned Education and Training
  - Enhance annual operator training with additional information to be provided by DWQ (all)
  - Develop trackable training modules for operators (UDOT)
  - Develop a mentoring program in maintenance sheds (UDOT)
- Other Suggested BMPs
  - Identify a local repository for snow piles away from surface waters, including irrigation canals (PCMC, Summit County)
- Other Planned BMPs
  - Complete covered salt storage (UDOT, by 2019)
  - Enhanced control systems on trucks
    - Controls that prevent operators from over-applying salt (UDOT, Summit County)
    - Pre-wetting to minimize the amount of salt, prevent bouncing, and prevent ice from bonding to the road (PCMC)

Stormwater

Stormwater runoff from roads and active construction is considered a potential source of TDS (Figure 11). However, the majority of stormwater runoff associated with high TDS loads were correlated with events that require road salt or during spring runoff.

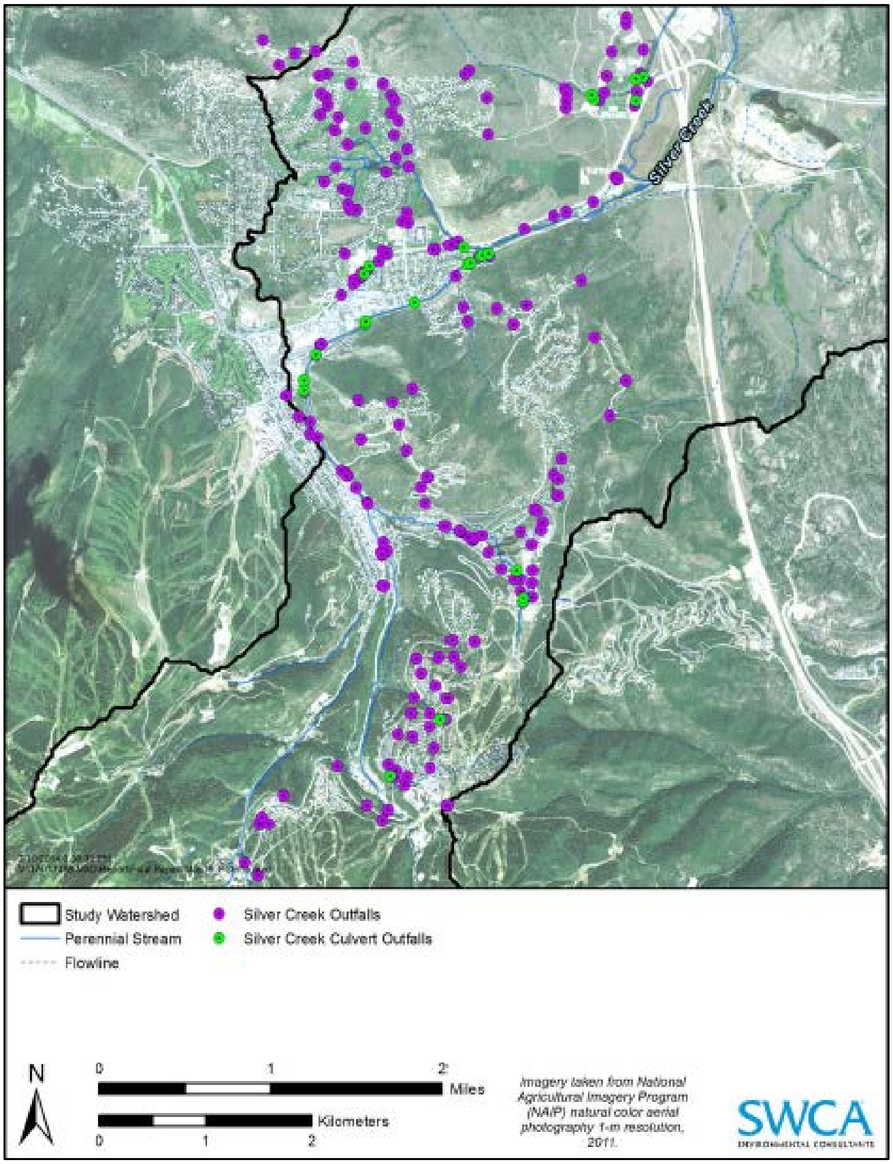

FIGURE 11. LOCATIONS OF STORMWATER OUTFALLS IN THE SILVER CREEK WATERSHED (DEQ, 2014).

Septic systems

Many homes in Summit County are still on septic systems, another potential source of TDS loading (Figure 12). There are three types of residences within the watershed, primary residence (212 homes), secondary residence (40), and recreational homes (310). SBWRD is collaborating with Summit County Health Department and DWQ to connect neighborhoods to sewer and require new developments to meet stringent septic system requirements in order to reduce nutrient loading, which may also reduce TDS contributions to groundwater.

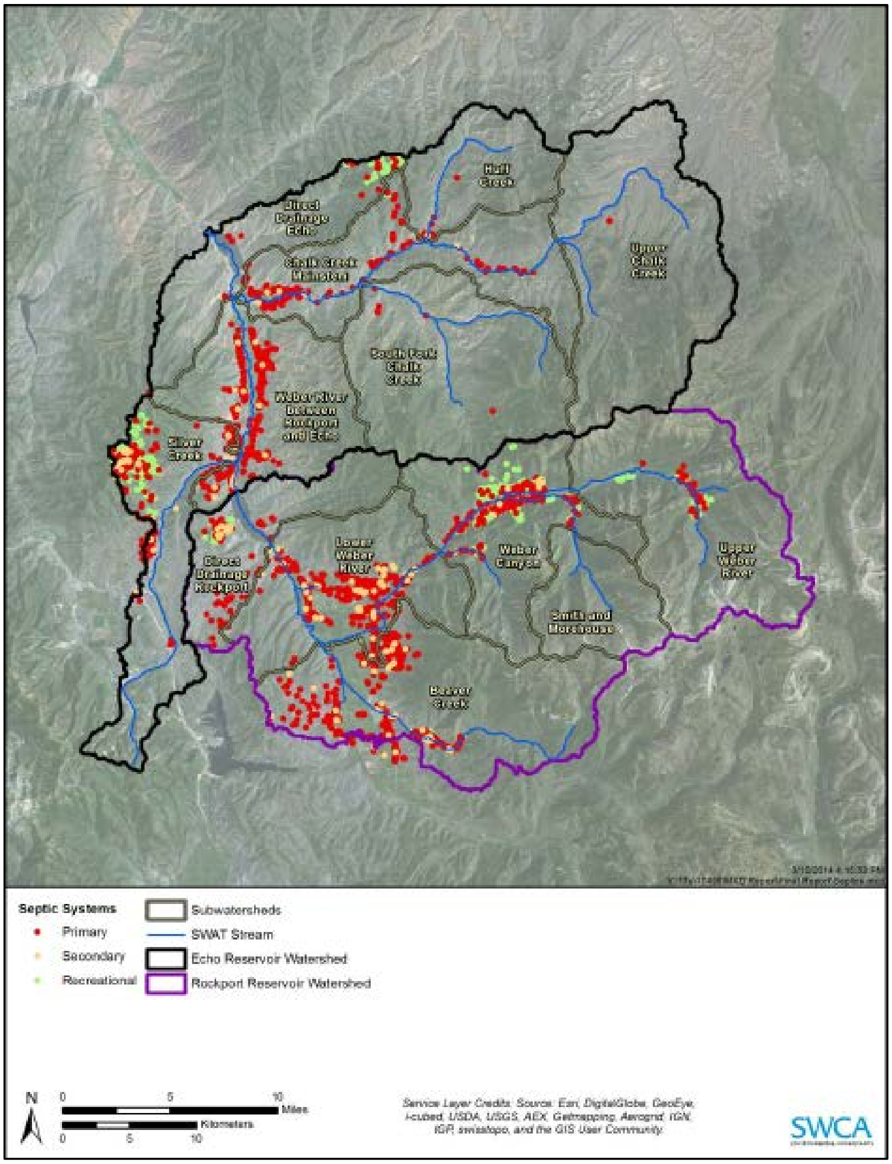

FIGURE 12. SEPTIC SYSTEM MAPPED IN THE UPPER WEBER RIVER WATERSHED, INCLUDING SILVER CREEK (DWQ, 2014).

Mine tailings

Extensive mining occurred in this area historically and mine tailings compose at least a portion of the stream channel between Silver Creek Canyon and the headwaters. As shown in Figure 13, metal concentrations increase from upstream to downstream. This is opposite of TDS concentrations which decrease downstream, indicating that the tailings are not the dominant source of TDS. Any TDS loading from the tailings is anticipated to decrease once remediation is complete. EPA is overseeing remediation, and it is anticipated to take at least 20 years.

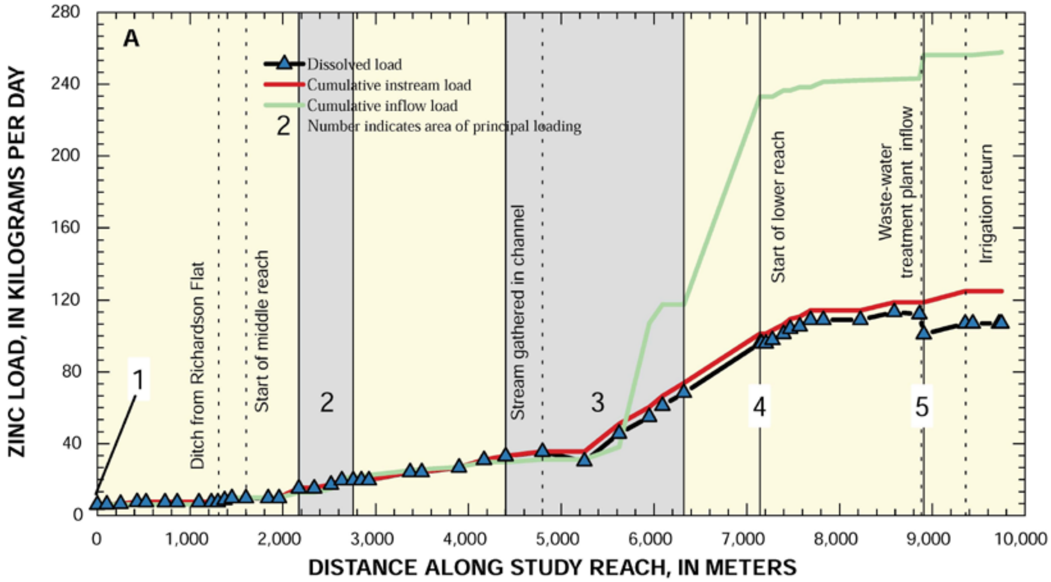

FIGURE 13. METAL LOADING FROM THE HEADWATERS OF SILVER CREEK (1) THROUGH ATKINSON (FAR RIGHT) (KIMBALL ET AL., 2007).

Prospector Square

Prospector Square is a commercial and residential area that was built in the 1980s on legacy mine tailings. A drain was installed to lower the water table in a portion of the area to facilitate development, and that drain is a known source of metals and TDS (Figure 14). In 2009, PCMC installed a bio-cell as passive treatment for metal contamination from Prospector Drain (Figure 15). While the bio-cell does reduce metals, it does not reduce TDS and treats only a portion of the flow from the Prospector Drain. Remediation of this area is being addressed in an Administrative Settlement and Order on Consent (ASOC) between PCMC and EPA that should consider TDS.

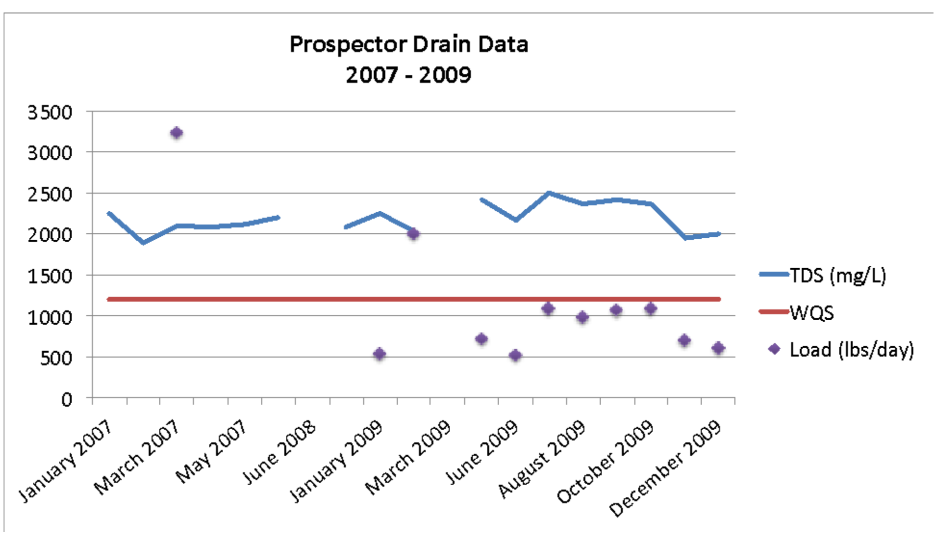

FIGURE 14. DATA FROM PROSPECTOR DRAIN, COLLECTED AND PROVIDED BY PCMC FROM 2007 TO 2009 Y AXIS IS IN MG/L.

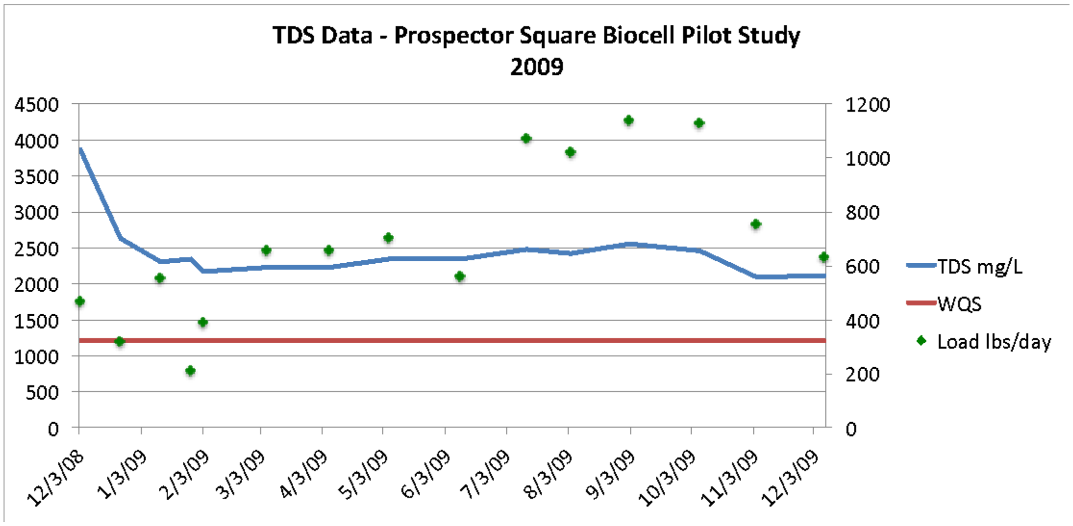

FIGURE 15. DATA FROM THE PROSPECTOR SQUARE BIOCELL PILOT STUDY, COLLECTED AND PROVIDED BY PCMC FROM 2007 TO 2009 Y AXIS ON THE LEFT IS IN MG/L AND THE RIGHT IS LBS/DAY .

Wastewater Treatment Facility

The Snyderville Basin Water Reclamation District (SBWRD) operates two wastewater treatment facilities in the Park City Municipal area: Silver Creek Water Reclamation Facility (SCWRF) (UPDES #UT0024414) and East Canyon Water Reclamation Facility (UPDES # UT0020001). These treatment facilities discharge to Silver Creek and East Canyon Creek, respectively.

Sampling indicates that influent TDS concentrations can be high, ranging from 900 to 2000 mg/L at SCWRF that pass through the facility and result in elevated effluent concentrations (Figure 16). Figure 17 plots the monthly effluent TDS values from SCWRF and shows the highest concentrations of TDS passes through their system in late fall, winter, and spring. Although their system is not specifically designed to remove TDS, it is consistently reduced. The sources of TDS loading to the treatment facilities are water softeners, drinking water sources, and seasonal infiltration and inflow. Infiltration and inflow averages 14% of total inflow volume and is higher during spring runoff when salty water from the streets enters through manholes (K. Lundeen, personal communication with SBWRD, 12/27/2017).

RESIDENTIAL WATER SOFTENERS

Home water softeners are used throughout this watershed due to high hardness of culinary water. While hardness varies in the Silver Creek watershed, samples collected throughout the 2000s average above 400 mg/L (DEQ, 2004).

Few BMPs exist for water softeners. There are programmable softeners available that reduce the amount of sodium chloride required by setting the hardness and allowing specific dosing; alternatively, potassium chloride can be used. Either option would be voluntary, as no regulatory authority exists to require homeowner participation. Information and education campaigns to address this concern are being considered by SBWRD.

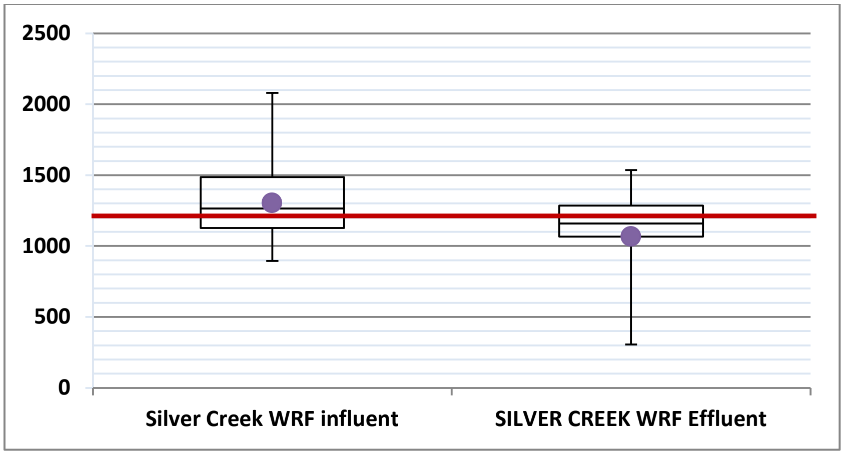

FIGURE 16. BOX PLOTS OF INFLUENT AND EFFLUENT TDS CONCENTRATIONS AT SCWRF (MG/L) (2015-2016). PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

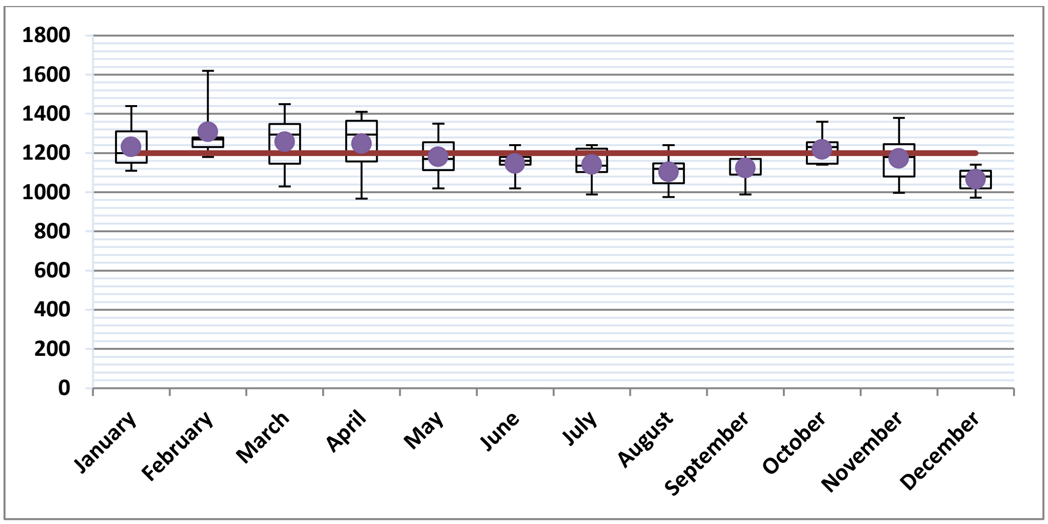

FIGURE 17. BOX PLOTS OF EFFLUENT TDS VALUES FROM SCWRF (MG/L)(2008-2017). PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

DRINKING WATER SOURCES

Drinking water sources include springs, wells, and mine tunnels surrounding Park City, operated by PCMC, Mountain Regional Water, and Summit Water. Table 3 provides information on TDS in some of the drinking water sources. Drinking water enters the SCWRF through routine use, but water from the mine tunnels is also discharged directly to Silver Creek.

TABLE 3. TDS CONCENTRATIONS FOR DRINKING WATER SOURCES IN THE PARK CITY AREA.

Drinking Water Source	# of Samples	Min (mg/L)	Mean (mg/L)	Max
PCMC Wells	221	500	735	1530
PCMC Springs	34	216	257	600
PCMC Tunnels	90	184	417	808
PCMC Treated Water (Quinn's Junction Water Treatment Plant)	19	180	239	300
Summit Water Wells	807	111	334	768

Population Growth

Park City and Summit County have been experiencing explosive growth over the past 20 years (Figure 18). Based on data from the Governor's Office of Management and Budget (2012), Summit County's population grew 91.6% from 1990 to 2000 and is expected to increase by another 97% between 2010 and 2040. Park City's population has nearly doubled from 4,468 residents in 1990 to 7,547 in 2010. Population estimate reports show Park City growing to 13,744 in 2040, an 82% increase from 2010. Because of this growth, TDS contributions are anticipated to increase. All jurisdictions that apply road salt anticipate an increase in salt use as a higher population of residents and tourists use the roads during winter. More homes and sewer connections will also increase the TDS load to the WWTP.

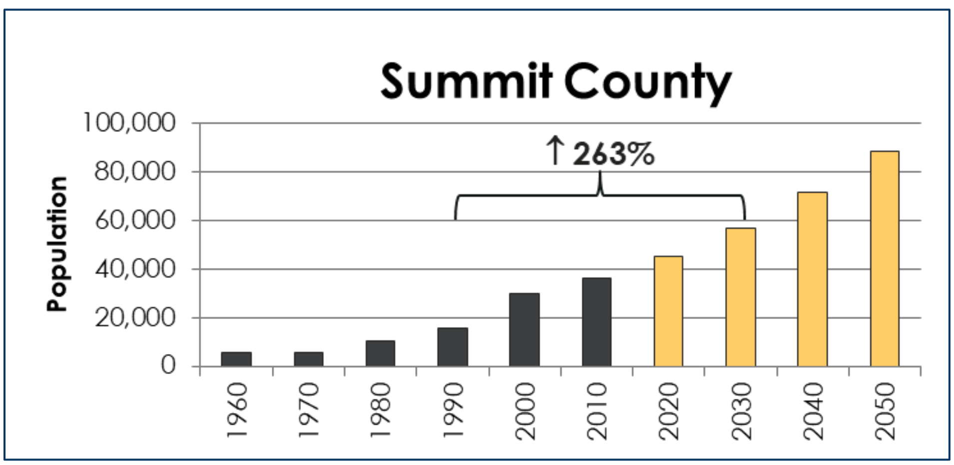

FIGURE 18. PROJECTED POPULATION GROWTH BASED ON CENSUS DATA (DWQ, 2014).

DATA COLLECTION AND ANALYSIS

Data Collection

DWQ and SBWRD collaborated to collect data in support of a TDS study from January through December 2016. DWQ's monitoring group also collected data as part of the intensive monitoring run beginning in October 2015 and ending September 2016. Table 4 presents the available data for each monitoring location, ordered from upstream to downstream.

TABLE 4. INVENTORY OF SILVER CREEK TDS DATA

MLID	Station Description	Samples Collected by	Start Date	End Date	Count
4926950	Silver Ck @ City Park Ab Prospector Square	DWQ DWQ/SBWRD	7/18/2008 10/27/2015	6/18/2009 12/1/2016	11 25
4926850	Silver Ck @ US40 Xing E of Park City	DWQ DWQ/SBWRD	1/21/2009 10/27/2015	6/18/2009 12/01/2016	6 25
4926800	Silver Ck Ab Silver Ck WWTP @ Promontory Ranch Rd Xing	DWQ DWQ/SBWRD	9/11/2008 10/27/2015	11/05/2009 12/01/2016	9 24
4926803	Silver Creek WWTP (influent)	DWQ/SBWRD	07/02/2015	12/01/2016	24
4926790	Silver Creek WWTP (effluent)	DWQ DWQ/SBWRD SBWRD	02/25/2009 10/27/2015 5/2008	8/20/2012 12/1/2016 6/2017	14 23 104
4926740	Silver Ck @ Farm Xing in Atkinson	DWQ DWQ/SBWRD	7/18/2008 10/27/2015	11/05/2009 12/1/2016	13 25
4926750	Silver Creek @ Wanship Ab Cnfl/Weber R	DWQ DWQ/SBWRD	7/17/2008 10/27/2015	6/17/2009 12/01/2016	12 24

Site Descriptions

Figure 19 displays where TDS data were collected (identified by Monitoring Location ID [MLID]). The monitoring site Silver Creek @ City Park Above Prospector Square (4926950) is located in the most developed area of Park City adjacent to Bonanza Drive. US40 Xing (4926850) is downstream of Prospector Square and the sinkhole location and is between U248 and the Rail Trail. Promontory (4926800) is upstream of SCWRF in the meadows area (Figure 7). SCWRF influent and effluent are 4926803 and 4926790, respectively. SCWRF is located on the uplands near the northern end of the meadows area. Atkinson (4926740) is at the USGS Gage at the northern end of the meadows area, just upstream of Silver Creek Canyon. Wanship (4926750) is in the town of Wanship, approximately 6 miles downstream of Atkinson. It is near the mouth of Silver Creek Canyon, upstream of the confluence with the Weber River.

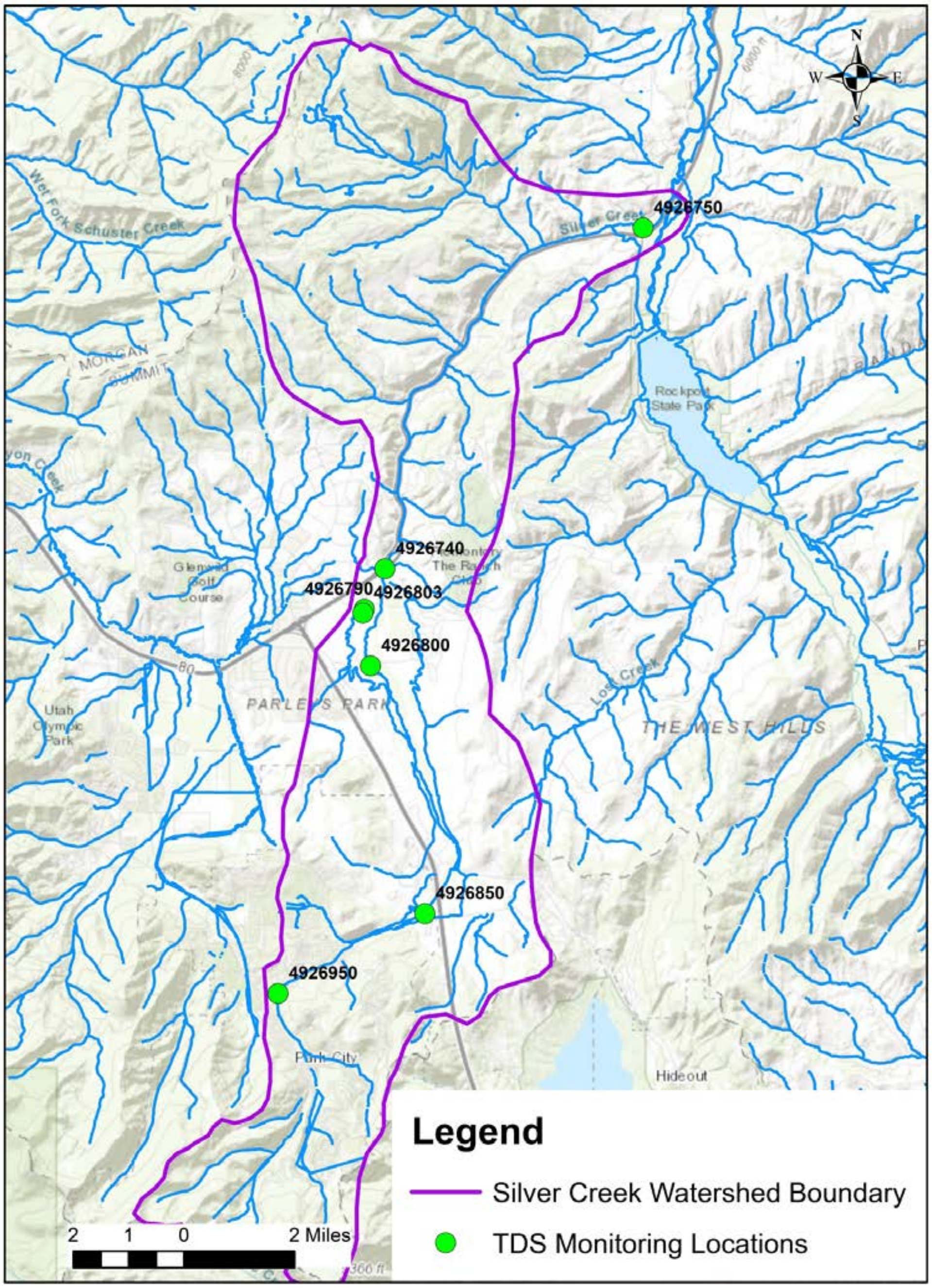

FIGURE 19. MONITORING LOCATIONS IN THE SILVER CREEKWATERSHED.

Data Analyses

Statistics by Monitoring Location - Upstream to downstream

Table 5 and Figure 20 present summary statistics and box plots for each monitoring location.

TABLE 5. SUMMARY STATISTICS - ALL TDS DATA.

MLID	Station Description	Count	Min. (mg/L)	Mean (mg/L)	Median (mg/L)	Max. (mg/L)	# Greater Than Criterion	% Greater than Criterion
4926950	Silver Ck @ City Park Ab Prospector Square	36	358	1051	721	5412	9	25%
4926850	Silver Ck @ US40 Xing E of Park City	31	572	1061	812	2524	8	26%
4926800	Silver Ck Ab Silver Ck WWTP @ Promontory Ranch Rd Xing	33	706	1146	1130	1912	12	36%
4926803	Silver Creek WWTP influent	24	896	1304	1265	2080	NA	NA
4926790	Silver Creek WWTP effluent (DWQ) Silver Creek WWTP effluent (SBWRD)	37 104	306 968	1069 1183	1160 1170	1536 1620	17 38	46% 37%
4926740	Silver Ck @ Farm Xing in Atkinson	38	792	1077	1046	1392	7	18%
4926750	Silver Creek @ Wanship Ab Cnfl/Weber R	36	334	799	820	1270	1	3%

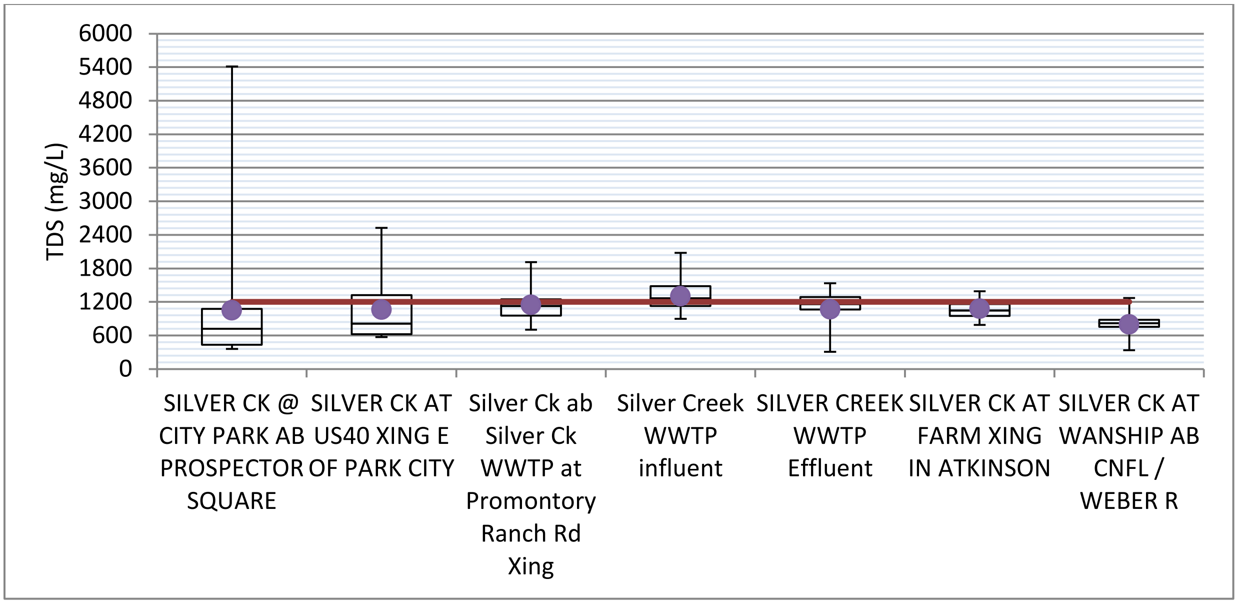

FIGURE 20. BOX PLOTS PRESENTED FROM UPSTREAM TO DOWNSTREAM, AND INCLUDE INFLUENT AND EFFLUENT CONCENTRATIONS FROM THE SCWRF FOR REFERENCE. PURPLE DOTS ARE MEAN VALUES. DATA PRESENTED IS FROM JULY 2008 – DECEMBER 2016. RED LINE IS THE 1,200 MG/L CURRENT CRITERION.

Variability is highest at the upstream site and generally decreases downstream. This is especially true of the Above Prospector site (4926950), which is adjacent to Bonanza Drive. Road drainage has been piped directly to Silver Creek along this reach.

Silver Creek at Wanship has less than 10% exceedance and complies with the 1,200 mg/L criterion.

Specific Conductance/TDS Regression

In addition to performing statistical analysis on TDS data from each site, DWQ used paired data to correlate specific conductance measurements collected at the USGS gage with TDS concentrations quantified in the lab (Figure 21). The regression analysis was then used to examine long-term USGS gage measurements of specific conductance to calculate TDS values for the stream at Atkinson (4926740, USGS Gage 10129900).

TDS = 0.58 x Specific Conductance

$R^2 = 0.82$

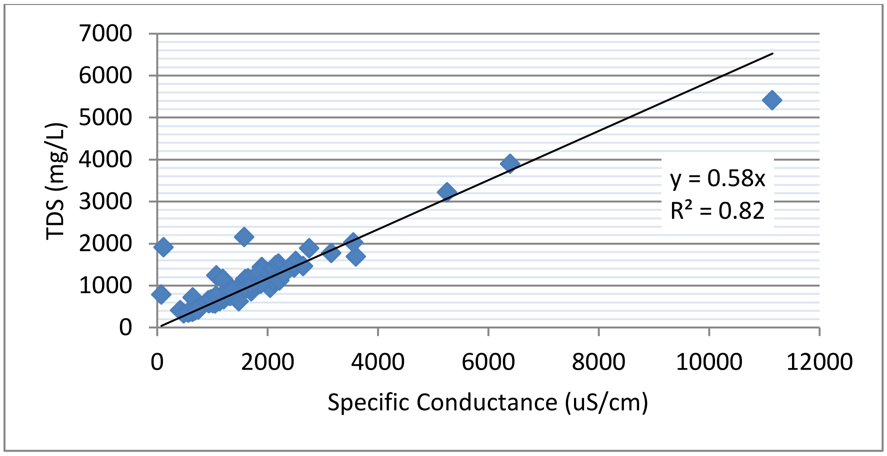

FIGURE 21. REGRESSION OF CONDUCTANCE DATA FROM THE USGS GAGE AT ATKINSON AND PAIRED TDS CONCENTRATIONS. DATA FROM 1/1/2008 THROUGH 12/31/2016.

Figure 22 shows the daily average specific conductance (blue line) compared to both the calculated daily TDS value and the current criterion. Based on the calculated daily averages for TDS, Atkinson is meeting the criterion in March through November. Values are at or slightly above the criterion in December through February.

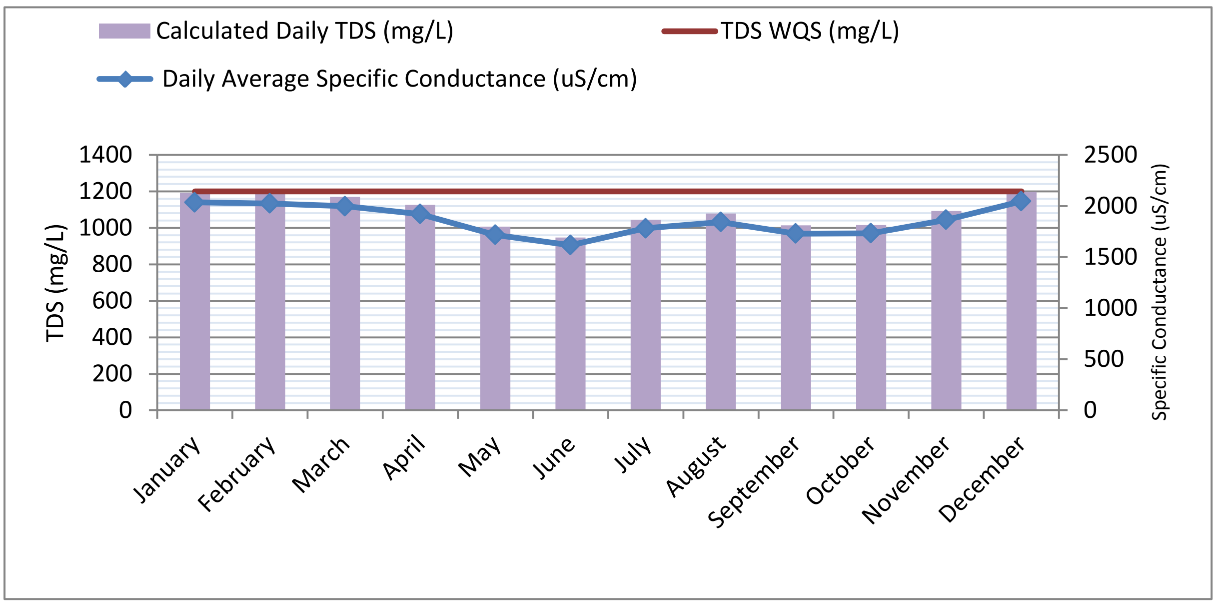

FIGURE 22. AVERAGE SPECIFIC CONDUCTANCE AND CALCULATED TDS BY MONTH AT USGS GAGE 1012990 ATKINSON (BELOW SCWRF).

Analyses by Season

Box plots were constructed for all data available for each site based on season. Climatic seasons were defined as: Fall – September, October, November; Winter – December, January, February; Spring – March, April, May; Summer – June, July, August. Water right agreements define the irrigation season in the Snyderville Basin as May through September.

SEASONS – CLIMATIC

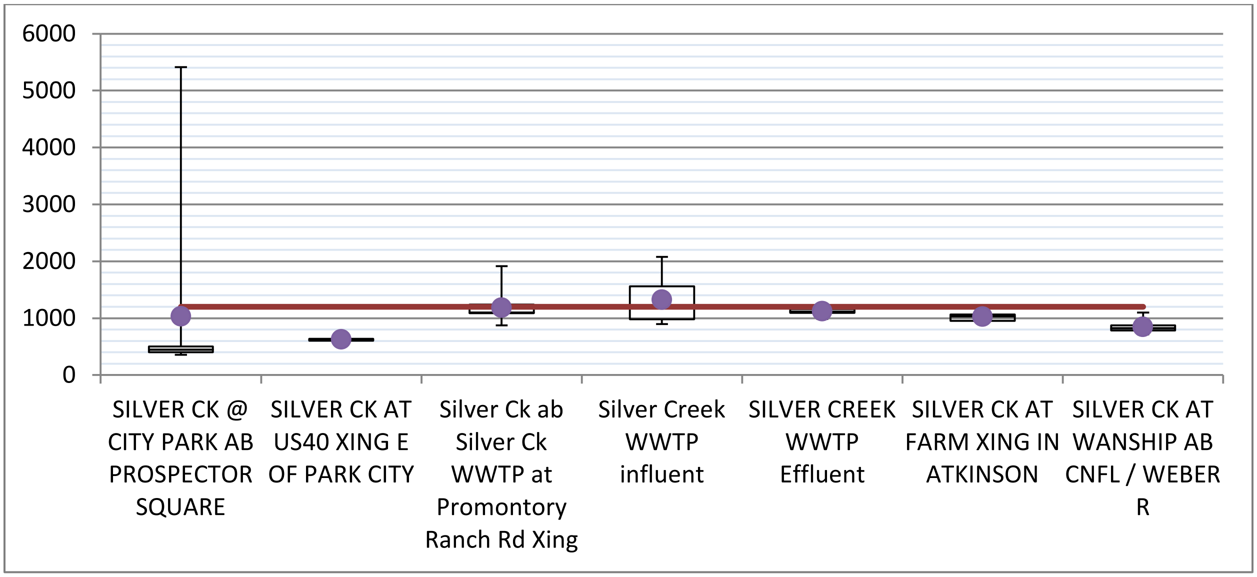

FIGURE 23. FALL TDS CONCENTRATIONS (MG/L). INFLUENT AND EFFLUENT ARE INCLUDED FOR COMPARISON. THE PURPLE DOTS REPRESENT THE MEAN VALUE, AND THE RED LINE IS THE CURRENT CRITERION.

Fall TDS concentrations are highly variable, particularly at Prospector Square. WQS are met at Atkinson and Wanship.

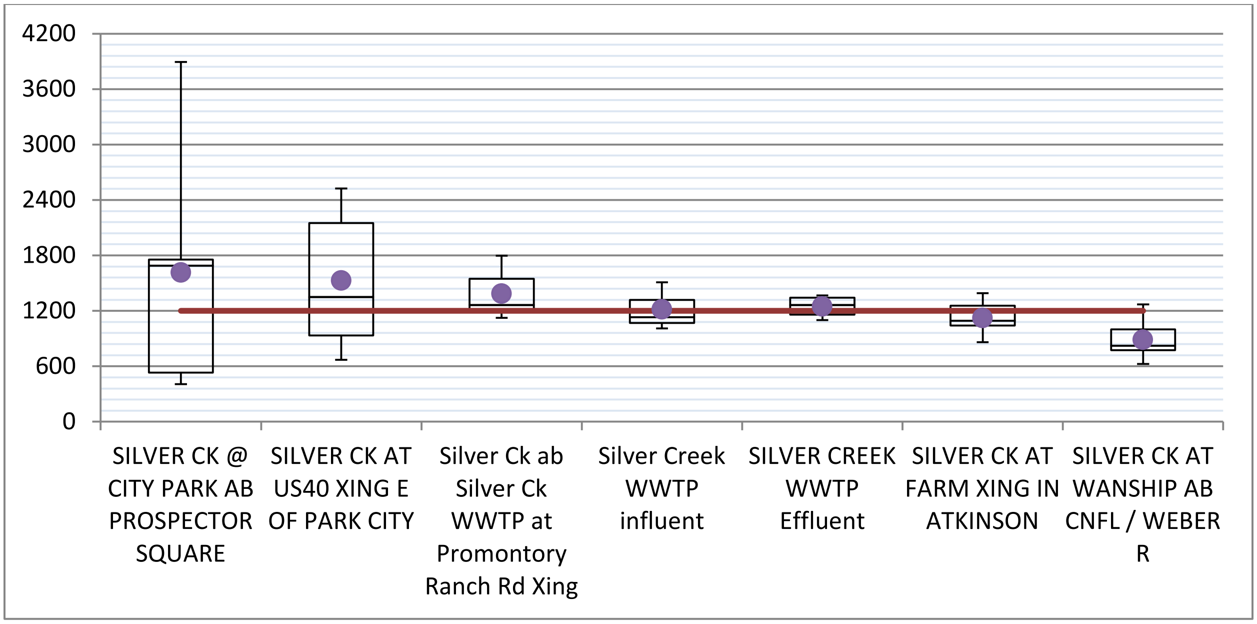

FIGURE 24. WINTER TDS CONCENTRATIONS (MG/L) - PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS CURRENT CRITERION.

Winter TDS concentrations are also highly variable, with the highest variability in the upstream sites.

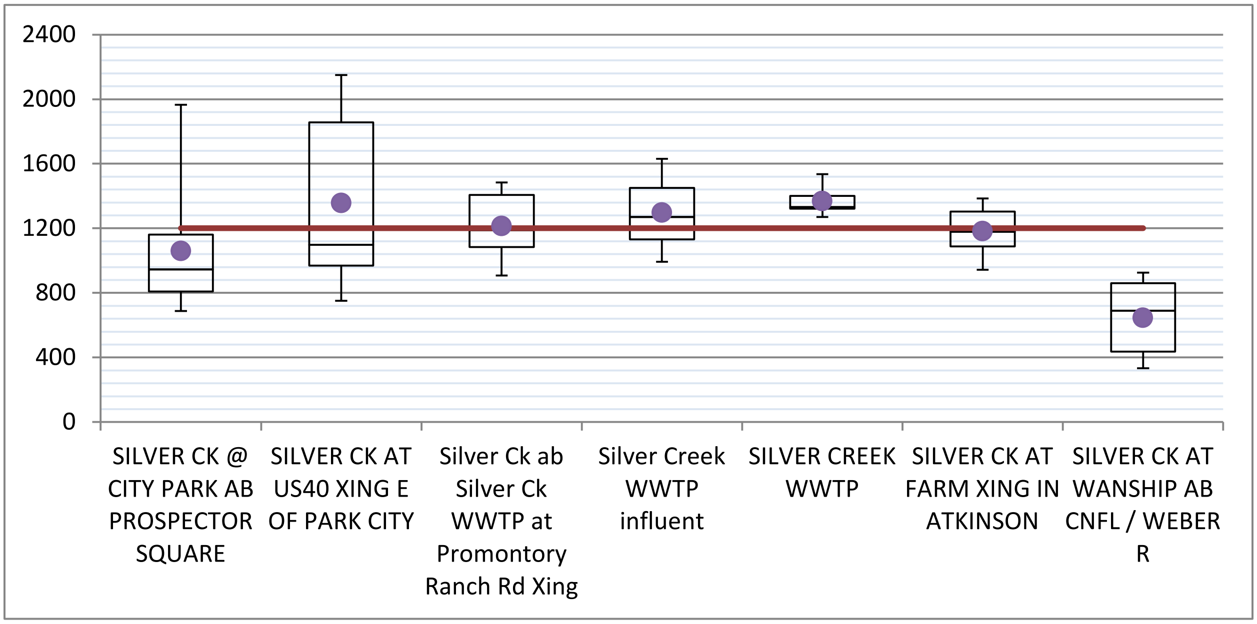

FIGURE 25. SPRING TDS CONCENTRATIONS (MG/L) - PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

Spring TDS concentrations are variable and the means are at or above the current criterion at all sites but Wanship, which meets the current criterion.

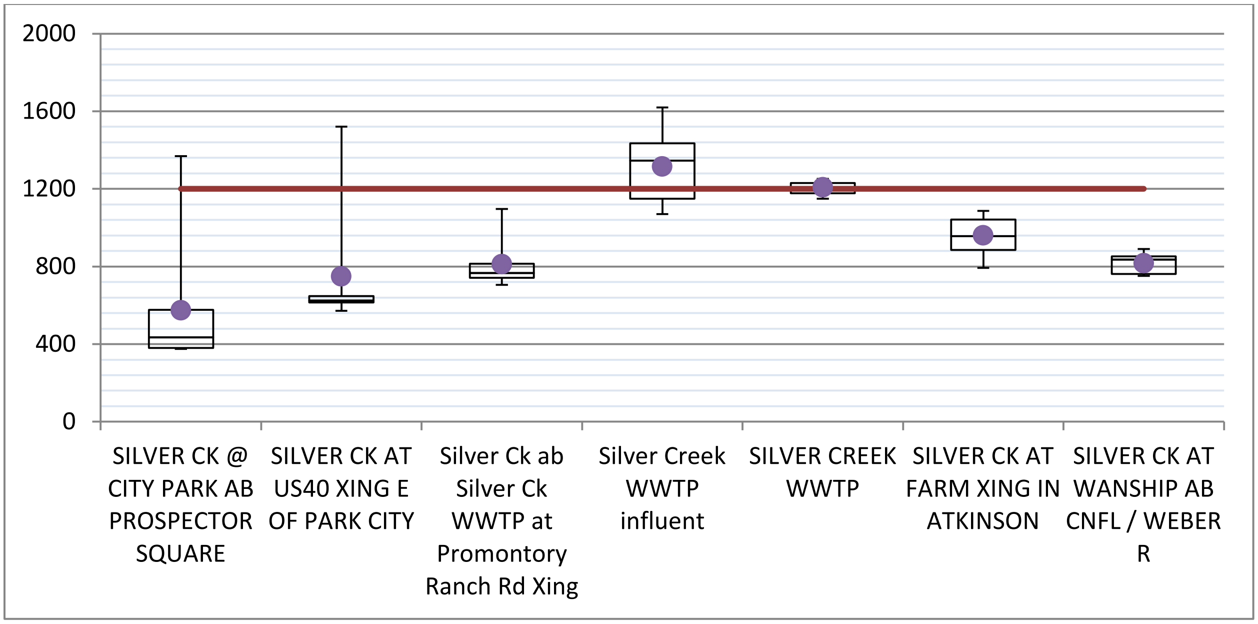

FIGURE 26. SUMMER TDS CONCENTRATIONS (MG/L) - PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

The current criterion is exceeded at upstream sites periodically in the summer, but the mean values meet criterion. Atkinson and Wanship comply with the TDS criterion during summer. On average, summer concentrations in Silver Creek above the WWTP are 59% lower than in the winter months supporting that road salting is the primary source of TDS in Silver Creek in the winter.

SEASONS - IRRIGATION AND NON-IRRIGATION

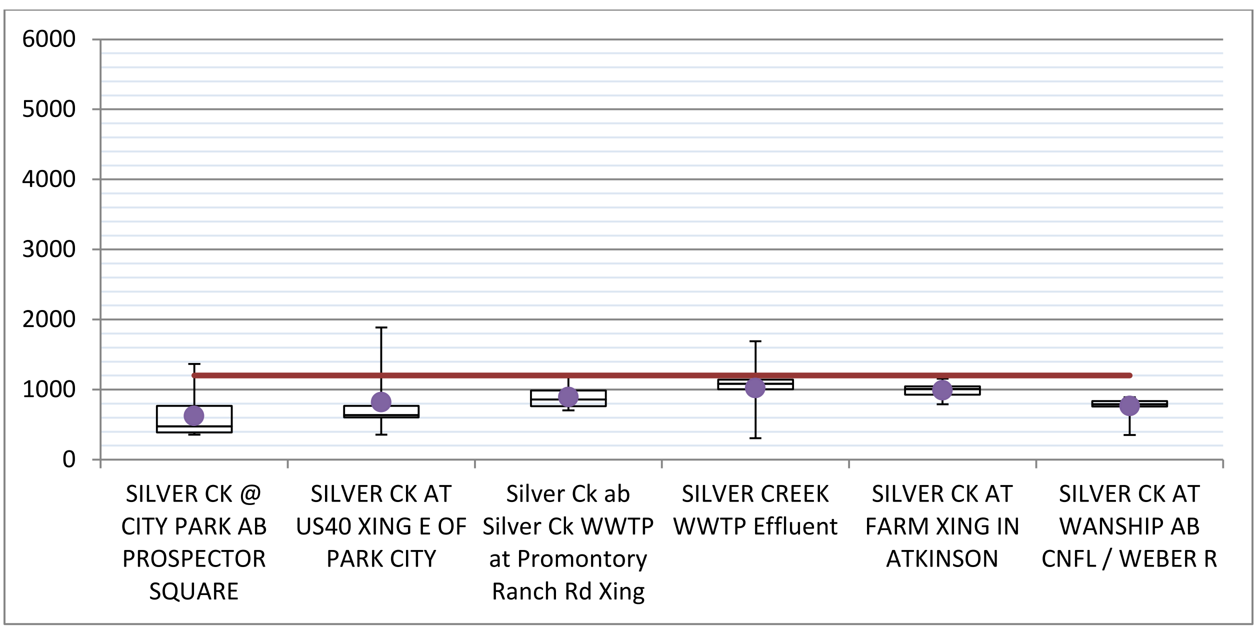

FIGURE 27. IRRIGATION SEASON TDS CONCENTRATIONS (MAY – SEPTEMBER) (MG/L). PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

The data were also summarized and compared by irrigation/non-irrigation season. Means meet the current criterion in the irrigation season, but there are periodic exceedances in the upstream sites. The criterion is met at Atkinson and Wanship.

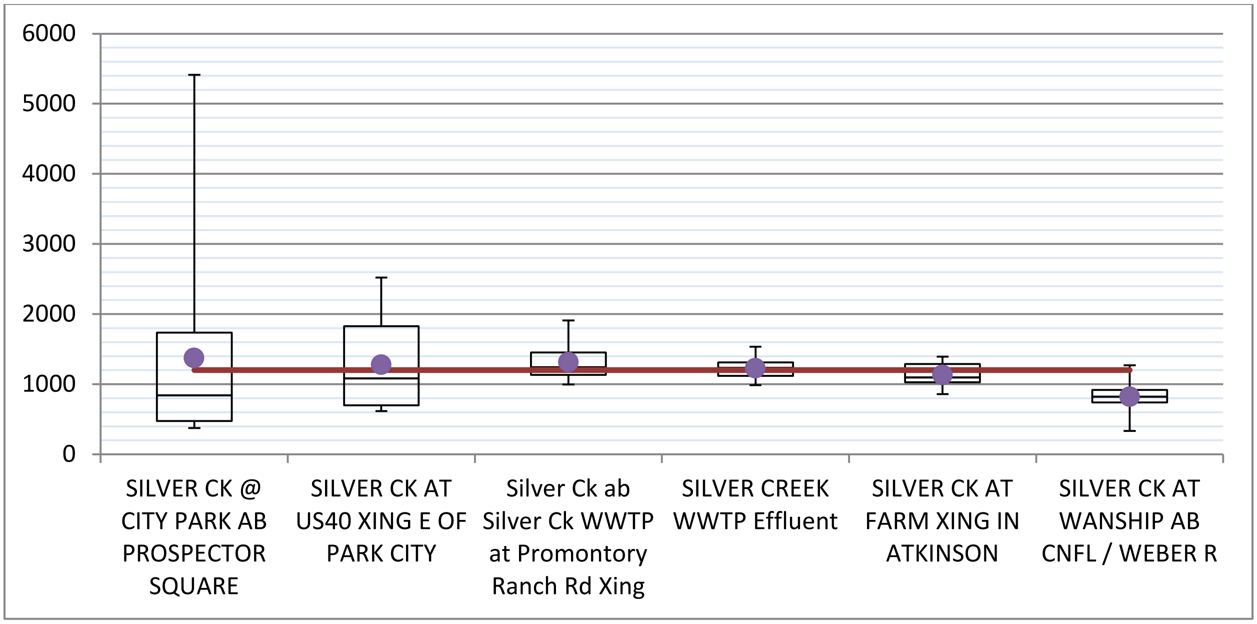

FIGURE 28. NON-IRRIGATION SEASON TDS CONCENTRATIONS (OCTOBER – APRIL) (MG/L). PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

During the non-irrigation season, the means for all upstream sites are near or above the current criterion. At Wanship there was one exceedance of the criterion (Table 4).

Load Duration Curves

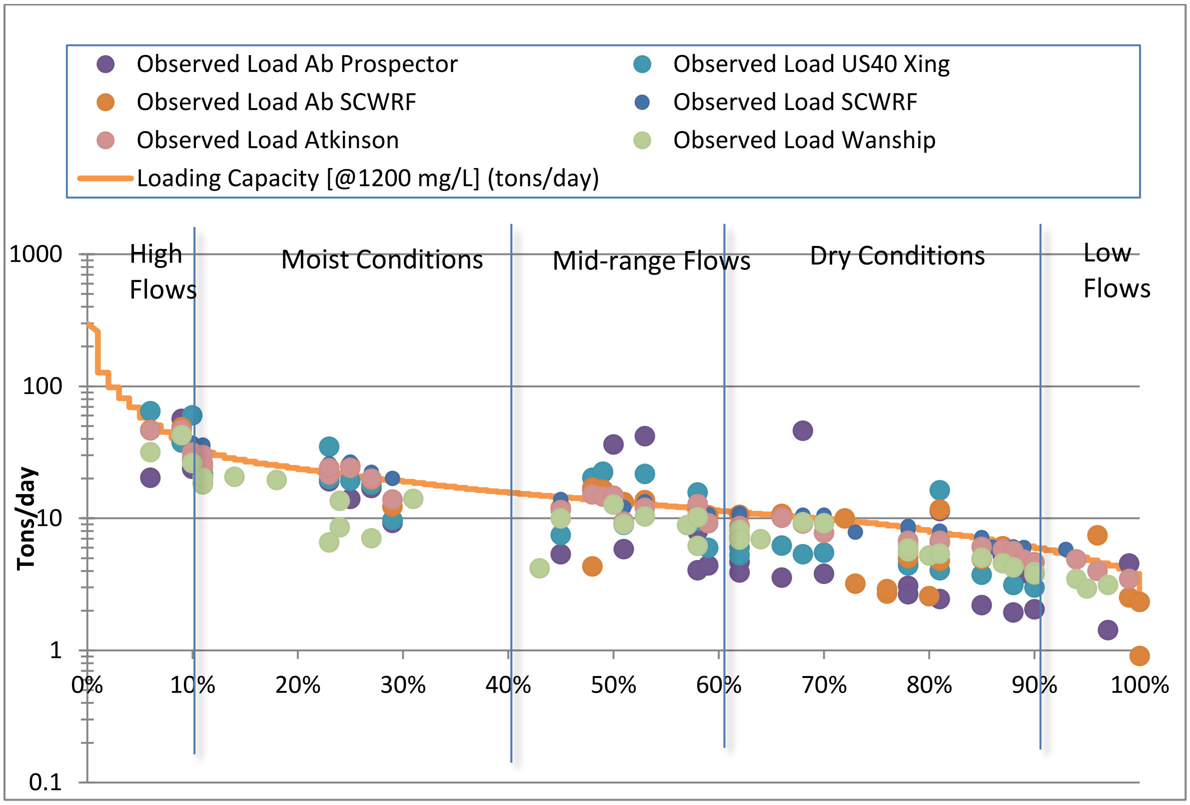

FIGURE 29. LOAD DURATION CURVE DEMONSTRATING THE LOADING CAPACITY OF SILVER CREEK IN TONS PER DAY (ORANGE LINE) PLOTTED WITH OBSERVED LOADS AT EACH MONITORING LOCATION FOR THE YEARS 2008 THROUGH 2016.

Load duration curves (LDCs) are used in TMDL development to identify relationships between streamflow regimes (dry, moist, high flow) and pollutant loading. They are based on flow duration curves, which model the cumulative frequency of flow data for a period of record. The flow duration curve is multiplied by the water quality criterion for a given parameter and a conversion factor for that parameter (EPA, 2007). The LDC is then compared to the loading data to look for patterns. For example, a pattern of loading above the LDC at high flows may represent surface runoff and erosional sources, while a pattern of loading above the curve during dry conditions or low flow may represent consistent groundwater and/or wastewater inputs.

A LDC was developed for Silver Creek to determine whether loading patterns indicated a particular source of TDS loading in the watershed (Figure 29). The LDC for Silver Creek is compared to loads at each Silver Creek location. No clear pattern was observed between flow regime and load. That is, no particular flow condition results in excess TDS loading to the stream indicating a combination of sources.

Analysis – Influence of water from Judge Tunnel

Judge Tunnel is a legacy mine tunnel used as a drinking water source for the Park City area. Depending on the demand for drinking water, Judge Tunnel can contribute a significant amount of water to Silver Creek and Mcleod Creek in the East Canyon watershed. Stakeholders in the watershed indicated that

Judge Tunnel has had an influence on water quality in Silver Creek over the past decade. Prior to 2013, Judge Tunnel did not discharge regularly to Silver Creek because it was diverted for drinking water use. PCMC stopped using Judge Tunnel water as a drinking source in 2013 until further treatment options could be put in place. As such, Judge Tunnel flow resumed to Silver Creek in 2013. In 2024, PCMC will be diverting Judge Tunnel water out of Silver Creek once again as part of their SCO with DWQ and DDW. To determine the effect of Judge Tunnel water on Silver Creek TDS concentrations data was analyzed from before and after 2013.

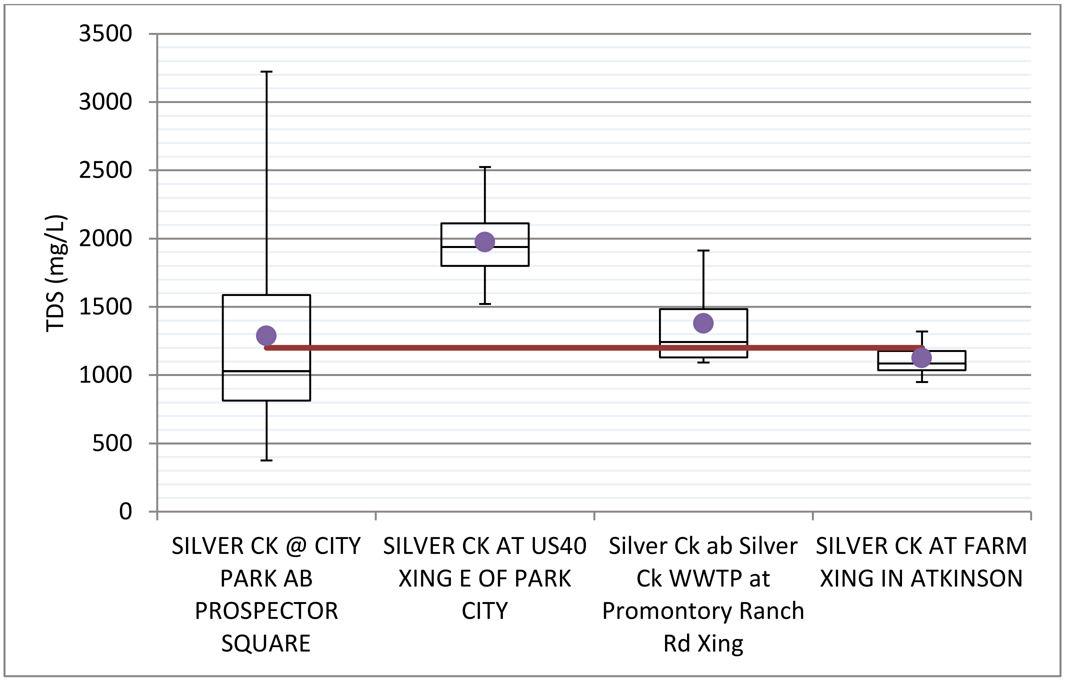

FIGURE 30. SILVER CREEK SITES PRE-2013 (WITHOUT JUDGE TUNNEL WATER). PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

Figure 30 shows the data available prior to 2013. It indicates that TDS was variable and exceeded the criterion, particularly at US40 Xing East of Park City.

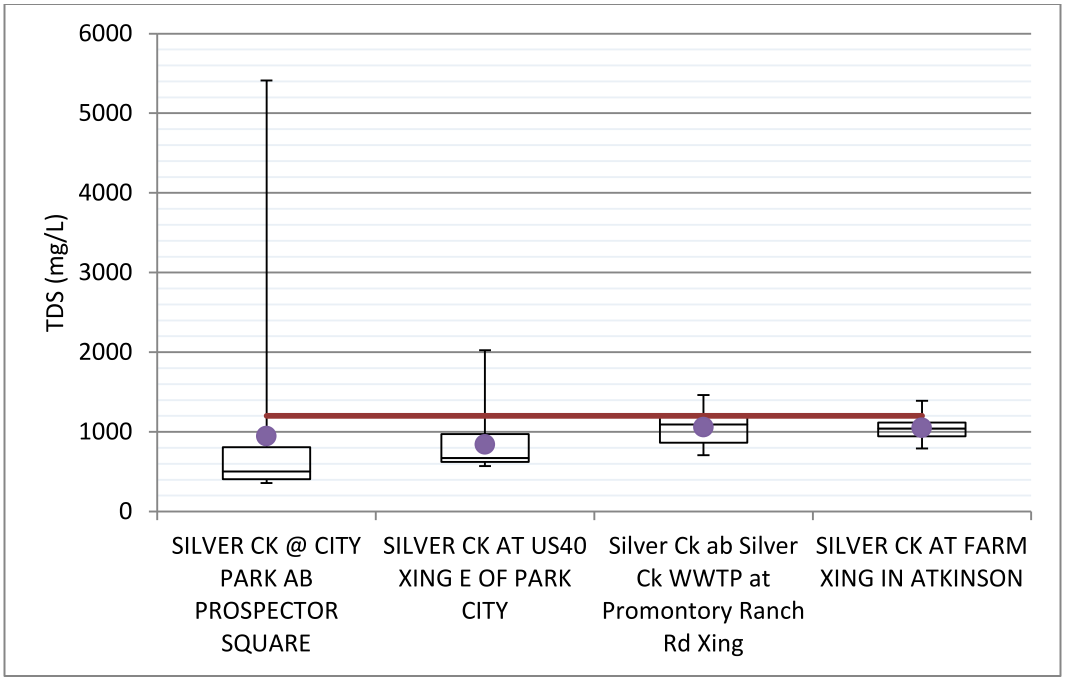

FIGURE 31. SILVER CREEK SITES POST 2013 (WITH JUDGE TUNNEL WATER). PURPLE DOTS REPRESENT THE MEAN VALUE, RED LINE IS THE CURRENT CRITERION.

Figure 31 shows box plots for data collected after 2013. While the Prospector site is still quite variable, the mean values meet the current criterion and the variability of downstream sites is lower.

STATISTICS AND HYPOTHESIS TESTING

TABLE 6. SUMMARY OF STATISTICS - SILVER CREEEK WITHOUT AND WITH JUDGE TUNNEL WATER.

Statistics	Pre 2013 (without Judge Tunnel input)	Post 2013 (with Judge Tunnel input)
Number of Valid Observations	39	99
Number of Distinct Observations	37	89
Minimum	376	358
Maximum	3222	5412
Mean	1360	973.9
Median	1200	914
Standard Deviation	541.5	629.6
90^{th} Percentile with 95% Confidence (bootstrap method)	2364	1442

Statistics were calculated using ProUCL 5.1.002, statistical software developed by the Environmental Protection Agency for analyzing environmental data (Table 6). The histogram and goodness of fit tests indicate that the data is not normally distributed; as such, non-parametric statistical tests were used to calculate descriptive statistics and determine the 90th percentile with a 95% confidence level. Bootstrap methods (3,000 intervals) yielded 90th percentile values of 2,364 mg/L and 1,442 mg/L, respectively.

A t-test was performed to determine if the means of the data pre- and post-2013 data differ. The hypothesis was that there is no difference in the means before and after 2013. This hypothesis was rejected at the 0.05 confidence level, which indicates that the mean values differ. Based on the data, the mean was greater in 2013 without Judge Tunnel water (Figure 32). Thus, Judge Tunnel water dilutes TDS concentrations in Silver Creek. DWQ considered whether to propose a criterion based on the potential future condition in 2024 when PCMC removes Judge Tunnel water from Silver Creek, however, setting the criterion based on this condition would not be as protective of the existing use downstream. If the criterion is violated after 2024, the impact of removing Judge Tunnel's input should be considered.

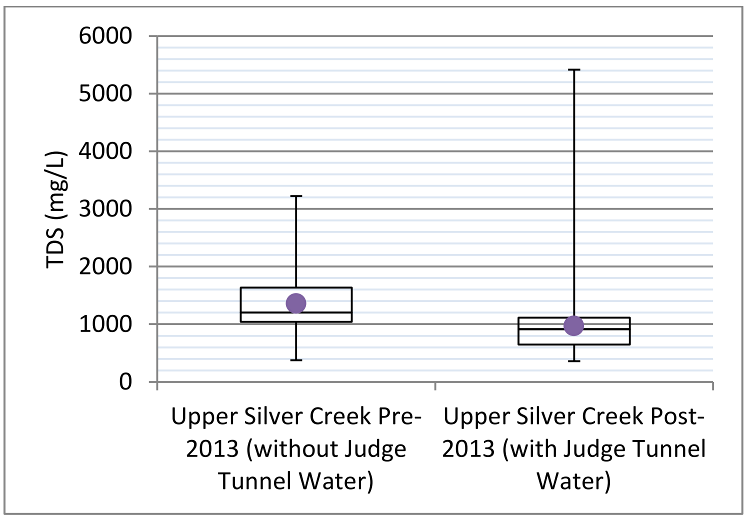

FIGURE 32. UPPER SILVER CREEK SITES PRE AND POST 2013.

RESULTS

Assessment Unit Split

Based on the data analysis, Silver Creek at Wanship is meeting the current criterion of 1,200 mg/L TDS. DWQ proposes to split the assessment unit into and upper and lower Silver Creek based on the properties of the watershed and the hydrologic boundary defined by the USGS. Upper Silver Creek (Silver Creek – 2) will include Silver Creek and tributaries from the confluence with Tollgate Creek to the headwaters (Figure 33). Lower Silver Creek (Silver Creek – 1) will include Silver Creek from the confluence with the Weber River to below the confluence with Tollgate Creek.

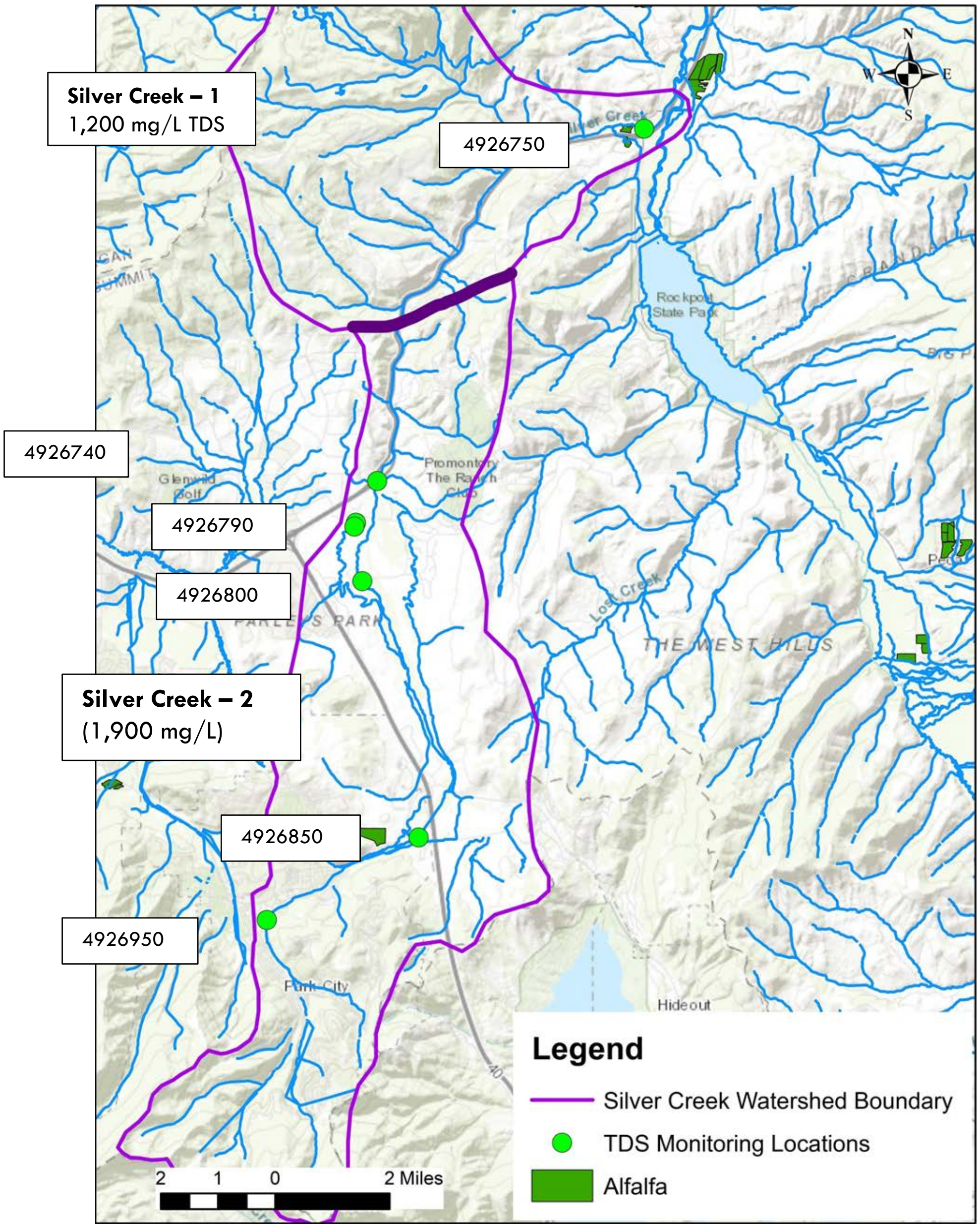

FIGURE 33. SKETCH MAP OF PROPOSED ASSESMENT UNIT BOUNDARIES AND TDS WATER QUALITY CRITERIA.

Silver Creek-2

Data Summary for Silver Creek - 2

Silver Creek-2 includes all stream sites from Atkinson (4926740) upstream to Silver Creek above Prospector Square (4926950). Mine tailings are prevalent in the stream channel at all of these sites, particularly at Promontory Ranch Road (4926800) (Table 7).

TABLE 7. COMBINED DATA SUMMARY FOR THE 4 MLIDS IN SILVER CREEK-2.

MLIDs	Station Descriptions: Stations located in Silver Creek-2	Count	Min. (mg/L)	Mean (mg/L)	Median (mg/L)	Max. (mg/L)	Standard Deviation	90th Percentile
4926950, 4926850, 4926800, 4926740	Silver Ck @ City Park Ab Prospector Square, Silver Ck @ US40 Xing E of Park City, Silver Ck Ab Silver Ck WWTP @ Promontory Ranch Rd Xing, Silver Ck @ Farm Xing in Atkinson	142	358	1103	1033	5412	637	1,909

Statistical Analysis for Upper Silver Creek

The 90th Percentile of the data for Silver Creek upstream of and including the USGS gage was calculated using ProUCL 5.1.002. The histogram and goodness of fit tests indicate that the data is not normally distributed; as such, non-parametric statistical tests were used to determine the 90th percentile with a 95% confidence level. Bootstrap methods (3,000 intervals) yielded a 90th percentile value of 1,909 mg/L.

Revised TDS Criterion for Upper Silver Creek – Silver Creek - 2

A maximum TDS concentration of 2,300 mg/L is potentially protective of the irrigation uses in the watershed (see Irrigation Section). However, DWQ proposes to use the 90th percentile of 1,900 mg/L (rounded down from 1,909) as a maximum criterion for Upper Silver Creek. Although Judge Tunnel has provided dilution of TDS concentrations in Silver Creek that will be removed in 2024, DWQ is not proposing to adjust the criterion in anticipation of that future condition. Rather, DWQ proposes to use the 90th percentile value because this protects the existing and potential future irrigation downstream uses at Wanship. Based on a mass balance analysis, 1,900 mg/L is the highest the criterion could be set to protect the downstream uses by meeting the 1,200 mg/L criterion at Wanship (discussed below).

The 1,900 mg/L TDS criterion is necessary because of uncontrollable man-caused conditions primarily from winter applications of road salt to protect human life. The Silver Creek watershed is extensively impacted by historical mining activities and determining natural conditions is difficult because of the lack of reference conditions. Based on measurements of unimpacted groundwater and PCMC Springs

(Table 3), natural TDS concentrations could be approximately 250 mg/L on average. Comparing this TDS concentration to an approximate average concentration in Silver Creek above the WWTP of 1,100 mg/L (Table 5) suggests that approximately 75 percent of the TDS in Silver Creek comes from man-caused nonpoint sources. Coincidentally, the approximate average of the Silver Creek WWTP effluent is 1,100 mg/L supporting that the WWTP effluent is not increasing TDS concentrations in Silver Creek. Estimating the specific contributions of the nonpoint sources discussed in Conceptual Site Model are difficult. The Load-Duration curves did not identify specific relationships.

Road salt is the dominant source of TDS in Silver Creek because summer TDS concentrations were 59 percent of winter concentrations (see discussion for Figure 26). Groundwater impacted by road salting and septic systems also likely contributes TDS to Silver Creek year round. As previously discussed, Brooks et al. and Susong et al. (1998) attributed elevated chloride concentrations in groundwater to road salting. In the summer, approximately 70% of the TDS is estimated to be from man-caused sources based on a comparison of observed TDS concentrations in Silver Creek above the WWTP to the naturally occurring 250 mg/L.

Because of these uncertainties, the criterion may be revised in the future during a Triennial Review of the water quality standards if TDS concentrations in Silver Creek are observed to change. The influences of the Judge Tunnel may affect future TDS concentrations. The BMPs for road salting being implemented by governmental transportation agencies may reduce TDS contributions but weather will have a larger impact. Winter maintenance contributions of TDS concentrations will increase or decrease in response to weather. The overwhelming concerns for traffic accidents or other impacts to life and safety will continue to trump the attainment of water quality goals.

Protection of Downstream Uses – Silver Creek -1

Flow Regression

To consider the mass balance of TDS and protection of downstream uses, a flow regression was completed in order to estimate flows at the Wanship site based on the gaged site at Atkinson. Gage data was paired with flows measured in the field at Wanship to develop a regression (R^2 = 0.95) (Figure 34). Since flow at Wanship is much higher during spring runoff due to input from intermittent streams, spring runoff flows were not used in the regression. While this makes the model more representative of standard conditions, it also makes the model a conservative estimate during high flows, since dilution at Wanship can also be expected to be higher than modeled during high flow conditions. The regression formula is: $Flow_{(Wanship)} = 1.61 \times Flow_{(Atkinson\ USGS)}$

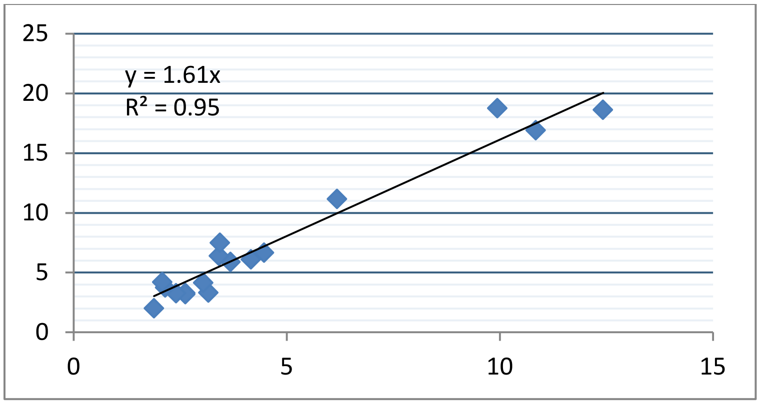

FIGURE 34. REGRESSION OF FLOW FROM USGS GAGE AND PAIRED FLOW MEASUREMENTS AT WANSHIP.

Mass Balance

A mass balance calculation was performed in order to determine if the proposed criterion is protective of downstream uses. This was performed using calculated TDS, flow values from the USGS gage, and paired modeled values at Wanship. $TDS(Wanship) = \frac{TDS(Atkinson)\ x\ Discharge(Atkinson)}{Discharge(Wanship)}$

Model results are shown in Figure 35.

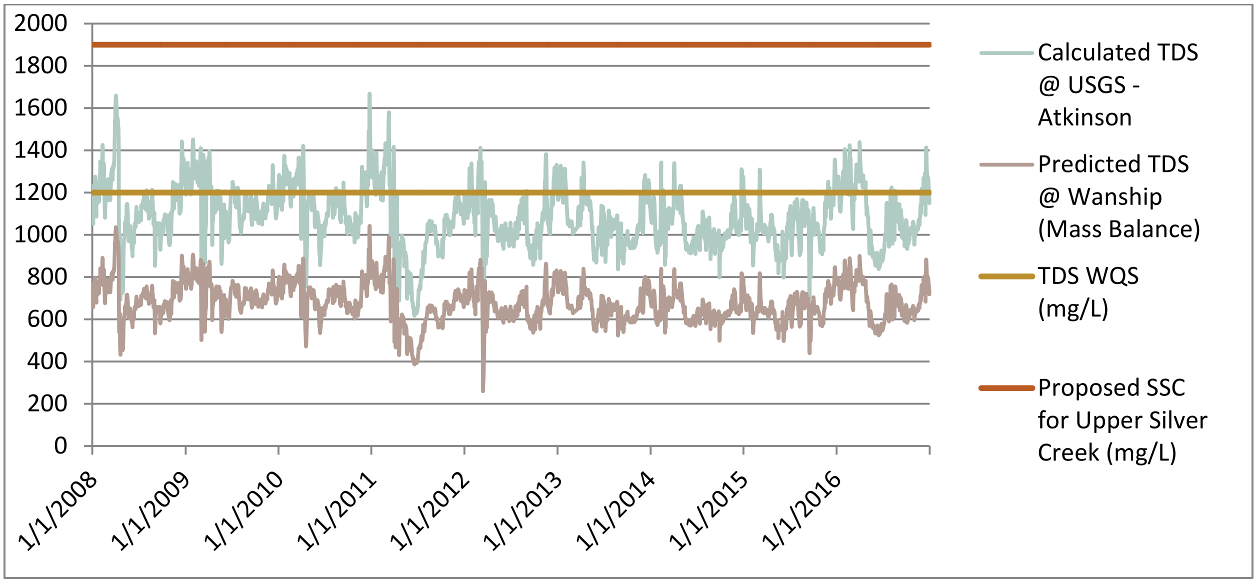

FIGURE 35. GRAPH OF THE CALCULATED TDS CONCENTRATION AT ATKINSON (BASED ON REGRESSION) AND THE PREDICTED TDS AT WANSHIP (BASED ON MASS BALANCE). WHEN THE ATKINSON SITE ATTAINS 1,900 MG/L, WANSHIP ATTAINS 1,200 MG/L.

Criterion Change: Impact on Class 4 Agricultural Use

Based on mass balance calculations, when the magnitude of the criterion is set at 1,900 mg/L at Atkinson the maximum concentration at Wanship is 1,188 mg/L, which attains the statewide criterion of 1,200 mg/L. This is a conservative estimate on concentrations at the outlet of Silver Creek-2 (Atkinson).

Since 1,900 mg/L is the 90th percentile value based on existing conditions and Wanship currently attains 1,200 mg/L, the downstream agricultural use will be protected with a year-round instantaneous criterion of 1,900 mg/L in Silver Creek-2.

In rule, this will appear in R317-2-13.4 Weber River Basin (a) Weber River Drainage, and in R317-2-14. Numeric Criteria Table 2.14.1.

R317-2-13.4 Weber River Basin

(a) Weber River Drainage

Weber River and tributaries, from Stoddard diversion to Headwaters, except as listed below	1C	2B	3A	4
Silver Creek and tributaries, from confluence with Weber River to below the confluence with Tollgate Creek	1C	2B	3A	4
Silver Creek and tributaries, from confluence with Tollgate Creek to Headwaters	1C	2B	3A	4*

R317-2-14. Numeric Criteria Table 2.14.1

FOOTNOTE: (4)

Silver Creek and tributaries, Summit County, from confluence with Tollgate Creek to headwaters: January through December, maximum 1,900 mg/L. Assessments will be based on TDS concentrations measured at the location of MLID/STORET 4926740.

Criterion Change: Impact on Fishable/Swimmable Uses (CWA Section 101(a)(2))

The proposed Silver Creek – 1 assessment unit is attaining all beneficial uses (1C, 2B, 3A, and 4).

1C DRINKING WATER

A change to the TDS criterion based on existing conditions is unlikely to affect the 1C drinking water standard, as there is no criterion for TDS. The existing drinking water use is unaffected because the points of diversion are the Judge and Spiro tunnels. DWQ is working with PCMC and DDW on treatment of drinking water sources in the Park City area.

2B SECONDARY CONTACT RECREATION

The 2B secondary contact recreation beneficial use is being attained in Silver Creek-2.

3ACOLD WATER FISHERY

A change to the TDS standard based on existing conditions is unlikely to affect the existing uses of the Class 3A cold-water fishery because the other stressors likely existed since mining occurred in Park City. Other constituents including low DO, high pH, and elevated cadmium and zinc remain current causes of the 3A impairment. Sources of cadmium and zinc include the mine tunnels where most of the water originates. While PCMC is addressing the mine tunnel sources under their discharge permit, fully meeting the water quality criteria is unlikely within the next 30 years. Additionally, much of Silver

Creek comprises mine tailings in the stream channel and degraded physical habitat. The remediation that EPA is coordinating under the Superfund program may improve physical habitat conditions for fish and their supporting food web in addition to raising DO, raising pH, and lowering in-stream metal concentrations and TDS. However, completion is uncertain because EPA does not currently have the resources to fully remediate the area. EPA and DEQ are coordinating with the United States Fish and Wildlife Service on a Natural Resource Damage Assessment and Restoration process for Silver Creek that may help fund future remediation and restoration. The highest attainable aquatic life use cannot be confidently determined at this time but the toxic metals zinc and cadmium, not TDS, are predicted to remain the stressors that limit attainment of the use.

CONCLUSIONS

Use and Value

TDS concentrations in Silver Creek are elevated because of road salt applied for human safety. This human-caused source of pollution prevent the attainment of 1,200 mg/L statewide criterion and cannot be remedied. DWQ determined that a revised TDS criterion is protective of the existing and anticipated future agricultural uses in Silver Creek-2. The 1,900 mg/L criterion for Silver Creek-2 will also protect downstream uses. The revised criterion is also protective of existing aquatic life uses and is anticipated to be protective of potential future determinations of the highest attainable aquatic life use. For the aquatic life uses, based on 40 CFR 131.10(g)(3): "human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place." If TDS concentrations in Silver Creek change in the future, the criterion should be reevaluated during a Triennial Review.

DWQ will split the assessment unit into Silver Creek – 1 (from the confluence with the Weber River to Tollgate Canyon) and Silver Creek – 2 (from Tollgate Canyon to the headwaters). Silver Creek – 1 will retain the 1,200 mg/L TDS criterion for Class 4 agricultural use. Silver Creek – 2 will have a 1,900 mg/L TDS instantaneous criterion year-round. This will be protective of the agricultural uses downstream.

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