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Rockport Reservoir and Echo Reservoir Total Maximum Daily Loads

Implementation Plan

Prepared for

Utah Department of Environmental Quality, Division of Water Quality

Prepared by

SWCA Environmental Consultants

February 2014

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Prepared for

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ABBREVIATIONS

µg/L	micrograms per liter
BOD	biological oxygen demand
BMP	best management practice
CPP	cementitious permeable pavement
cfs	cubic feet per second
CRMP	coordinated resource management plan
DOC	dissolved organic carbon
DOM	dissolved organic matter
ECP	Erosion Control Plan
EPA	U.S. Environmental Protection Act
ha	hectare
I-80	Interstate 80
kg	kilogram
KVCD	Kamas Valley Conservation District
MGD	million gallons per day
mg/L	milligrams per liter
NRCS	Natural Resources Conservation Service
SCHD	Summit County Health Department
SOD	sediment oxygen demand
SP3	Stormwater Pollution Prevention Plan
SWAT	Soil and Water Assessment Tool
SWCA	SWCA Environmental Consultants
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorus
UDEQ	Utah Department of Environmental Quality
US-40	U.S. Route 40
USFS	U.S. Forest Service
UPDES	Utah Pollutant Discharge Elimination System
WRF	water reclamation facility
WBWCD	Weber Basin Water Conservancy District
WWTP	wastewater treatment plant

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1. INTRODUCTION

The Rockport Reservoir and Echo Reservoir watershed-based implementation plan outlines a strategy for reducing nutrient loads to attain water quality standards for dissolved oxygen (DO) in each reservoir. When combined with existing implementation planning, management measures, and nutrient reduction efforts, completion of the proposed implementation plan will result in reservoirs that are healthy and productive for use by current and future generations.

This implementation plan includes the nine key elements identified by the U.S. Environmental Protection Agency (EPA) that are considered critical for achieving improvements in water quality (EPA 2008) and builds on the *Rockport Reservoir and Echo Reservoir Total Maximum Daily Loads Final Report* (Utah Department of Environmental Quality [UDEQ] 2014). The EPA requires that these nine elements be addressed in watershed plans funded with incremental Clean Water Act Section 319 funds, and strongly recommends that they be included in all watershed plans intended to address water quality impairments. Although there is no formal requirement for the EPA to approve watershed plans, the plans must address the nine elements discussed below if they are developed in support of Section 319-funded projects (EPA 2008). This implementation plan also provides reasonable assurance that the load reductions identified in the TMDL can be attained through implementation of best management practices (BMPs) throughout the watersheds. The project implementation plan identifies land use–specific BMPs, priorities for implementation, a timeframe for implementation, a monitoring plan, and unit costs associated with recommended structural BMPs.

The EPA's nine elements are listed below in the order they appear in the guidelines; however, it should be noted that although they are listed as *a* through *i*, they do not necessarily need to be completed sequentially.

a) Identify and quantify causes and sources of the impairment(s).

b) Estimate load reductions needed to meet water quality standards.

c) Identify BMPs needed to achieve load reductions and critical areas where these management measures will be implemented.

d) Estimate needed technical and financial resources.

e) Provide an information, education, and public participation component.

f) Include a schedule for implementing nonpoint source management measures.

g) Identify/describe interim measurable milestones for implementation.

h) Establish criteria to determine if load reductions/targets are being achieved.

i) Provide a monitoring component to evaluate effectiveness of the implementation over time for criteria in h.

For the purposes of this implementation plan, BMPs refer to any action or measure implemented or maintained in the watershed to control nonpoint sources of nutrients to waters in the Rockport Reservoir and Echo Reservoir watersheds (also referred collectively as the *study watershed*). These include traditional structural and nonstructural BMPs, as defined by the Natural Resources Conservation Service (NRCS) and U.S. Forest Service (USFS), as well as actions and measures related to community planning and coordination, and education of stakeholders. Recommendations for nonpoint source reductions consider all sources and are based on management measures that consider feasible BMPs, effectiveness, attainability, cost, and the goal of distributing the responsibility for water quality improvement among all sources in the study watershed.

The recommendations in this implementation plan are based on load reductions needed for the summer season (April–September), which is the critical season identified in the TMDL due to reservoir stratification and summer algal blooms. However, the TMDL also includes annual load allocations and BMPs that should be implemented year-round.

The implementation strategy for reducing nutrients is an iterative process where data are gathered on an ongoing basis, sources are identified and reduced or eliminated if possible, and control measures including BMPs are implemented, assessed, and modified as needed. Measures to abate probable sources of nutrients include everything from public education and improved stormwater management to reducing the influence from inadequate and/or failing septic systems. Implementation of a suite of BMPs, as described in this plan, provides reasonable assurance that load reductions will be achieved and designated uses will be restored.

This implementation plan has been developed based on a 72% and 70% reduction in nonpoint source phosphorus loads to Rockport and Echo Reservoirs, respectively, and a 68% and 87% reduction in nonpoint source nitrogen loads, respectively. These reductions are needed to compensate for projected population growth and associated wastewater treatment.

2. KEY ELEMENTS OF THE IMPLEMENTATION PLAN

2.1. Identification of Sources and Current Load Summary (element a)

This section discusses nutrient sources that contribute to the DO impairment of Rockport and Echo Reservoirs. The Weber River and its major tributaries Silver Creek, Chalk Creek, and Beaver Creek transport nutrients from point sources and nonpoint sources in the study watershed to the reservoirs.

The point sources consist of four existing wastewater treatment plants (WWTPs), a fish hatchery, and a series of mine tunnels originating in the Park City area. Blue Sky Ranch is a new point source with planned discharge into the study watershed. Francis WWTP is an existing non-discharging lagoon system that may convert to a discharging system in the near future. Nonpoint sources of nutrients in the study watershed include stormwater runoff, agricultural activities, septic systems, and channel erosion. The Three Mile Canyon Landfill in Summit County is also known to contribute nitrate, and possibly phosphorus, to Rockport Reservoir. In addition, releases from Rockport Reservoir to Weber River represent an upstream load to the Echo Reservoir watershed. Agricultural activities consist of irrigation and fertilizer applications to support crops, crop harvesting, and grazing of sheep and cows. Grazing occurs on public and private land. Contributions from individual nonpoint sources vary throughout the year and by location within the study watershed. These sources are difficult to monitor and are not regulated; however, their impacts can be mitigated through BMPs, reservoir management, and channel stabilization.

Rockport Reservoir and Echo Reservoir watersheds are divided into subwatersheds (Figure 1) for purposes of source identification and implementation planning. Characterizing sources at the subwatershed level contributes to a more meaningful implementation plan that is based on prioritization of a suite of BMPs for specific sources and areas of the study watershed. Characteristics for each subwatershed that illustrate the relative importance of specific sources as well as total load contribution during the summer season by subwatershed are summarized in Table 1. All of the nutrient loads discussed in this section are seasonal, representing the period of April 1–September 30, the critical period for DO impairment in the reservoirs. Loads are derived based on data and model output for the year 2007, a year that represents an average climatic condition and for which there are sufficient water quality data in the tributaries and reservoirs to develop and calibrate watershed and reservoir water quality models (see Appendix A in the TMDL document).

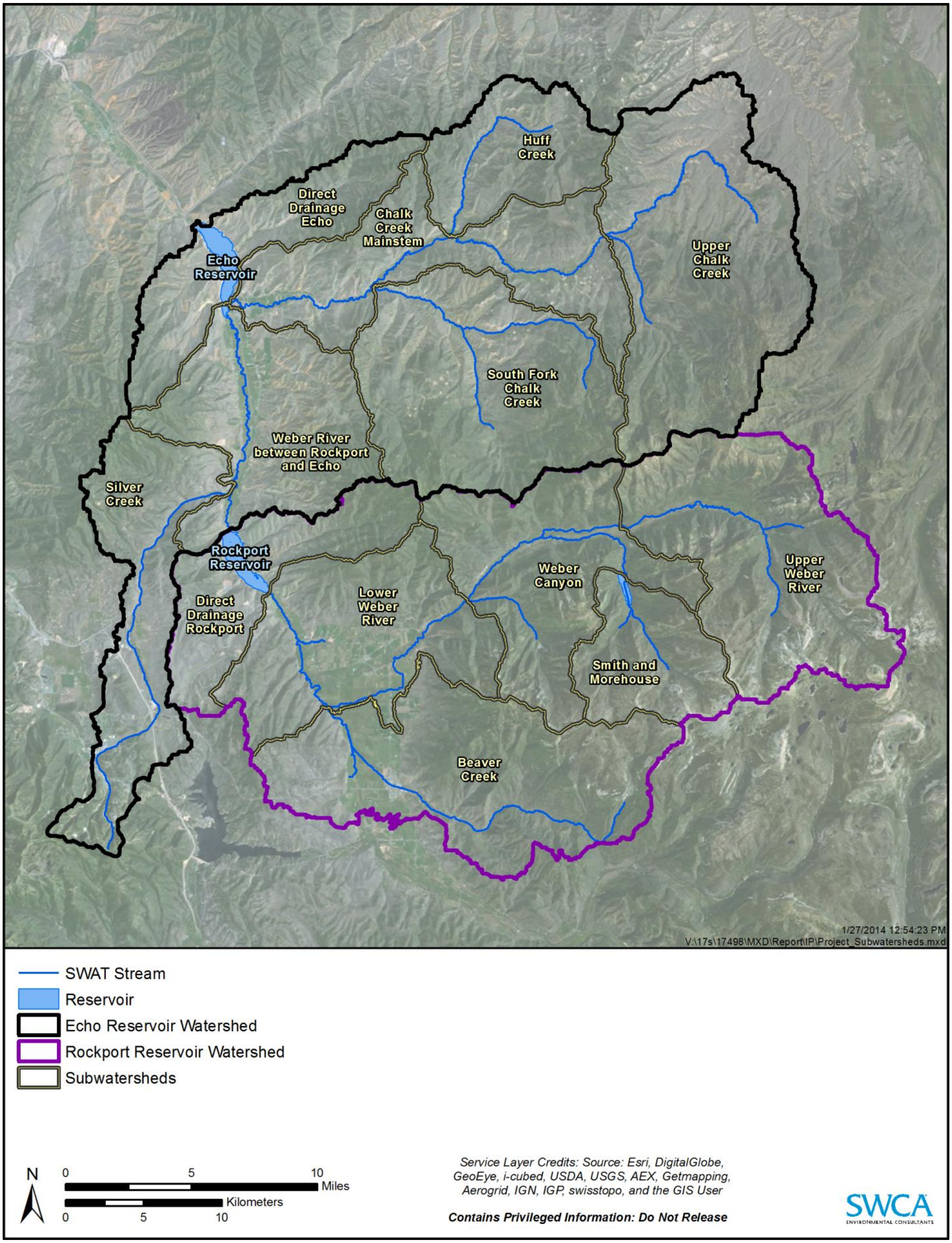

Figure 1. Subwatersheds used for source identification and characterization in the Rockport Reservoir and Echo Reservoir watersheds.

Table 1. Characteristics of Subwatersheds in the Rockport Reservoir and Echo Reservoir Watersheds

Subwatershed	Total Acreage	Percentage Agricultural	Percentage Urban	Percentage Forest, Shrub, and Wetland	Point Sources	Nitrogen Delivery Ratio	Phosphorus Delivery Ratio	Total Nitrogen Load to Reservoir (kilograms /summer season)	Total Phosphorus Load to Reservoir (kilograms /summer season)
Rockport Reservoir Watershed									
Beaver Creek	53,549	13.5%	3.9%	82.6%	Kamas WWTP and DWR Kamas Fish Hatchery	79%	83%	2,981	687
Direct Drainage Rockport	22,584	0.5%	5.0%	94.5%	None	100%	100%	2,948	306
Lower Weber River	36,572	21.1%	3.8%	75.2%	Oakley WWTP	100%	100%	3,434	814
Smith and Morehouse	17,627	< 0.1%	0.4%	99.6%	None	55%	56%	1,596	126
Upper Weber River	47,514	1.5%	0.4%	98.1%	None	45%	56%	3,453	225
Weber Canyon	34,817	3.5%	3.7%	92.8%	None	67%	56%	4,161	180
Total	**212,663**	**8.0%**	**2.9%**	**89.1%**	**N/A**	**N/A**	**N/A**	**18,573**	**2,337**
Echo Reservoir Watershed									
Chalk Creek Mainstem	36,181	7.9%	2.7%	89.4%	Coalville WWTP	100%	100%	5,440	505
Direct Drainage Echo	23,793	3.8%	2.2%	94.0%	None	100%	100%	384	162
Huff Creek	19,767	1.6%	0.7%	97.8%	None	71%	70%	1,019	260
Silver Creek	32,556	4.1%	25.0%	70.9%	Silver Creek Water Reclamation Facility; Park City tunnels; Blue Sky	75%	72%	13,775	1,986
South Fork Chalk Creek	47,863	0.6%	0.8%	98.5%	None	84%	84%	2,695	769
Upper Chalk Creek	56,876	0.2%	0.3%	99.5%	None	82%	83%	2,319	46

Table 1. Characteristics of Subwatersheds in the Rockport Reservoir and Echo Reservoir Watersheds

Subwatershed	Total Acreage	Percentage Agricultural	Percentage Urban	Percentage Forest, Shrub, and Wetland	Point Sources	Nitrogen Delivery Ratio	Phosphorus Delivery Ratio	Total Nitrogen Load to Reservoir (kilograms /summer season)	Total Phosphorus Load to Reservoir (kilograms /summer season)
Weber River between Rockport and Echo	34,186	12.3%	4.3%	83.4%	None	100%	100%	17,077	1,658
Total	**251,222**	**4.0%**	**4.7%**	**91.3%**	**N/A**	**N/A**	**N/A**	**42,709**	**5,387**

Note: N/A= not applicable

Current summer and annual loads are summarized in Table 2. The nutrient load to receiving waters is higher than the nutrient load that reaches the reservoir on account of nutrient processing that occurs en route from tributary to reservoir. The current summer load to receiving waters in the Rockport Reservoir watershed is 500 kilograms (kg) total phosphorus (TP)/season and 2,603 kg total nitrogen (TN)/season. The current summer TP load to Rockport Reservoir is 2,337 kg TP/season (12.8 kg TP/day), including a point source load of 337 kg TP/season (1.9 kg TP/day) and a nonpoint source load of 2,000 kg TP/season (10.9 kg TP/day). The current summer TN load to Rockport Reservoir is 18,573 kg TN/season (102 kg TN/day). The point source contribution is 1,754 kg TN/season (9.6 kg TN/day), and the nonpoint sources contribute 16,819 kg TN/season (92 kg TN/day). The annual load to receiving waters in the Rockport Reservoir watershed is 1,180 kg TP/year and 6,625 kg TN/year. The annual TP load to Rockport Reservoir is 3,359 kg TP/year, including a point source load of 804 kg TP/year and a nonpoint source load of 2,555 kg TP/year. The annual TN load to Rockport Reservoir is 27,642 kg TN/year. The point source contribution is 4,512 kg TN/year, and the nonpoint sources contribute 23,130 kg TN/year.

The current load to receiving waters in the Echo Reservoir watershed is 2,057 kg TP/season and 17,751 kg TN/season. The current summer load of TP and TN to Echo Reservoir is 5,387 kg TP/season (29.6 kg/day) and 42,709 kg TN/season (235 kg TN/day). Point sources contribute 1,427 kg TP/day (8 kg TP/day) and 12,111 kg TN/season (66.5 kg TN/day), whereas nonpoint sources contribute 3,960 kg TP/season (21.7 kg TP/day) and 30,598 kg TN/season (168 kg TN/day). The annual load to receiving waters in the Echo Reservoir watershed is 4,135 kg TP/year and 31,854 kg TN/year. The annual TP load to Echo Reservoir is 9,288 kg TP/year, including a point source load of 2,871 kg TP/year and a nonpoint source load of 6,417 kg TP/year. The annual TN load to Echo Reservoir is 76,660 kg TN/year. The point source contribution is 21,986 kg TN/year, and the nonpoint sources contribute 54,674 kg TN/year.

Table 2. Summary of Current Summer and Annual Loads to Receiving Waters and Resulting Loads to the Rockport and Echo Reservoirs

	Total Phosphorus				**Total Nitrogen**			
	Current Summer Load to Receiving Waters (kg/season)	**Annual Load to Receiving Waters (kg/year)**	**Current Summer Load to Reservoir (kg/season)**	**Annual Load to Reservoir (kg/year)**	**Current Summer Load to Receiving Waters (kg/season)**	**Annual Load to Receiving Waters (kg/year)**	**Current Summer Load to Reservoir (kg/season)**	**Annual Load to Reservoir (kg/year)**
Rockport Reservoir								
Point source load	500	1,180	337	804	2,603	6,625	1,754	4,512
Nonpoint source load	N/A	N/A	2,000	2,555	N/A	N/A	16,819	23,130
Total load	**N/A**	**N/A**	**2,337**	**3,359**	**N/A**	**N/A**	**18,573**	**27,642**
Echo Reservoir								
Point source load	2,057	4,135	1,427	2,871	17,751	31,854	12,111	21,986
Nonpoint source load	N/A	N/A	3,960	6,417	N/A	N/A	30,598	54,674
Total load	**N/A**	**N/A**	**5,387**	**9,288**	**N/A**	**N/A**	**42,709**	**76,660**

2.1.1.Point Sources

Point sources of nutrients have the potential to affect water quality year-round in the Weber River Basin. During periods of low flow, point sources represent a larger portion of the load to streams. Currently, four municipal WWTPs discharge treated effluent at eight outfalls in the study watershed (Figure 2). The outfalls discharge nutrients, organic matter, and sediment, among other pollutants commonly found in wastewater, and have the potential to affect DO concentrations in downstream reservoirs. The Utah Pollutant Discharge Elimination System (UPDES) program regulates WWTPs and monitors their discharges to ensure compliance with their permit.

The Kamas WWTP and Oakley WWTP discharge in the Rockport Reservoir watershed. The DWR Fish Hatchery was reopened in November 2012 and is permitted to discharge to the Weber River in the Rockport Reservoir watershed. Francis WWTP is an existing, non-discharging lagoon system in the Rockport Reservoir watershed that may convert to a discharging system in the near future.

The Silver Creek Water Reclamation Facility (WRF) and the Coalville WWTP are in the Echo Reservoir watershed. Park City discharges water from several mine tunnels to Silver Creek in the Echo Reservoir watershed, though most of the water in Silver Creek is lost to the subsurface before reaching Echo Reservoir. Currently, the mine tunnels do not have UPDES permits, but the tunnels will be issued permits in the near future. Park City has monitored these sources in the past. Finally, Blue Sky Ranch will treat industrial and municipal wastewater and recently received a permit to discharge to Silver Creek in the Echo Reservoir watershed. The treatment system has not yet been constructed.

2.1.1.1. ROCKPORT RESERVOIR WATERSHED POINT SOURCES

2.1.1.1.1.Kamas City Wastewater Treatment Plant

The Kamas City WWTP (UPDES UT0020966) serves a population of approximately 1,500 people. The Kamas plant was most recently upgraded in 1991. The current design includes an 18-inch inlet pipe leading to five waste stabilization ponds (the first three of which are aerated), ultraviolet light disinfection, an effluent flow meter, a 10-kilowatt generator, and seven 20-horsepower aerators. The five lagoons cover approximately 18.8 acres. The total average nutrient loads to Beaver Creek are 1,587 kg TN/season and 348 kg TP/season. Based on the delivery ratio for this point source (Table 3), the total load delivered to Rockport Reservoir is 1,051 kg TN/season and 231 kg TP/season. Population growth for the Kamas City service area is projected to increase by 58% from 2010 to 2030 (see Table 6.7 in the TMDL report); however, the current capacity flow for the plant (0.40 million gallons per day [MGD]) is adequate to process the resulting increase in flow.

2.1.1.1.2.Oakley City Wastewater Treatment Plant

The Oakley City WWTP (UPDES UT0020061) was designed for daily flows of 0.25 MGD. The plant processes wastewater using the following methods. First, influent wastewater is run through a 2-millimeter screen followed by compaction and grit removal. Next, wastewater enters an aeration basin and then into a membrane bioreactor for additional filtration. Finally, wastewater is treated using an ultraviolet disinfection system before being discharged into the Weber River. The total average nutrient loads to the Lower Weber River are 1,016 kg TN/season and 152 kg TP/season. Based on the delivery ratio for this point source (Table 3), the total load delivered to Rockport Reservoir is 703 kg TN/season and 106 kg TP/season. Population growth for the Oakley City service area is projected to increase by 124% from 2010 to 2030 (see Table 6.7 in the TMDL report), with a future estimated flow of 0.33 MGD (see Table 6.8 in the TMDL report).

Table 3. Nutrient Loads from Point Sources in the Rockport Reservoir and Echo Reservoir Watersheds

Subwatershed	Point Source	Load to Receiving Waterbody (kg/season)[1]		Load to Reservoir (kg/season)[2]		Percentage of Load Reaching the Reservoir (delivery ratio)	
		TN	**TP**	**TN**	**TP**	**TN**	**TP**
Rockport Reservoir Watershed							
Beaver Creek	Kamas WWTP	1,587	348	1,051	231	66%	66%
	DWR Kamas Fish Hatchery	N/A	N/A	N/A	N/A	69%	70%
	Francis WWTP[3]	N/A	N/A	N/A	N/A	69%	70%
Lower Weber River	Oakley WWTP	1,016	152	703	106	69%	70%
Total	**3**	**2,603**	**500**	**1,754**	**337**	**N/A**	**N/A**
Echo Reservoir Watershed							
Chalk Creek Mainstem	Coalville WWTP	946	193	715	165	76%	86%
Silver Creek	Silver Creek WRF	15,976	1,797	11,343	1,258	71%	70%
	Park City tunnels total	830	67	53	4	6%	6%
	Judge Tunnel	*89*	*7*	*6*	*0*	*6%*	*6%*
	Spiro Tunnel	*620*	*24*	*40*	*1*	*6%*	*6%*
	Prospector Drain/Biocell	*121*	*37*	*8*	*2*	*6%*	*6%*
	Blue Sky Ranch and Resort (future discharge)[3]	N/A	N/A	N/A	N/A	71%	70%
Total	**6**	**17,751**	**2,057**	**12,111**	**1,427**	**N/A**	**N/A**

[1] Calculated based on discharge monitoring report data.
[2] Calculated based on results from the Soil and Water Assessment Tool.
[3] Not currently discharging; delivery ratios based on subbasin delivery ratio.

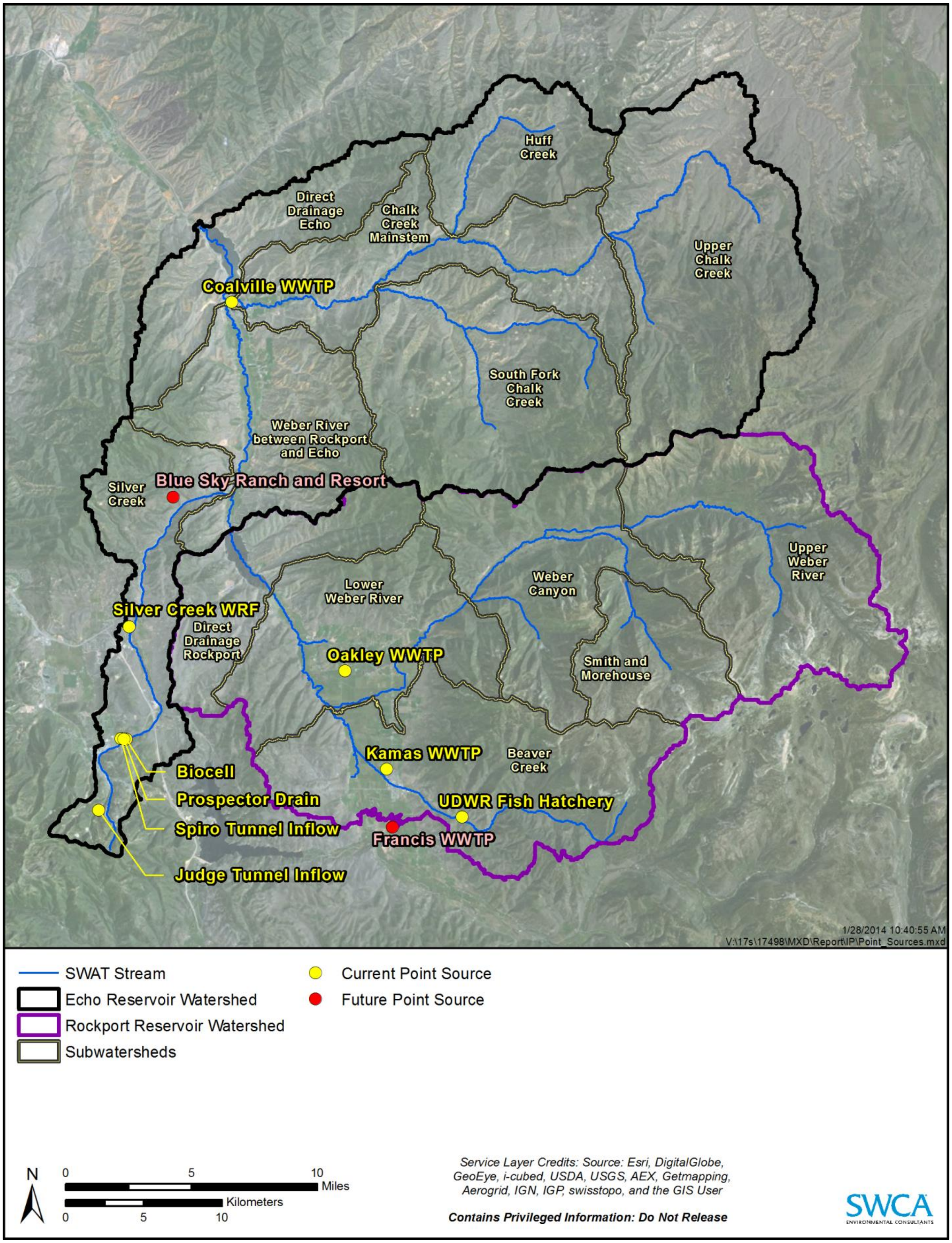

Figure 2. Point source outfall locations in the Rockport Reservoir and Echo Reservoir watersheds.

2.1.1.1.3.DWR Kamas Fish Hatchery

The Utah Division of Wildlife Resources (DWR) operates a fish hatchery near Kamas that discharges to Beaver Creek. A UPDES general permit regulates these discharges. The hatchery was rebuilt in 2000, but has operated only intermittently over the last 10 years. The recent closure in 2010 was related to whirling disease (personal communication, Wes Pearce, DWR, and Andrew Myers, SWCA Environmental Consultants [SWCA], September 18, 2013); however, the hatchery reopened in November 2012 and is currently operating. The hatchery operates as a flow-through system, and discharge ranges from 2.13 to 4.47 MGD between April and September according to DWR data. BMPs to reduce nutrient loads in the effluent were implemented in 2003 (personal communication, Lonnie Shull, UDEQ, and Erica Gaddis, SWCA, July 19, 2013). The nutrient loads discharged are estimated to be 177 kg TP/season and 1,162 kg TN/season. Rockport Reservoir receives 69%–70% of the load discharged to Beaver Creek. The facility is not expected to expand and therefore the nutrient loads discharged should remain at existing levels.

2.1.1.1.4.Town of Francis Wastewater

The Town of Francis (UPDES UTOP00202) currently manages wastewater in a lagoon system without discharging to surface waters. Francis is currently discussing the possibility of expanding the wastewater treatment system, which could include discharging to the Weber River. Such a system would operate at an average daily flow of 0.14 MGD with the potential to expand to 0.36 MGD by 2035. Based on current wastewater characterization data, the TP concentration in the influent is 7 mg/L. TN estimates were not available but current ammonia-N concentrations in the influent are 25 milligrams per liter (mg/L) (Carollo Engineers 2012).

2.1.1.2. ECHO RESERVOIR WATERSHED POINT SOURCES

2.1.1.2.1.Coalville City Corporation Wastewater Plant

The Coalville City Corporation WWTP (UPDES UT0021288) serves a population of approximately 1,470 people. It was originally designed as a trickling filter plant in 1964. Since then, three upgrades have been completed. First, in 1985, the plant was modified to an extended aeration/activated sludge plant. Subsequent additions include two biosolids drying beds in 1992, the addition of a Somat screw press for dewatering, a composting pad, and alterations to existing drying beds in 1995. Plant design allows for an average daily flow of 0.35 MGD and peak flow of 0.42 MGD. Coalville City is currently in the process of moving the WWTP. The newly designed WWTP accounts for growth through 2035. The total average nutrient loads to Chalk Creek are 946 kg TN/season and 193 kg TP/season. Based on the delivery ratio for this point source (see Table 3), the total load delivered to Echo Reservoir is 715 kg TN/season and 165 kg TP/season. Construction is currently underway on a new WWTP in Coalville, Utah.

2.1.1.2.2.Silver Creek Water Reclamation Facility

The Snyderville Basin Water Reclamation District operates the Silver Creek WRF (UPDES UT0024414), a conventional, secondary treatment plant that services residential areas and permitted significant industrial users in portions of the watershed, including areas of Park City. Constituents with specific effluent limitations are DO, biochemical oxygen demand (BOD), total suspended solids, ammonia, *E. coli*, oil and grease, and pH. Phosphorus is not regulated with a specific effluent limitation, but is sampled on a monthly basis under the existing permit, which is currently in the process of being renewed. No flow is indicated in the UPDES permit, but the current facility has a capacity of 2.0 MGD and average monthly summer flow is 1.23 MGD. Upgrades are currently being planned, with final designs based on a discharge of 4.0 MGD.

The total average nutrient loads to Silver Creek are 15,976 kg TN/season and 1,797 kg TP/season. Based on the delivery ratio for this point source (see Table 3), the total load delivered to Echo Reservoir is 11,343 kg TN/season and 1,258 kg TP/season.

2.1.1.2.3.Judge Tunnel

Judge Tunnel (UPDES UT0025925) carries groundwater from a series of mine tunnels to a chlorination vault where the flow is treated and becomes drinking water for Park City (see Figure 2). If the turbidity is too high, the water bypasses the vault and is released into Empire Creek, a tributary to Silver Creek (Park City Municipal Corporation 2012). Judge Tunnel's average monthly flow is somewhat variable, but generally small compared to mainstem flows. The average monthly discharge is 0.4 cubic feet per second (cfs). The state will be issuing a UPDES permit for Judge Tunnel to regulate discharges from the tunnel.

The total average nutrient loads to Silver Creek are 89 kg TN/season and 7 kg TP/season. Based on the delivery ratio for this point source (see Table 3), the total load delivered to Echo Reservoir is 6 kg TN/season and 0 kg TP/season.

2.1.1.2.4.Spiro Tunnel

Like Judge Tunnel, Spiro Tunnel (UPDES UT0025941) collects groundwater from mine tunnels (see Figure 2). Spiro Tunnel discharges water into two irrigation ditches in the Silver Creek watershed: 1) the Bates, Snyder, Dority Ditch and 2) the Pace Homer Ditch. Spiro Tunnel discharges directly into Silver Creek at the Pace Homer Ditch (Park City Municipal Corporation 2012). The Spiro Tunnel average discharge is approximately 1.5 cfs.

The total average nutrient loads to Silver Creek are 620 kg TN/season and 24 kg TP/season. Based on the delivery ratio for this point source (see Table 3), the total load delivered to Echo Reservoir is 40 kg TN/season and 1 kg TP/season.

2.1.1.2.5.Prospector Drain and Biocell

Prospector Drain collects shallow groundwater impacted by mine tailings. This drain also collected stormwater until 2012 when Park City eliminated cross-connection from stormwater sources.

A portion of flow from Prospector Drain goes into the biocell, which treats the water for metal contamination. The biocell contains organic matter in the form of manure, which may explain the high nutrient concentrations in the biocell discharge, which goes to Silver Creek. The remaining water in Prospector Drain flows untreated to Silver Creek (Park City Municipal Corporation 2012). These sources contribute a relatively small quantity of flow to Silver Creek. The Prospector Drain discharges an estimated 0.07 cfs, and the biocell may contribute 0.04 cfs.

The biocell and Prospector Drain are expected to be part of an EPA-directed Comprehensive Environmental Response, Compensation, and Liability Act removal action in the foreseeable future. The discharges from these sources will be addressed, pending EPA approval of a removal action. Therefore, no UPDES permit will be issued for these point sources until the EPA-directed removal action is complete (Park City Municipal Corporation 2012).

The total average nutrient loads to Silver Creek from Prospector Drain and the biocell combined are 121 kg TN/season and 37 kg TP/season. Based on the delivery ratio for this point source (see Table 3), the combined total load delivered to Echo Reservoir is 8 kg TN/season and 2 kg TP/season.

2.1.1.2.6. Blue Sky Ranch and Resort

Blue Sky Ranch and Resort is a resort development in the lower part of the Silver Creek watershed. It is not currently discharging but because it has received a permit, a waste load allocation has been included in this TMDL.

2.1.2. Nonpoint Sources

Nonpoint source pollution originates from many diffuse sources across the landscape. In the study watershed, nonpoint sources include stormwater, agricultural practices such as livestock grazing and irrigation on both public and private land, septic systems, channel erosion, and a landfill. Restoring water quality and protecting beneficial uses will require describing and addressing each of these sources individually using an appropriate set of implementation measures. Efforts to reduce nonpoint sources are voluntary. The following nonpoint source load descriptions and subsequent reductions are based on summer seasonal loads (April–September) when the DO impairment is most critical.

2.1.2.1. STORMWATER

Residential subdivisions and commercial development (Figure 3) has increased the amount of impervious surface area (roads, parking lots, etc.) in the study watershed, which contributes to an increase in stormwater runoff (Figure 3). Figure 4 shows the outfalls in Park City. Additional outfalls likely exist in other areas of the study watershed, but have not yet been mapped. Stormwater transports nutrients that have accumulated on surfaces during dry periods. The runoff generally begins as diffuse flow (e.g., off a parking lot), which is then directed to gutters and storm drains. These drains direct stormwater into canals and other drainages, where it eventually reaches a stream. Stormwater can be problematic at active construction sites because of sediment loading. Construction in areas with soils of severe erosion potential underlain by a rock formation with elevated phosphorus concentrations may generate excess loads of phosphorus if proper BMPs are not used.

Because of its more rural nature, stormwater generates a smaller nutrient load in the Rockport Reservoir watershed compared to the Echo Reservoir watershed. Stormwater in the Rockport Reservoir watershed generates 278 kg TP/season and 601 kg TN/season, contributing 12% TP and 3% TN of the total load. Within the Rockport Reservoir watershed, the Direct Drainage subwatershed contains the highest percentage of impervious cover and generates the highest loads from stormwater, 123 kg TP/season and 226 kg TN/season. The Lower Weber River, Weber Canyon, and Beaver Creek subwatersheds are similar in the amount of development that has occurred, and they generate similar amounts of nutrient loads from stormwater, 42–54 kg TP/season and 106–130 kg TN/season. The subwatersheds with the least amount of impervious surface—Upper Weber River and Smith and Morehouse subwatersheds—are higher in the drainage and generate very little nutrient load from stormwater. These subwatersheds generate less than 10 kg TP/season and 20 or less kg TN/season (Table 4).

The Echo Reservoir watershed contains areas that have seen increased urbanization in the last decade, including portions of Park City as well as the Interstate 80 (I-80) corridor and U.S. Route 40 (US-40) corridor. Stormwater accounts for 683 kg TP/season and 933 kg TN/season to the Echo Reservoir, contributing to 13% TP and 2% TN of the total load. The Silver Creek subwatershed contributes the most load in the Echo Reservoir watershed (413 kg TP/season and 522 kg TN/season) because it contains nearly 5% impervious cover, and 25% of the subwatershed is low- to medium-density development. The I-80 and US-40 road corridors are also primarily within the Silver Creek subwatershed. Chalk Creek contributes 93 kg TP/season and 95 kg TN/season, whereas Upper Chalk Creek generates the least stormwater, having the least amount of development and impervious cover (Table 4).

The acreages from the land use datasets were used to calculate the percentage of low- to medium-density development and the percentage of high-density development and roads. The percentage of impervious cover was calculated using proportions of low, medium, and high-density development and their respective impervious cover percentages.

Table 4. Summary of Stormwater Related Subwatershed Characteristics and Loads to Reservoirs

Subwatershed	Total Acres	TP Load[1] (kg/season)	TN Load[1] (kg/season)	Low- to Medium-Density Development (percentage of the watershed)	High-Density Development and Roads (percentage of the watershed)	Impervious Cover (percentage of the subwatershed)
Rockport Reservoir Watershed						
Beaver Creek	53,549	47	106	3.9%	< 0.1%	0.7%
Direct Drainage Rockport	22,584	123	226	5.0%	< 0.1%	0.8%
Lower Weber River	36,572	54	130	3.8%	< 0.1%	0.7%
Smith and Morehouse	17,627	3	4	0.4%	< 0.1%	0.1%
Upper Weber River	47,514	9	20	0.4%	< 0.1%	0.1%
Weber Canyon	34,817	42	115	3.7%	< 0.1%	0.7%
Total	**212,663**	**278**	**601**	**2.9%**	< 0.1%	**0.5%**
Echo Reservoir Watershed						
Chalk Creek Mainstem	36,181	93	95	2.7%	< 0.1%	0.4%
Direct Drainage Echo	23,793	58	99	2.2%	0.2%	0.3%
Huff Creek	19,767	26	27	0.7%	< 0.1%	0.1%
Silver Creek	32,556	413	522	25.0%	0.7%	4.7%
South Fork Chalk Creek	47,863	37	42	0.8%	< 0.1%	0.1%
Upper Chalk Creek	56,876	5	18	0.3%	< 0.1%	< 0.1%
Weber River between Rockport and Echo	34,186	51	130	4.3%	0.4%	0.8%
Total	**251,222**	**683**	**933**	**4.7%**	**0.2%**	**0.8%**

[1] Load delivered to reservoir from each subwatershed for summer season (April 1–September 30).

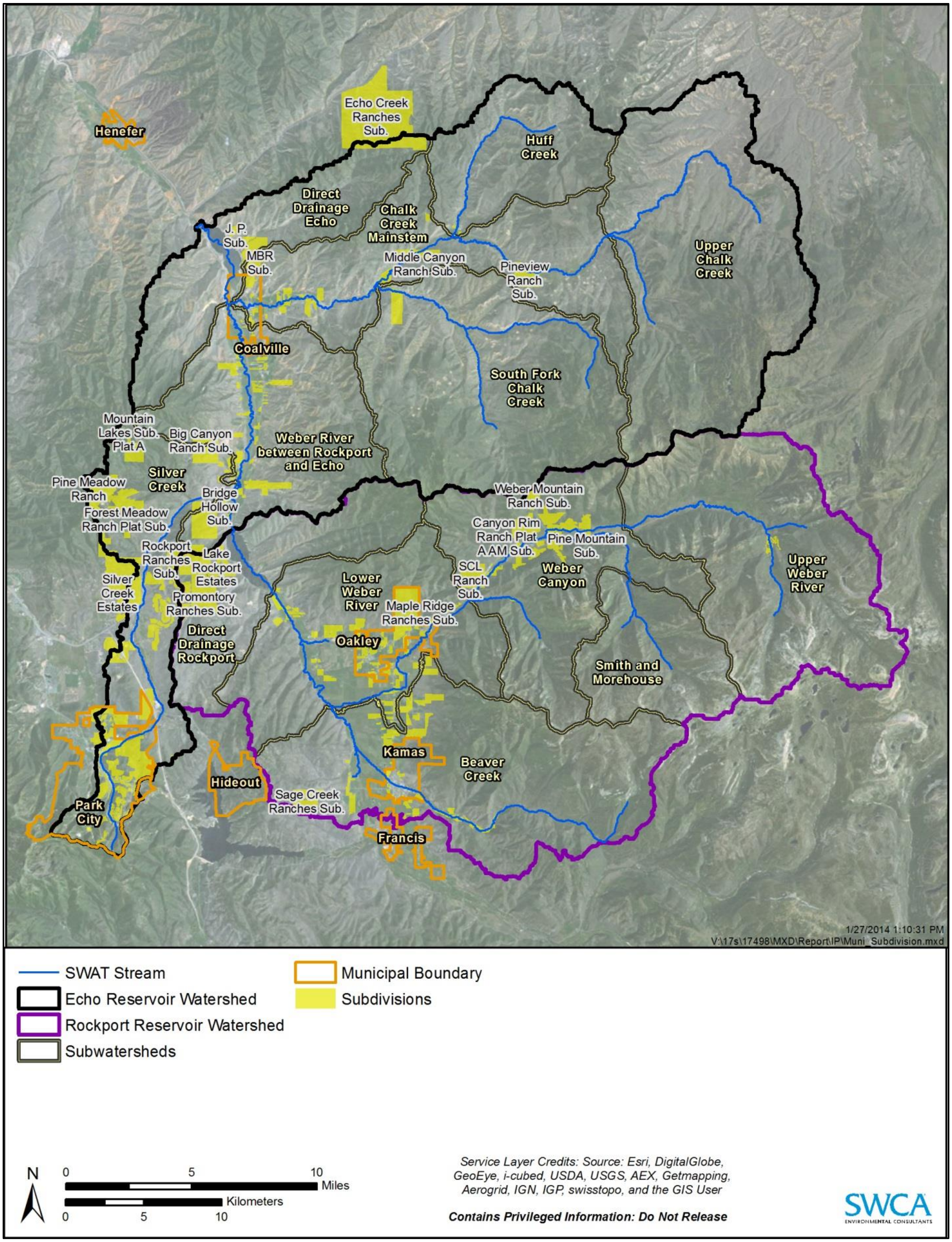

Figure 3. Municipalities and subdivisions in the Rockport Reservoir and Echo Reservoir watersheds.

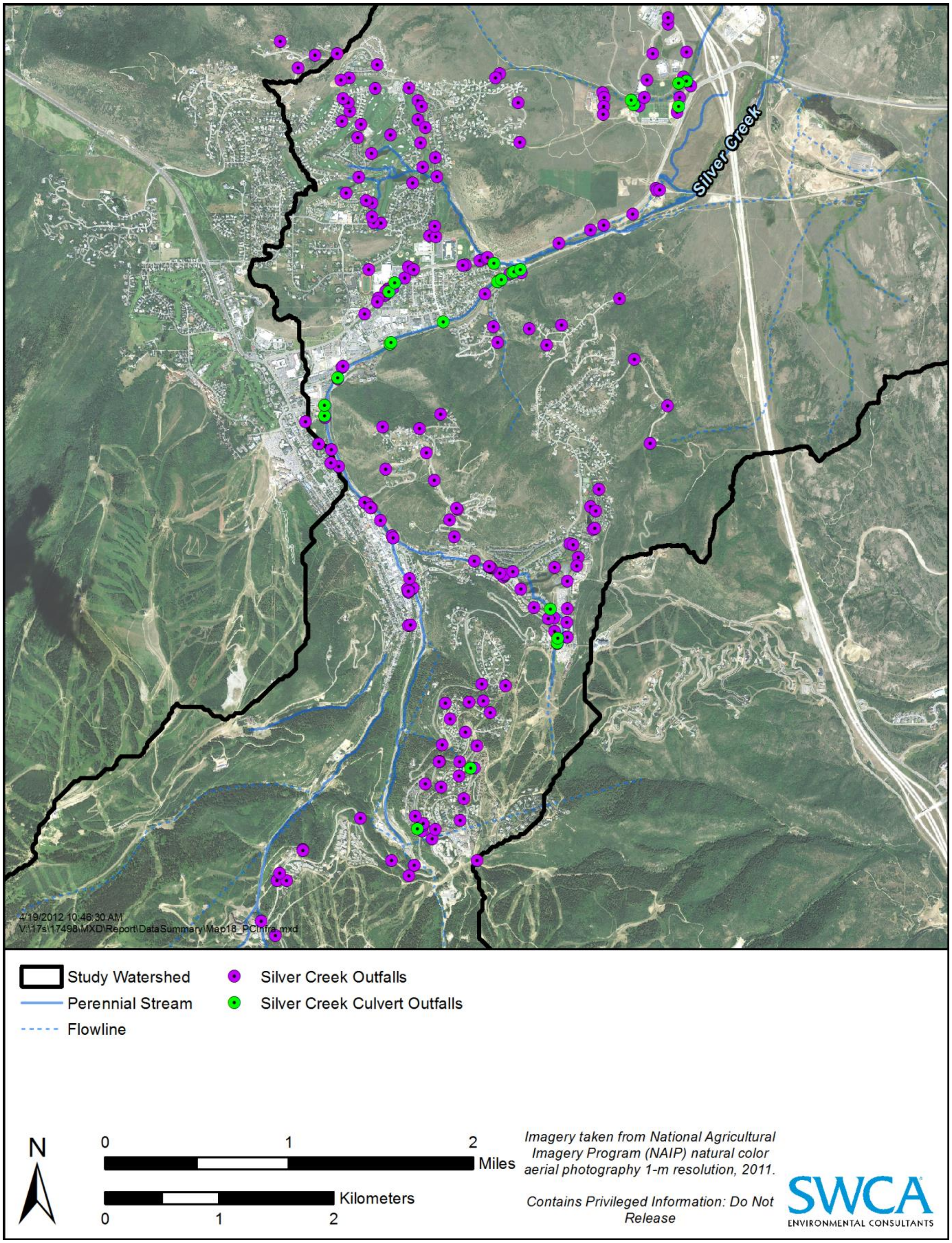

Figure 4. Locations of stormwater outfalls in the Silver Creek subwatershed.

2.1.2.2. AGRICULTURAL SOURCES

Grazing, hay, and alfalfa production is the primary agricultural activity that occurs in the study watershed (Figure 5). These activities involve the use of fertilizers, manure spreading, and irrigation in some areas of the study watershed. Agriculture is considered a nonpoint source. As water runs across agricultural fields, it picks up sediment and nutrients that are deposited and mobilized through active grazing, application of fertilizers, and irrigation.

The percentage of subwatershed within public grazing allotments was calculated assuming that USFS lands identified as an allotment within the subwatershed were grazed. The Smith and Morehouse allotment is not currently an active allotment and, although included in the area percentage, is not included in load calculations. The percentage of the watershed coinciding with private grazing land uses is assumed to be proportional to the acreage of forest, pasture, and range that is privately owned. The percentage of watershed as crop is calculated as the proportion of subwatershed area that is identified as agriculture, alfalfa, hay, or orchard on the land use map; however, some pastured areas are also used for crop production during the summer season.

In the Rockport Reservoir watershed, agricultural activities on both public and private land generate 1,235 kg TP/season and 8,166 kg TN/season, contributing to 53% TP and 44% TN of the total load. Grazing occurs on up to 56% of the total watershed area, depending on the season and individual operations, whereas crops occur on 2% of the watershed area. The Lower Weber River subwatershed generates the highest phosphorus load from agricultural activities in the Rockport Reservoir watershed (553 kg TP/season). In this subwatershed, 33% of the land may be used for private grazing, and over 7% is used to cultivate crops. Weber Canyon and Upper Weber contribute the highest nitrogen load (2,167 and 2,132 kg TN/season, respectively). The Beaver Creek subwatershed is used for both public grazing and private grazing and generates 322 kg TP/season and 848 kg TN/season (Table 5).

Agricultural activities in the Echo Reservoir watershed generate 965 kg TP/season and 13,019 kg TN/season, contributing to 18% TP and 30% TN of the total load. The “Weber River between Rockport and Echo” subwatershed contributes the most TP from agriculture to Echo Reservoir (276 kg/season). Huff Creek accounts for 125 kg TP/season, whereas Silver Creek contributes 270 kg TP/season. The “Weber River between Rockport and Echo” subwatershed generates 4,973 kg TN/season, almost 40% of the TN load from agriculture in the Echo Reservoir watershed. The Chalk Creek Mainstem contributes high amounts of TN as well (3,465 kg/season). Direct drainage to Echo Reservoir accounts for approximately 60 kg TN/season. No public grazing allotments are present in the Echo Reservoir watershed, but private grazing occurs in each subwatershed. Crop cultivation, if present, occurs on less than 5% of the subwatershed area.

Table 5. Summary of Agricultural-Related Subwatershed Characteristics and Loads to Reservoirs

Subwatershed	Total Acres	Percentage of Subwatershed within Public Grazing Allotments	Percentage of Watershed Coinciding with Private Grazing Land Uses	Percentage of Watershed as Crop	TP Load[1] (kg/season)	TN Load[1] (kg/season)
Rockport Reservoir Watershed						
Beaver Creek	53,549	47%	20%	2.9%	322	848
Direct Drainage Rockport	22,584	0%	20%	< 0.1%	147	746
Lower Weber River	36,572	7%	33%	7.2%	553	1,078
Smith and Morehouse	17,627	100%[2]	0%	< 0.1%	73	1,195
Upper Weber River	47,514	25%	20%	0.2%	86	2,132
Weber Canyon	34,817	46%	13%	0.1%	54	2,167
Total	**212,663**	**35%**	**21%**	**2.1%**	**1,235**	**8,166**
Echo Reservoir Watershed						
Chalk Creek Mainstem	36,181	0%	34%	2.24%	92	3,465
Direct Drainage Echo	23,793	0%	24%	3.39%	76	61
Huff Creek	19,767	0%	34%	< 0.1%	125	568
Silver Creek	32,556	0%	32%	0.44%	270	1,309
South Fork Chalk Creek	47,863	0%	41%	< 0.1%	115	1,078
Upper Chalk Creek	56,876	< 0.1%	55%	< 0.1%	11	1,565
Weber River between Rockport and Echo	34,186	0%	29%	3.73%	276	4,973
Total	**251,222**	**< 1%**	**38%**	1.2%	**965**	**13,019**

[1] Load delivered to reservoir from each subwatershed for summer season (April 1–September 30) and includes contribution from public grazing, private grazing, and fertilizer/irrigation activities.

[2] The Smith and Morehouse allotment is not currently active.

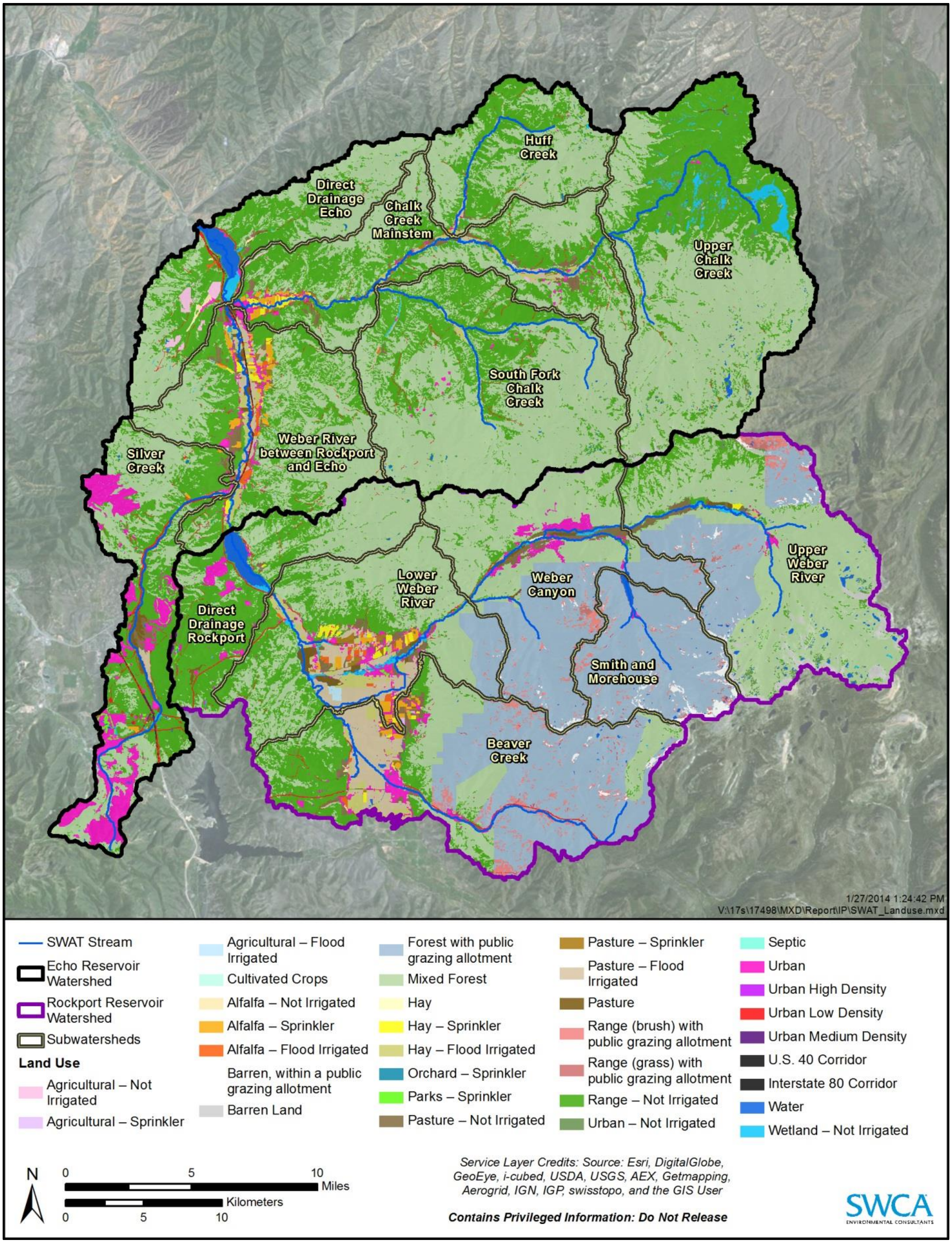

Figure 5. Land use by subwatershed in Rockport Reservoir and Echo Reservoir watersheds.

2.1.2.2.1.Grazing on Public Land

Five USFS allotments occur in the study watershed (Figure 6), however the Smith and Morehouse allotments do not currently have any active grazing permits. Among benefits such as clean water, wildlife protection, recreation, "forage for livestock" on public forest land is protected under the Multiple Use Sustained-Yield Act of 1960 (Swank 1998). It is important to note that a) allotments do not coincide with subwatershed boundaries and may only be partially contained in a watershed and b) cattle are not dispersed evenly across the landscape. Allotment data were used to estimate the number of livestock that graze in the watershed (Table 6). USFS allotments are exclusively high elevation, with use restricted to the summer season. Cattle graze on USFS land primarily in July, August, and September, although some grazing occurs as early as June and as late as October. Generally, cattle that graze on public lands are pastured on private lands in the valley during the rest of the year. Load contribution from public grazing occurs in the Rockport Reservoir watershed only and is 196 kg TP/season and 2,929 kg TN/ season, resulting in an 8% TP and 16% TN contribution to the total reservoir load.

Table 6. Identified Grazing Permits on USFS Lands in Rockport Reservoir and Echo Reservoir Watersheds

Allotment Name[1]	Allotment Area in the Watershed (acres)	Typical Dates	Average Animals in the Watershed	Average Animal Units in the Watershed	Animal Type
Rockport Reservoir Watershed					
Humpy Creek	973	July 25–September 24	382	76	Ewe/lamb pairs
Kamas Valley	25,299	June 10–October 15	336	336	Cows
Moffit	2,747	July 11–September 29	1,048	210	Ewe/lamb pairs
Weber River	28,975	June 21–September 30	186	186	Cows
Total	**57,994**		**1,952**	**808**	
Echo Reservoir Watershed					
Humpy Creek	5	July 25–September 24	2	0.4	Ewe/lamb pairs
Total	**5**		**2**	**0.4**	

[2] The Smith and Morehouse allotment is not currently active.

2.1.2.2.2.Grazing on Private Land

Rangeland and pasturelands in the study watershed are typically adjacent to local streams. Cattle within a grazed pasture rarely spread out and cover the entire acreage evenly; rather, they tend to congregate around areas where water is readily available (riparian areas and stream channels) and forage is plentiful. Consequently, a greater proportion of the manure is deposited in or nearby stream channels and riparian areas, resulting in a greater potential for direct transport of nutrients and pathogens. Grazing within the watershed occurs on public USFS-managed allotments as well as on private land. Employees from the NRCS at the Coalville office supplied information on private grazing, including estimates of the animal units by season in the watershed zones (Figure 6) for both Rockport Reservoir and Echo Reservoir watersheds.

Typically, cattle graze in the valleys in the fall and spring. In the hot summer months, they are taken to the higher elevation forests, and in the winter, they are relocated to the West Desert. Table 7 provides the estimated number of cattle grazing seasonally on private lands in the study watershed. There are significantly more cattle grazing on private lands than on public lands. For the Weber River watershed, cattle density is greatest during summer and fall seasons. The Beaver Creek subwatershed is the exception; here, approximately 2,000 cattle graze year-round. Load contribution from private grazing occurs in both the Rockport and Echo Reservoir watersheds. For Rockport, private grazing contributes to 688 kg TP/season and 4,275 kg TN/season, resulting in a 29% TP and 23% TN contribution to the total reservoir load. For Echo Reservoir, private grazing contributes to 755 kg TP/season and 9,903 kg TN/season, resulting in a 14% TP and 23% TN contribution to the total reservoir load.

Table 7. Number of Grazing Cattle per Season on Private Land

NRCS Zone	Spring (March 21–June 21)	Summer (June 22–September 21)	Fall (September 22–December 22)	Winter (December 23–March 21)
Rockport Reservoir Watershed				
Beaver Creek	2,000	2,000	2,000	2,000
Weber River between Rockport and Weber-Provo Diversion	1,000	1,500	1,500	1,000
Weber River Canyon	1,000	3,000	1,500	500
Total	**4,000**	**6,500**	**5,000**	**3,500**
Echo Reservoir Watershed				
Chalk Creek	500	3,500	3,500	500
Silver Creek	100	1,100	500	100
Weber River between Echo and Rockport	1,500	1,500	2,500	1,500
Total	**2,100**	**6,100**	**6,500**	**2,100**

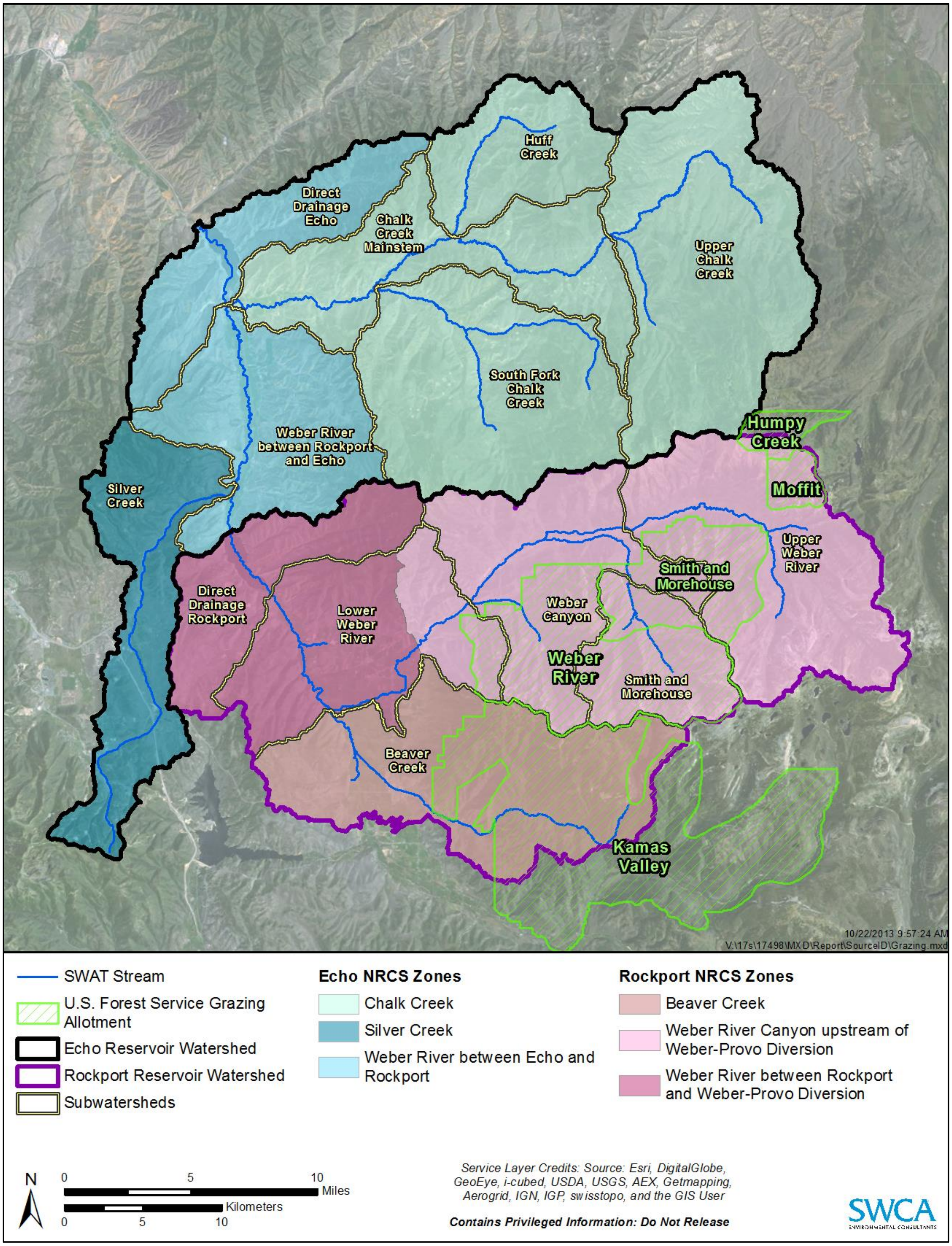

Figure 6. Zones used to broadly quantify the number of grazing animals on private property (NRCS zones) and the locations of USFS allotments in the Rockport Reservoir and Echo Reservoir watersheds.

2.1.2.2.3.Fertilizer and Irrigation Activities

Fertilizer and manure are applied to fields to improve crop yields on agricultural lands. Fertilizer is also used in urban areas, generally on lawns, landscaping, and turf on golf courses and recreational sports fields. Applied fertilizer may wash off during storm events or during irrigation, particularly flood irrigation. Water flowing off fields may drain directly back to the stream or to irrigation or drainage ditches. Runoff from urban landscapes directly adjacent to a stream may transport fertilizer directly to that stream. For example, a stream may run through a golf course that has been landscaped to the streambanks. Storm drains may also conduct flow off urban areas and transport fertilizer to streams.

The NRCS provided broad estimates of fertilizer application types and rates for the entire watershed. They indicated that most of the fertilizer used in both the Rockport Reservoir and Echo Reservoir watersheds is a commercial type with 11:52:11 (N:P:K) applied at a rate of 35 kg/year. Areas within 1 mile of a dairy operation were assumed to use manure in place of commercial fertilizers, using the same application rate. Urban areas are likely to be fertilized to keep grass and turf alive, but they are also likely to be more water efficient. These areas were assigned a lower application rate of 5 kg/hectare (ha). It was assumed fertilizer was not applied to high-density urban areas.

Nutrient loads from fertilizer application are included in the total loads from agriculture described in section 5.1.2.2 of the TMDL report. The characteristics of fertilizer application will affect the amount of nutrients washed off, with surface runoff generated by storm events, spring runoff, or irrigation return flow. In the Rockport Reservoir watershed, the Lower Weber River subwatershed contains the highest percentage of fertilized area, with agricultural and urban areas being fertilized. Beaver Creek fertilizer application is approximately half that of the Lower Weber River watershed, whereas essentially no fertilizer application occurs in the Smith and Morehouse subwatershed. In the Upper Weber River and Weber Canyon subwatersheds, fertilizer application occurs mostly in urban areas, with little application to agricultural areas (Table 8).

Table 8. Fertilizer Characteristics

Subwatershed	Total Acres	Percentage of Watershed Fertilized	Acres of Fertilized Agricultural Areas (using 35 kg/ha)	Acres of Fertilized Urban Areas (using 5 kg/ha)
Rockport Reservoir Watershed				
Beaver Creek	53,549	6.0%	1,575	1,566
Direct Drainage Rockport	22,584	3.0%	10	654
Lower Weber River	36,572	11.0%	2,640	1,238
Smith and Morehouse	17,627	0.3%	0	49
Upper Weber River	47,514	0.5%	80	153
Weber Canyon	34,817	2.0%	40	746
Total	**212,663**	**4.0%**	**4,345**	**4,407**
Echo Reservoir Watershed				
Chalk Creek Mainstem	36,181	5.7%	1,263	816
Direct Drainage Echo	23,793	4.5%	754	311
Huff Creek	19,767	1.0%	105	100
Silver Creek	32,556	14.3%	143	4,516
South Fork Chalk Creek	47,863	1.0%	155	319
Upper Chalk Creek	56,876	0.2%	0	125
Weber River between Rockport and Echo	34,186	9.5%	2,063	1,187
Total	**251,222**	**5.0%**	**4,483**	**7,375**

Irrigation return flow is runoff from agricultural fields (such as pasture and hay fields) that is generated by irrigating the field. The runoff either returns to the irrigation ditch or the stream directly down gradient from the field. Irrigation return flow is primarily associated with flood irrigation practices and less so with sprinkler irrigation. Flood irrigation allows water to flow from a ditch or stream onto the fields directly through a head gate or other diverting works. This method effectively flushes soil, biomass, manure, and fertilizer off the field and into the ditch or stream. Sprinkler systems apply less water at rates that allow water to infiltrate the soil, thereby reducing irrigation return flow generated from surface runoff.

Over-irrigation of pasture and hay land will also raise the water table and lead to changes in the mobility of phosphorus in soils. Phosphorus has been observed to move more easily through soils that are consistently waterlogged because most of the iron present in these soils is reduced, and sorption potential is decreased (Sharpley 1995). Waterlogged soils are also prone to the loss and transport of fine, lightweight soil particles (such as silt and clay) to receiving waters. These fine particles represent the primary phosphorus sorption sites in the soil. These particles carry a significant amount of phosphorus with them when they are removed and leave the remaining soil deficient in phosphorus holding capacity (Hedley et al. 1995). Nitrogen is highly mobile in soils, and over-irrigation would promote leaching through the soil layers. Return flow also easily transports nitrogen to irrigation canals and streams from irrigated fields.

Flood irrigation efficiency was assumed to be 30%, and sprinkler irrigation was assumed to be 70%. The surface runoff was assumed to be 40% from flood-irrigated land and 5% for sprinkler-irrigated lands (personal communication, Thomas Hoskins, NRCS, and Erica Gaddis, SWCA, December 12, 2012). These values reflect the difference in the amount and quality of irrigation return flow generated from flood irrigation compared to sprinkler irrigation.

Nutrient loads from irrigation return flows are included with the total loads from agriculture described in section 5.1.2.2 of the TMDL report. Irrigation methods will affect the quantity of nutrients transported by irrigation return flow. Sprinkler irrigation generates less return flow; compared to flood irrigation, it transports less fertilizer, sediment, and other debris from agricultural fields that contain nutrients. Based on the Water Related Land Use data (Figure 7), flood irrigation is the primary form of irrigation in the Rockport Reservoir watershed. Sprinkler and flood irrigation is almost equivalent in Echo Reservoir watershed, with flood irrigation being slightly higher.

In the Rockport Reservoir watershed, 5.6% of the total area is irrigated, primarily with flood irrigation. Sprinkler irrigation is applied to 2,102 acres across the Rockport Reservoir watershed. The Lower Weber River subwatershed has the highest proportion of irrigated land (16%). In this subwatershed, 1,383 acres are sprinkler irrigated and 4,799 acres are flood irrigated. Irrigation occurs on 10% of the Beaver Creek subwatershed, with nearly 5,000 acres as flood irrigation and only 656 acres irrigated with sprinklers. Very little irrigation occurs in the Weber Canyon subwatershed, and no irrigation occurs in the Smith and Morehouse subwatershed (Table 9; Figure 7). Irrigation occurs on 3% of the Echo Reservoir watershed, with sprinkler irrigation occurring on 2,467 acres and flood irrigation occurring on 3,672 acres. Irrigation occurs on almost 10% of the "Weber River between Rockport and Echo" subwatershed. In this subwatershed, 1,185 acres are sprinkler irrigated and 1,947 acres are flood irrigated. No irrigation occurs in the Upper Chalk Creek subwatershed. In Silver Creek and the Direct Drainage Echo subwatershed, sprinkler irrigation occurs on more acreage than does flood irrigation. Most irrigation in the South Fork Chalk Creek subwatershed is under flood irrigation (Table 9; Figure 7).

Irrigation and fertilizer activities contribute 350 kg TP/season and 963 kg TN/season (15% and 5%, respectively) to the Rockport Reservoir and 211 kg TP/season and 3,117 kg TN/season (4% and 7%, respectively) to the Echo Reservoir.

Table 9. Irrigation Return Flow

Subwatershed	Total Acres	Percentage of Subwatershed Irrigated	Acres with Sprinkler Irrigation	Acres with Flood Irrigation
Rockport Reservoir Watershed				
Beaver Creek	53,549	10.5%	656	4,960
Direct Drainage Rockport	22,584	< 0.1%	12	1
Lower Weber River	36,572	16.9%	1,383	4,799
Smith and Morehouse	17,627	< 0.1%	0	0
Upper Weber River	47,514	0.2%	45	35
Weber Canyon	34,817	0.1%	5	29
Total	**212,663**	5.6%	**2,102**	**9,823**
Echo Reservoir Watershed				
Chalk Creek Mainstem	36,181	5.8%	906	1,182
Direct Drainage Echo	23,793	0.3%	54	28
Huff Creek	19,767	1.0%	11	192
Silver Creek	32,556	1.2%	310	89
South Fork Chalk Creek	47,863	< 0.1%	1	234
Upper Chalk Creek	56,876	0%	0	0
Weber River between Rockport and Echo	34,186	9.16%	1,185	1,947
Total	**251,222**	**3.0%**	**2,467**	**3,672**

Note: At least 100 acres of land in the South Fork subwatershed have been converted to sprinkler irrigation since the publishing of the water-related land use data upon which this table is based.

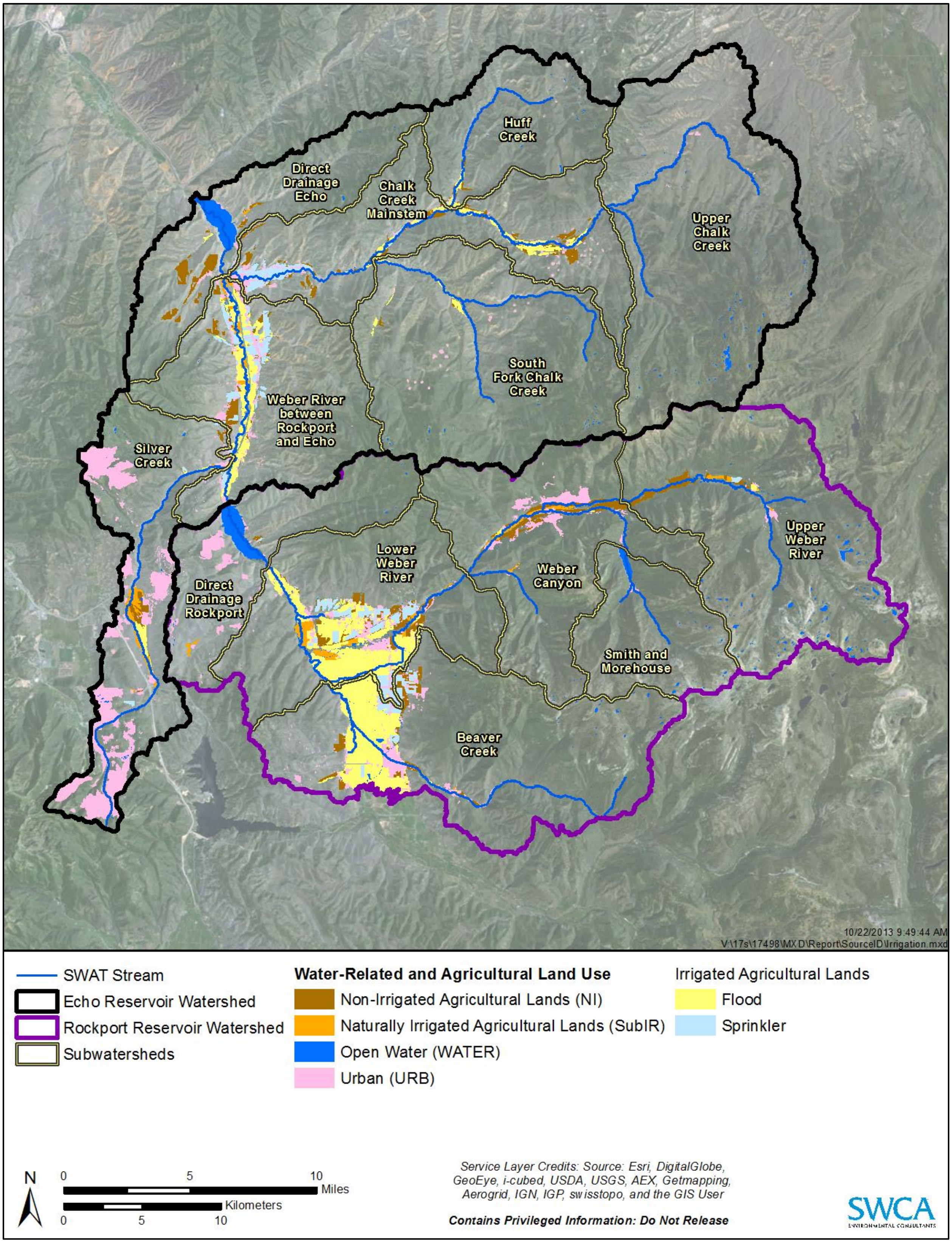

Figure 7. Areas of sprinkler and flood-irrigated lands in each subwatershed.

2.1.2.3. SEPTIC SYSTEMS

Although the WWTPs discussed above serve a large portion of the study watershed, there are an estimated 3,764 septic systems in the study watershed (Table 10; Figure 8). Septic system failure, improper design, and poor location of a leach field can increase the nutrient loads and BOD from these systems. A properly operating septic system treats wastewater and disposes of the water through an underground leach field. Soils beneath the leach field remove most pathogens by filtering, adsorption, and biological processes. However, where soils or groundwater conditions are marginally suitable, or where septic densities are too high, conventional septic systems fail and removal rates are reduced or no treatment occurs at all. A septic system can affect surface waters when soils below the leach field become clogged or flooded and when effluent reaches the surface where it can be washed off into a stream. An associated problem occurs when a septic system is flooded by groundwater or the depth-to-groundwater is near the base of the leach field and effluent is released to shallow groundwater, which discharges into nearby streams. Therefore, the proximity of septic systems to surface waters (Table 10) and the type and depth of the system (Table 11) are important factors that have the potential to affect water quality. Additionally, based on early discussions with Summit County Health Department (SCHD) and results from bacteria and human bacteroides sampling that occurred in late 2012, an EPA-recommended septic system failure rate of 10% was used (EPA 2000). However, it should be noted that this estimate is most likely too high for the region (personal communication, Richard Bullough (SCHD), and Erica Gaddis (SWCA), January 13, 2014).

Septic systems have been categorized based on their level of use. The Primary category contains buildings known to be primary residences and other buildings that are likely operating all year. Buildings listed as other or unknown, including those identified as Farmland Assessment Act buildings, were included in the Primary category to maintain a conservative estimate of septic systems and their operations within the study watershed. Secondary septic systems are based on a county classification of the residence of 6 months or less. Buildings that the county considers Recreational have less than 3 months of occupancy over the year.

Table 10. Number of Septic Tanks for Primary Residences, Secondary Residences, and Recreational Residences by Subwatershed

Subwatershed	Primary	Secondary	Recreational	Distance to Water (m)	TP Load[1] (kg/season)	TN Load[1] (kg/season)
Rockport Reservoir Watershed						
Beaver Creek	414	41	50	114	18	450
Direct Drainage Rockport	50	13	50	268	2	779
Lower Weber River	400	43	26	110	20	544
Upper Weber River	27	0	75	98	6	509
Weber Canyon	92	10	779	173	34	1,214
Total	**983**	**107**	**980**	**146**	**79**	**3,496**

Table 10. Number of Septic Tanks for Primary Residences, Secondary Residences, and Recreational Residences by Subwatershed

Subwatershed	Primary	Secondary	Recreational	Distance to Water (m)	TP Load[1] (kg/season)	TN Load[1] (kg/season)
Echo Reservoir Watershed						
Chalk Creek Mainstem	162	6	2	95	5	199
Direct Drainage Echo	6	–	21	192	0	44
Huff Creek	8	1	–	98	0	2
Silver Creek	212	40	310	189	4	302
South Fork Chalk Creek	6	–	–	47	1	6
Upper Chalk Creek	2	–	–	63	–	1
Weber River between Rockport and Echo	394	24	–	133	10	539
Total	**790**	**71**	**333**	**154**	**19**	**1,093**

[1] Load delivered to reservoir from each subwatershed for summer season (April 1–September 30).

Septic systems contribute 79 kg TP/season and 3,496 kg TN/season (3% and 19% of the total load, respectively) to Rockport Reservoir. The Weber Canyon subwatershed contributes the largest nutrients load from septic systems (34 kg TP/season and 1,214 kg TN/season). The Weber Canyon subwatershed contains 779 recreational septic systems and only 92 primary septic systems. The Lower Weber River subwatershed and the Beaver Creek subwatershed contribute just over 100 kg TP/season and 450–500 kg TN/season. These subwatersheds have over 400 primary septic systems and fewer than 100 recreational septic systems. The Direct Drainage subwatershed contributes 779 kg TN/season and only 2 kg TP/season. There are fewer than 200 septic systems in the subwatershed, and most are far from a waterbody. However, most are deep trench septic systems (Table 11).

Septic systems contribute 19 kg TP/season and 1,093 kg TN/season (< 1% and 3% of the total load, respectively) to Echo Reservoir. The "Weber River between Rockport and Echo" subwatershed contributes the most nutrients, accounting for about half (10 kg/season) of the TP and almost half (539 kg/season) of the TN load with mostly primary septic systems. The Silver Creek subwatershed, with 212 primary septic systems and 310 recreational septic systems, contributes 4 kg TP/season and 302 kg TN/season. Upper Chalk Creek contains almost no septic systems and does not contribute to nutrient loads from septic systems (see Table 10).

Table 11. Number of Septic Systems by Type and Depth

Subwatershed	Chamber	Deep Trench	Seepage Pit	Shallow
Rockport Reservoir Watershed				
Beaver Creek	15	109	1	69
Direct Drainage Rockport	0	48	0	9
Lower Weber River	7	69	0	61
Upper Weber River	2	15	0	25
Weber Canyon	4	271	1	29
Total	**28**	**512**	**2**	**193**

Table 11. Number of Septic Systems by Type and Depth

Subwatershed	Chamber	Deep Trench	Seepage Pit	Shallow
Echo Watershed				
Chalk Creek Mainstem	0	32	0	11
Direct Drainage Echo	0	2	0	3
Huff Creek	0	1	0	0
Silver Creek	10	205	3	34
South Fork Chalk Creek	1	0	0	0
Upper Chalk Creek	0	0	0	0
Weber River between Rockport and Echo	2	103	1	41
Total	**13**	**343**	**4**	**89**

[1] Within the study watershed, fewer than five systems of the following types occur: 50 trench, 750 trench, chamber/shallow, drainfield, infiltrated-deep, infiltrated-shallow, and shallow-infiltrated.

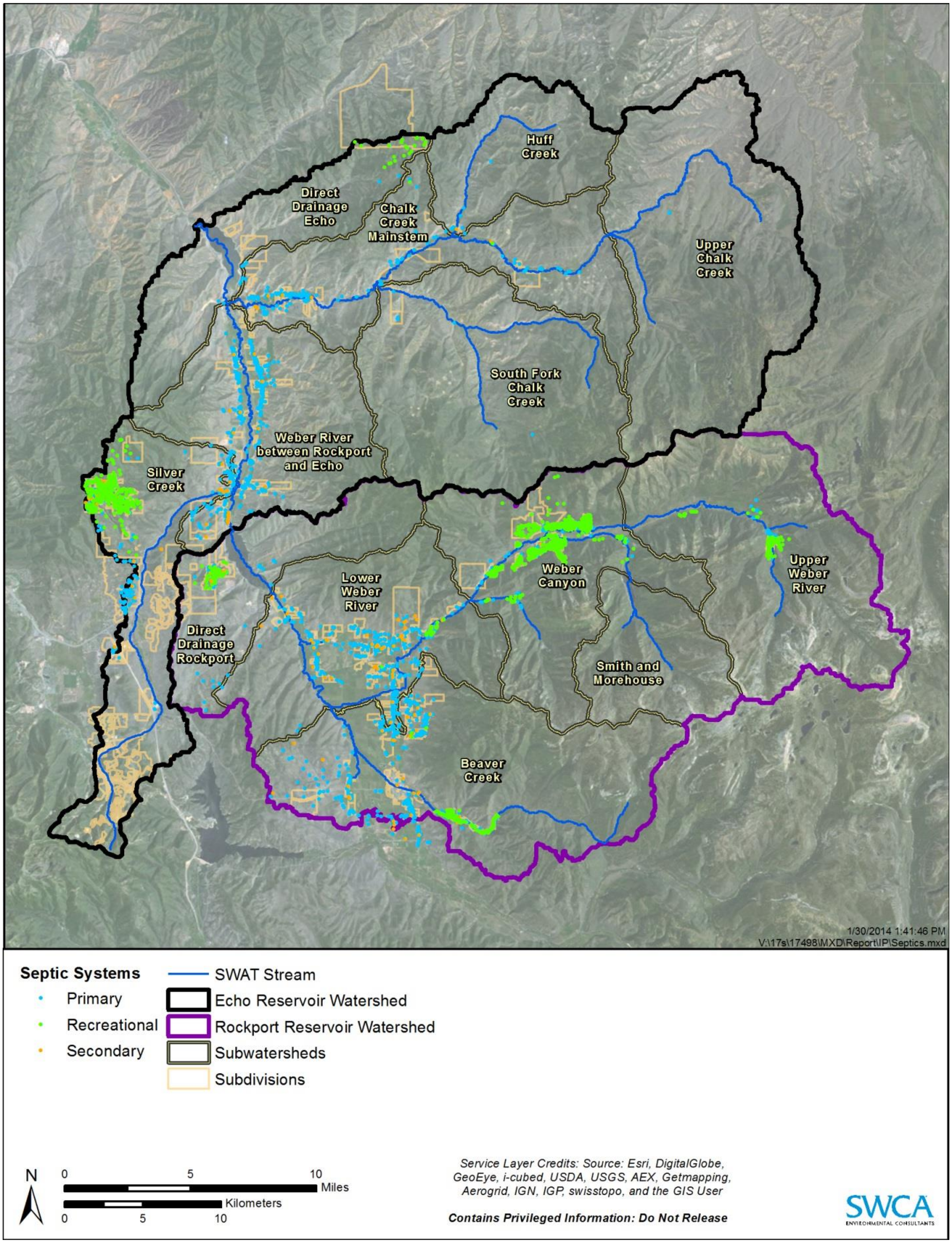

Figure 8. Location of septic systems in each subwatershed.

2.1.2.4. STREAMBANK EROSION

Population growth has led to a rise in development in the study watershed. The increase in impermeable surface area associated with residential and commercial development in the watershed can result in flashy peak flows that contribute to streambank erosion and inputs of organic matter, nitrogen, and phosphorus to receiving waters. Sources of sediment and pollutants include stormwater runoff from paved areas, erosion from construction sites, and sediment and nutrients from roads and livestock. Ski areas, golf courses, and livestock grazing also contribute to the potential of increased runoff and the transport of nutrients and sediment as discussed previously. Developments bordering streams have resulted in the removal and disruption of riparian vegetation, and peak storm flows have caused stream down cutting in some areas and widening in others (Bell et al. 2004). This portion of the total load is associated with the increase in channel erosion beyond natural background. The nutrient load from channel erosion is considered negligible in the Rockport Reservoir watershed. In the Echo Reservoir watershed, channel erosion is generally negligible except for South Fork Chalk Creek, Huff Creek, and "Weber River between Rockport and Echo" subwatersheds (Table 12). TP load is 691 kg TP/season (13% of total load) and TN load is 2,035 kg TN/season (5% of total load).

Table 12. Streambank Erosion Nutrient Loads by Subwatershed

Subwatershed	TP Load[1] (kg/season)	TN Load[1] (kg/season)
Echo Reservoir Watershed		
Chalk Creek Mainstem	0	0
Direct Drainage Echo	0	0
Huff Creek	70	177
Silver Creek	0	0
South Fork Chalk Creek	528	997
Upper Chalk Creek	0	0
Weber River between Rockport and Echo	93	861
Total	**691**	**2,035**

[1] Load delivered to reservoir from each subwatershed for summer season (April 1–September 30).

2.1.2.5. THREE MILE CANYON LANDFILL

The Three Mile Canyon Landfill, operated by Summit County, is 600 meters west and up gradient of the Rockport Reservoir. The unlined landfill has been in operation since the late 1980s and collects non-hazardous solid waste from municipal, commercial, industrial, and construction/demolition sources. Groundwater well data are available for one well up gradient of the landfill and two wells down gradient of the landfill. Nitrate concentrations up gradient of the landfill are typically below detection limits (< 0.01 mg/L). Nitrate concentrations down gradient of the landfill range from 1 to 44 mg/L. This increase indicates that landfill leachate is a significant source of nitrate to groundwater. Given the proximity of the landfill to Rockport Reservoir, there is a high probability that some of the groundwater with high nitrogen concentrations is delivered to the reservoir by subsurface flow. Data on groundwater flow into the reservoir are not available. Therefore, Soil and Water Assessment Tool (SWAT) model estimates of groundwater flow were used to estimate a nitrogen load from the landfill that is transported through groundwater. The proportion of the total groundwater flow in the Direct Drainage subwatershed that flows beneath the landfill was assumed to be 1% of the total groundwater flow to the reservoir. This value was calibrated as part of the reservoir modeling to account for a missing nitrogen source that was indicated by reservoir nitrogen data but not by tributary data. The average nitrate concentrations were assumed to be 25 mg/L, based on data collected in 2007, the year used for model calibration. The total estimated nitrate load from the landfill to Rockport Reservoir is 922 kg/season (5% of total load); however, it should be noted that this estimate is considered conservative.

2.1.2.6. NATURAL BACKGROUND

Background loads represent what would exist in the stream without human interaction in the study watershed. The soils and geology of the watershed contribute to the natural or background nutrient loads to the Weber River and its tributaries through soil and bedrock erosion and weathering. The watershed consists of several soil groups (Figure 9), all of which are various types of loam (see Table A-2 in Appendix A of the TMDL). Soils rated as having severe erosion hazard cover most of the watershed and are generally located in steeply sloped areas. A phosphatic shale layer with concentrations of rock phosphorus between 0.04% and 1.19% (Figure 10) is also present in the watershed. The areas of higher concentrations coincide with some areas of severe erosion hazard, indicating potential for higher natural phosphorus concentrations, particularly from easily eroded areas. These areas of higher phosphorus include Chalk Creek. Terrestrial and aquatic wildlife also contribute to the natural background load of nutrients.

Dust particles in the atmosphere can contribute phosphorus loads to the landscape and directly to waterbodies, although the amount depends on long-term climatic and short-term weather patterns and therefore varies greatly from year to year.

Some limestone and sandstone formations are present in parts of the study watershed, particularly the Silver Creek subwatershed. These rock types are commonly associated with karst topography. The sinkholes that developed in 1982 and 2008 along Silver Creek occurred close to each other in a limestone formation (Loughlin Water Associates, LLC. 2009). Although such formations do not contribute phosphorus, they will affect the total stream flow, thereby affecting the total nutrient load reaching a reservoir.

Natural background load accounts for 409 kg TP/season and 3,634 kg TN/season in Rockport Reservoir watershed, which equate to 18% of the TP load and 16% of the TN load. The Upper Weber subwatershed generates the highest natural background load of phosphorus, whereas the Lower Weber generates the highest nitrogen load (Table 13). In the Echo Reservoir watershed, background loads contribute 670 kg TP/season and 3,902 kg TN/season, which equate to 12% of the TP load and 9% of the TN load. The "Weber River between Rockport and Echo" subwatershed generates the most background load (297 kg TP/season and 958 kg TN/season). The Direct Drainage subwatershed generates the least background load (28 kg TP/season and 180 kg TN/season).

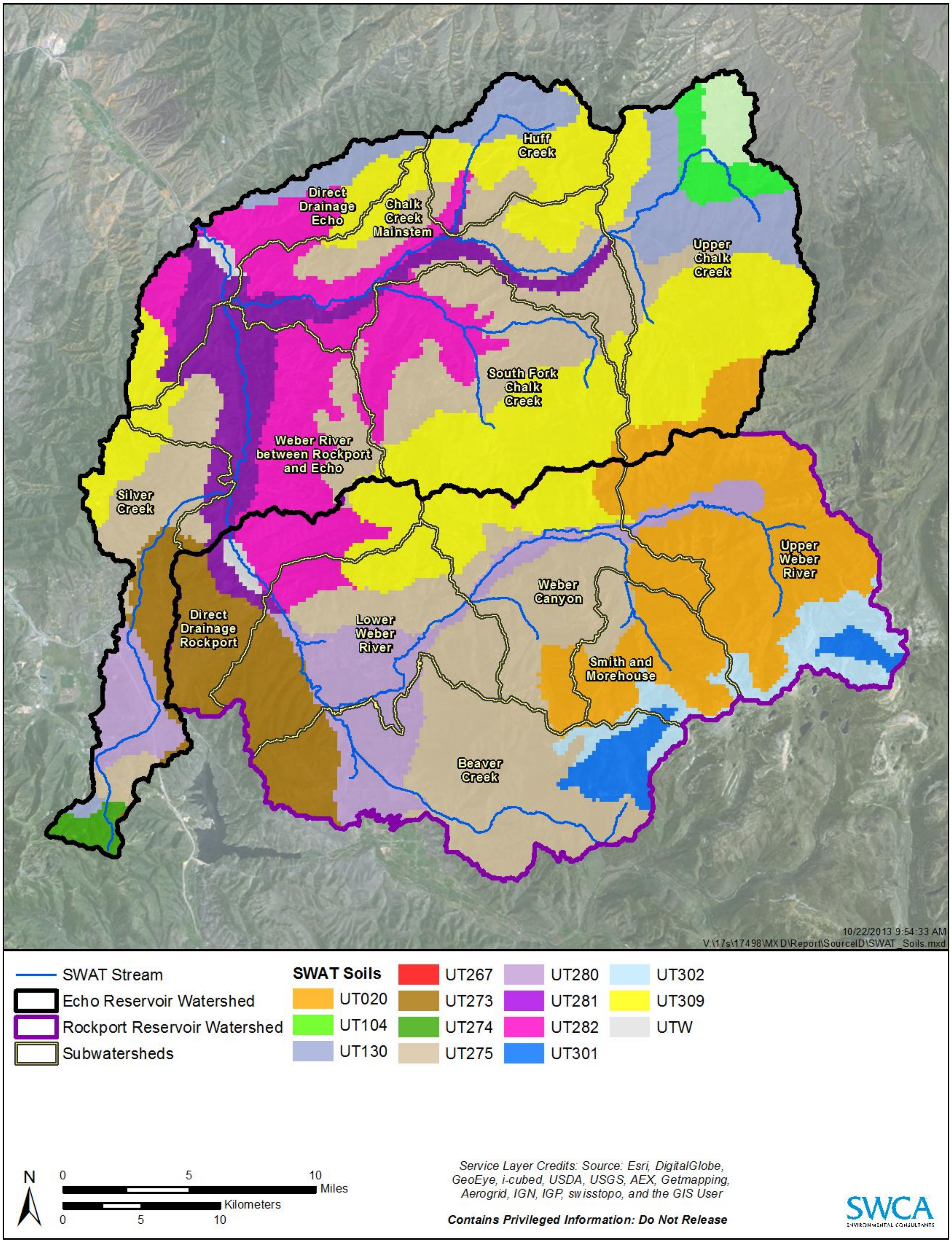

Figure 9. SWAT soils map showing STATSGO state map unit identification (STMUID) numbers.

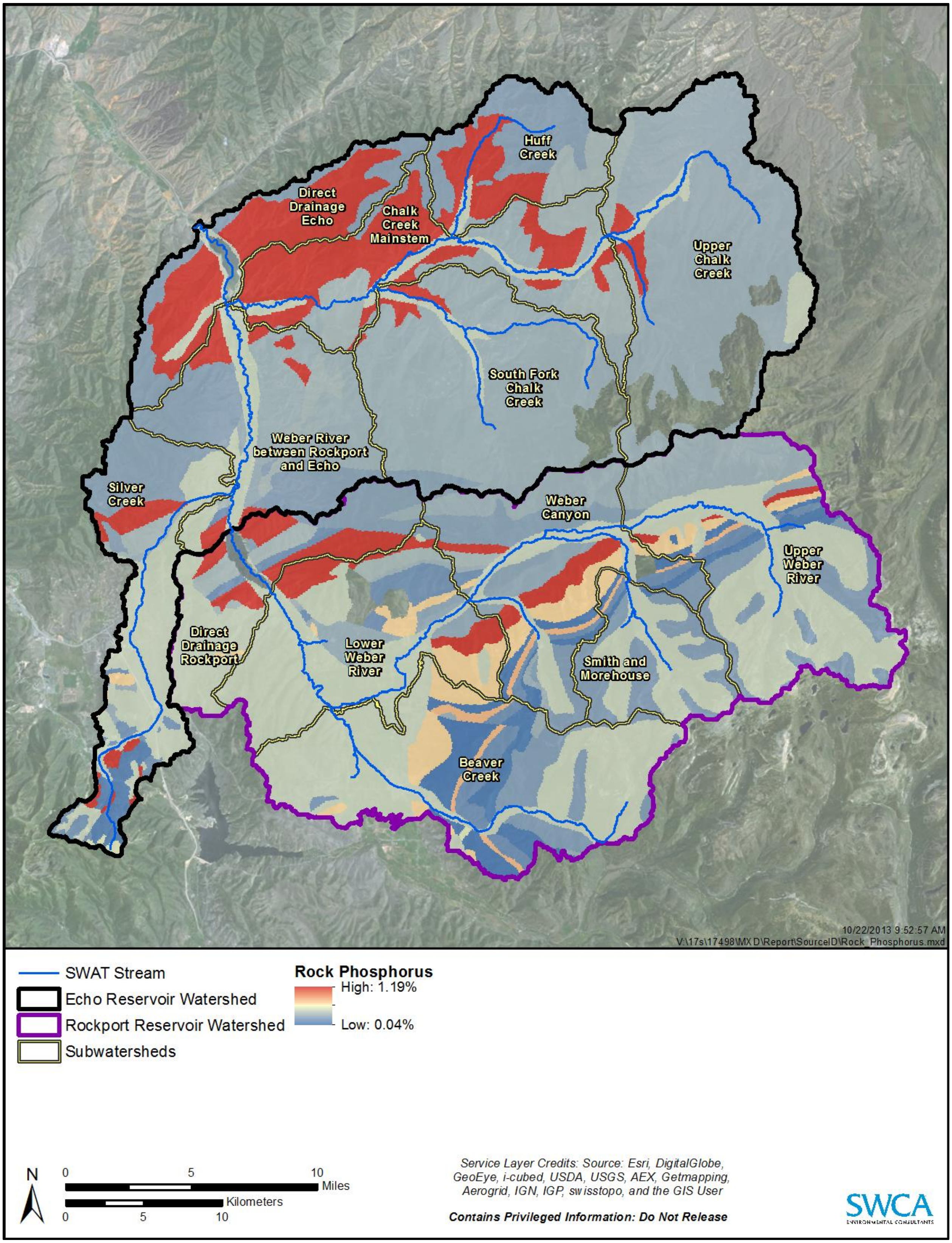

Figure 10. Rock phosphorus percentage in each subwatershed.

Table 13. Natural Background Nutrient Loads by Subwatershed

Subwatershed	TP Load[1] (kg/season)	TN Load[1] (kg/season)
Rockport Reservoir Watershed		
Beaver Creek	69	526
Direct Drainage Rockport	34	275
Lower Weber River	81	979
Smith and Morehouse	51	397
Upper Weber River	124	792
Weber Canyon	50	665
Total	**409**	**3,634**
Echo Reservoir Watershed		
Chalk Creek Mainstem	150	966
Direct Drainage Echo	28	180
Huff Creek	38	245
Silver Creek	37	246
South Fork Chalk Creek	89	572
Upper Chalk Creek	30	735
Weber River between Rockport and Echo	297	958
Total	**669**	**3,902**

[1] Load delivered to reservoir from each subwatershed for summer season (April 1–September 30).

2.1.3. Summer Season Source Summary

For the summer impairment season, (April 1–September 30), the average TP and TN loads to Echo Reservoir are 5,386 kg/season and 42,709 kg/season, respectively (Tables 14 and 15). Point sources represent approximately 26% of the TP load and 28% of the TN load into Echo Reservoir (Figures 11 and 12). Releases from Rockport Reservoir make up 17% of the TP load and 23% of the TN load. Background sources account for 12% of the TP and 9% of the TN load to Echo Reservoir. Stormwater, agricultural sources, and channel erosion are all significant sources of nonpoint sources in the Echo Reservoir watershed for phosphorus. Agricultural nonpoint sources comprise the largest nonpoint source in the watershed for nitrogen. In total, nonpoint sources (excluding background sources and releases from Rockport Reservoir) account for 44% of the TP load and 40% of the TN load to Echo Reservoir.

The average TP and TN loads to Rockport Reservoir are 2,337 kg/season and 18,573 kg/season, respectively (Tables 14 and 15). Point sources represent approximately 14% of the TP load and 9% of the TN load into Rockport Reservoir (Figures 13 and 14). Background sources account for 18% of the TP and 20% of the TN load to Echo Reservoir. Agricultural nonpoint sources comprise the largest nonpoint source in the watershed for both nitrogen and phosphorus. Stormwater is also a significant source of both nutrients to Rockport Reservoir. The landfill and septic systems, primarily in Weber Canyon and the Lower Weber subwatersheds, are also significant sources of nitrogen to Rockport Reservoir. In total, nonpoint sources (excluding background sources) account for 68% of the TP load and 71% of the TN load to Rockport Reservoir.

Table 14. Summary of Nonpoint Source Total Phosphorous Loads (kg/summer season [April–September])

Subwatershed	Stormwater	Private Grazing	Irrigation/ Fertilizer	Public Grazing	Septic Systems	Channel Erosion	Natural Background	Upstream	Total Nonpoint Source	Point Source Load	Total
Rockport Reservoir Watershed											
Beaver Creek	47	144	129	50	18	0	69	0	456	231	687
Direct Drainage Rockport	123	147	0	0	2	0	34	0	306	0	306
Lower Weber River	54	306	221	26	20	0	81	0	708	106	814
Smith and Morehouse	3	0	0	73	0	0	51	0	126	0	126
Upper Weber River	9	64	0	22	6	0	124	0	225	0	225
Weber Canyon	42	28	0	26	34	0	50	0	180	0	180
Total	**278**	**688**	**350**	**196**	**79**	**0**	**409**	**0**	**2,000**	**337**	**2,337**
Echo Reservoir Watershed											
Chalk Creek Mainstem	93	74	18	–	5	0	150	0	340	165	505
Direct Drainage Echo	58	60	15	–	0	0	28	0	162	0	162
Huff Creek	26	119	6	–	0	70	38	0	260	0	260
Silver Creek	413	216	54	–	4	0	37	0	724	1,262	1,986
South Fork Chalk Creek	37	109	6	–	1	528	89	0	769	0	769
Upper Chalk Creek	5	10	1	–	0	0	30	0	46	0	46
Weber River between Rockport and Echo	51	166	110	–	10	93	297	931	1,658	0	1,658
Total	**683**	**755**	**211**	**–**	**19**	**691**	**670**	**931**	**3,959**	**1,427**	**5,386**

Table 15. Summary of Nonpoint Source Total Nitrogen Loads (kg/summer season [April – September])

Subwatershed	Stormwater	Private Grazing	Irrigation/ Fertilizer	Public Grazing	Septic Systems	Channel Erosion	Three-Mile Canyon Landfill	Natural Background	Upstream	Total Nonpoint Source	Point Source Load	Total
Rockport Reservoir Watershed												
Beaver Creek	106	315	424	109	450	–	–	526	–	1,930	1,051	2,981
Direct Drainage Rockport	226	746	0	0	779	–	922	275	–	2,948	–	2,948
Lower Weber River	130	497	538	42	544	–	–	979	–	2,731	703	3,434
Smith and Morehouse	4	0	0	1,195	0	–	–	397	–	1,596	–	1,596
Upper Weber River	20	1,584	0	548	509	–	–	792	–	3,453	–	3,453
Weber Canyon	115	1,132	0	1,035	1,214	–	–	665	–	4,161	–	4,161
Total	**601**	**4,275**	**962**	**2,929**	**3,496**	**–**	**922**	**3,634**	**–**	**16,819**	**1,754**	**18,573**
Echo Reservoir Watershed												
Chalk Creek Mainstem	95	2,772	693	–	199	0	–	966	0	4,725	715	5,440
Direct Drainage Echo	99	49	12	–	44	0	–	180	0	384	–	384
Huff Creek	27	540	28	–	2	177	–	245	0	1,019	–	1,019
Silver Creek	522	1,047	262	–	302	0	–	246	0	2,379	11,396	13,775
South Fork Chalk Creek	42	1,024	54	–	6	997	–	572	0	2,695	–	2,695
Upper Chalk Creek	18	1,487	78	–	1	0	–	735	0	2,319	–	2,319
Weber River between Rockport and Echo	130	2,984	1,989	–	539	861	–	958	9,616	17,077	–	17,077
Total	**933**	**9,903**	**3,117**	–	**1,093**	**2,035**	**–**	**3,902**	**9,616**	**30,598**	**12,111**	**42,709**

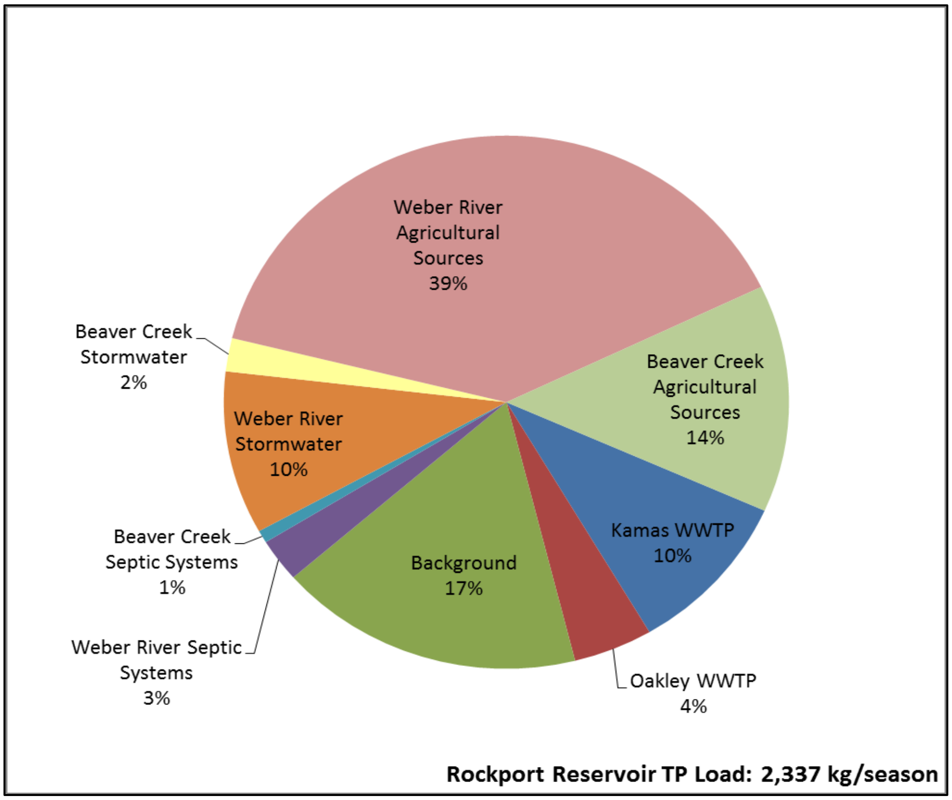

Figure 11. Proportion of summer season total phosphorus load associated with significant sources in the Rockport Reservoir watershed.

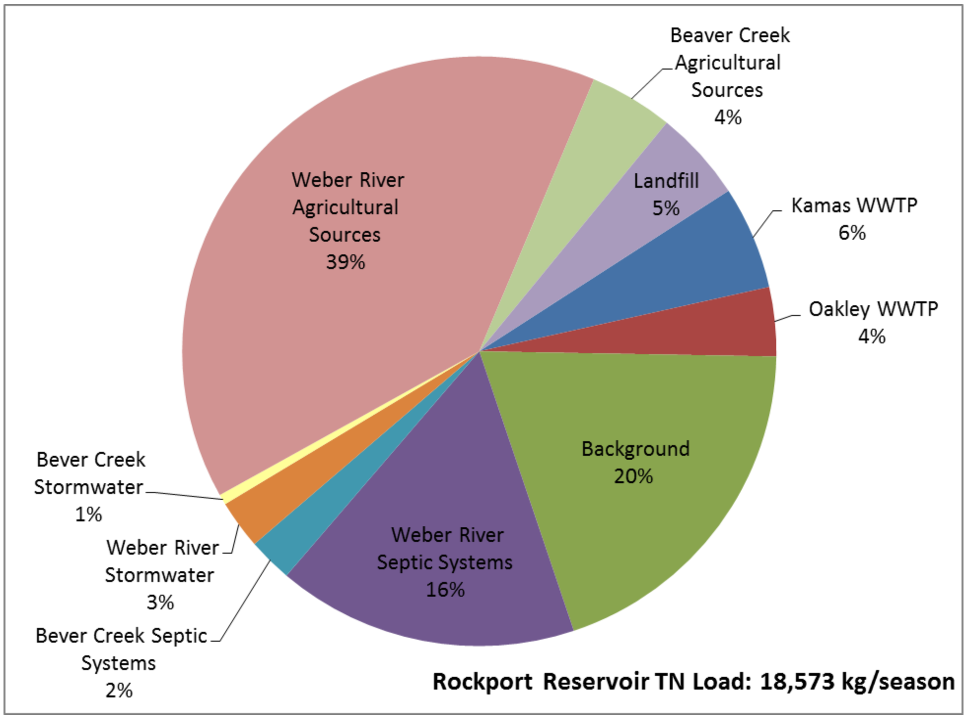

Figure 12. Proportion of summer season total nitrogen load associated with significant sources in the Rockport Reservoir watershed.

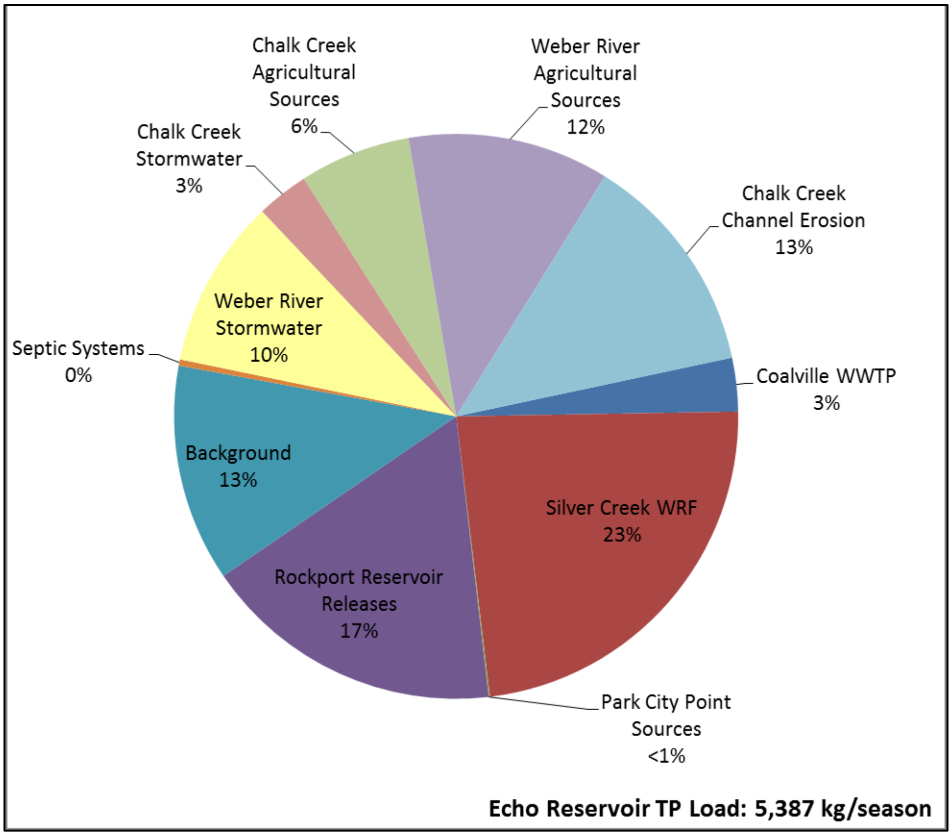

Figure 13. Proportion of summer season total phosphorus load associated with significant sources in the Echo Reservoir watershed.

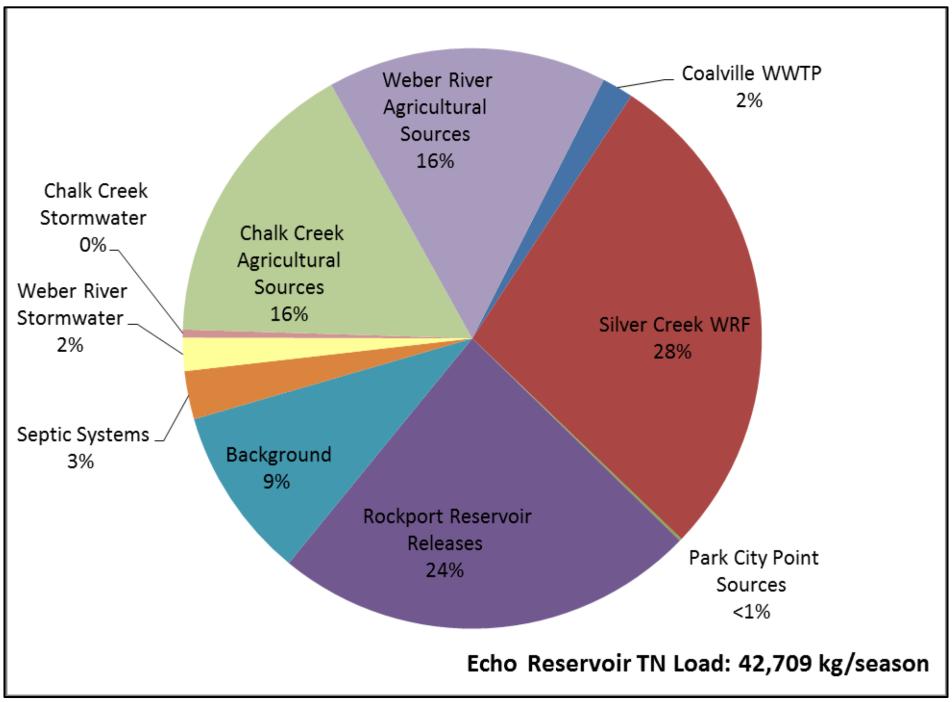

Figure 14. Proportion of summer season total nitrogen load associated with significant sources in the Echo Reservoir watershed

2.2. Load Reduction Estimates (element b)

The TMDL identifies the need to reduce nutrients, both nitrogen and phosphorus, by 35% to Rockport and Echo Reservoirs during the summer critical season (April–September). These load reductions are supported by BATHTUB modeling. Although the needed load reductions to Rockport Reservoir were found to be slightly less, the 35% reduction was applied because it is tributary to the Echo Reservoir watershed, which does require a 35% reduction. In addition, the TMDL includes an annual load allocation based on summer load reductions and current winter loads. Although winter loads are not currently contributing to the impairment in Rockport and Echo Reservoirs, the total annual loads will ensure that winter loads continue to be protective of water quality.

For Rockport Reservoir watershed, a 35% reduction translates to a reduction of the TP load of 818 kg TP/season and a load capacity of 1,519 kg TP/season. The target seasonal load corresponds to an average daily load of 8.3 kg TP/day. However, daily average could vary with hydrology over the season and is expected to be attained only on average over the course of the season. The target reduction for TN is 6,501 kg TN/season, also a 35% reduction. This reduction corresponds to a total seasonal load of 12,072 kg TN/season, or an average daily load of 66.3 kg TN/day during the season. As with TP, the daily value will vary and is expected to be attained as an average over the summer season (Table 16).

For Echo Reservoir watershed, a 35% reduction translates to a reduction of 1,885 kg TP/season (10.4 kg TP/day) and a loading capacity of 3,502 kg TP/season (19.2 kg TP/day). TN must be reduced by 14,948 kg TN/season (82 kg TP/day) with a load capacity of 27,761 kg TN/season (152 kg TN/day). Again, the daily value will vary and is expected to be attained as an average over the season. Load allocations for both point and nonpoint sources can be seen in Table 16.

Table 16. Summary of Maximum Total Phosphorus and Total Nitrogen Summer (April–September) Seasonal and Daily Loads for Attainment of Water Quality Standards in Rockport and Echo Reservoirs

	Total Phosphorus		Total Nitrogen	
	Average Season (kg/season)	**Average Daily (kg/day)**	**Average Season (kg/season)**	**Average Daily (kg/day)**
Rockport Reservoir				
Nonpoint source load allocation	952	5.2	6,853	37.7
Waste load allocation for point sources at current capacity	495	2.8	4,504	24.7
Waste load allocation for point sources future growth	72	0.4	716	3.9
MOS	–	06.32	–	–
Total load to reservoir	**1,519**	**8.3**	**12,072**	**66.3**
Echo Reservoir				
Nonpoint source load allocation	1,779	9.8	10,605	58.3
Waste load allocation for point sources at current capacity	1,237	6.8	12,238	67.2
Waste load allocation for point sources future growth	485	2.7	4,918	27.0
MOS	–	–	–	–
Total load to reservoir	**3,502**	**19.2**	**27,761**	**152.5**

For Rockport Reservoir watershed, a 24% reduction is required for both annual phosphorus and nitrogen loads. This reduction translates to a total allowable TP load of 2,541 kg TP/year, with 1,095 kg TP/year allocated to nonpoint sources and 990 kg TP/year allocated to points sources. The point source allocation for future loads is 456 kg TP/year. For nitrogen, the total allowable annual load is 21,141 kg TN/year with 7,608 kg/year allocated to nonpoint sources and 9,008 kg/year allocated to current point sources. The point sources allocation for future loads is 4,525 kg/year (Table 17).

For Echo Reservoir watershed, a 20% reduction is required for annual phosphorus loads and a 19% reduction is required for annual nitrogen loads. This reduction translates to a total allowable TP load of 7,403 kg TP/year, with 3,474 kg TP/year allocated to nonpoint sources and 2,473 kg TP/year allocated to points sources. The point source allocation for future loads is 1,455 kg TP/year. For nitrogen, the total allowable annual load is 61,712 kg TN/year, with 22,517 kg/year allocated to nonpoint sources and 24,440 kg/year allocated to current point sources. The point sources allocation for future loads is 14,755 kg/year (Table 17).

Table 17. Summary of Maximum Total Phosphorus and Total Nitrogen Annual Loads for Attainment of Water Quality Standards in Rockport and Echo Reservoirs

	Total Phosphorus	**Total Nitrogen**
	Average Annual (kg/year)	**Average Annual (kg/year)**
Rockport Reservoir		
Nonpoint source load allocation	1,095	7,608
Waste load allocation for point sources at current capacity	990	9,008
Waste load allocation for point sources future growth	456	4,525
MOS	–	–
Total load to reservoir	**2,541**	**21,141**
Echo Reservoir		
Nonpoint source load allocation	3,474	22,517
Waste load allocation for point sources at current capacity	2,473	24,440
Waste load allocation for point sources future growth	1,455	14,755
MOS	–	–
Total load to reservoir	**7,403**	**61,712**

When the total load is partitioned into point and nonpoint sources, attainment of water quality standards will require a 72% and 70% reduction in nonpoint phosphorus loads and a 68% and 87% reduction in nonpoint nitrogen loads from Rockport and Echo Reservoir watersheds, respectively. This percentage reduction incorporates the need for point sources to increase discharge rates due to population growth in the future and the recognition that a portion of the load capacity will be taken up by natural background sources. The resulting load allocation for nonpoint sources (excluding natural background) is 439 kg TP/season and 986 kg TP/season and 4,176 kg TN/season and 3,455 kg TN/season for Rockport and Echo Reservoir watersheds. The total allocated nonpoint source load is further allocated to individual nonpoint sources (Table 18; Table 19).

Table 18. Summary of Phosphorus Load Allocations for Nonpoint Sources (kg/season)

Subwatershed	Stormwater	Grazing Public	Grazing Private	Irrigation/ Fertilizer	Septic Systems	Channel Erosion	Three Mile Canyon Landfill	Upstream	Natural Background
Rockport Reservoir Watershed									
Beaver Creek	13	14	40	36	5	–	–	0	86
Direct Drainage Rockport	34	0	40	0	1	–	–	0	43
Lower Weber River	15	7	84	61	5	–	–	0	102
Smith and Morehouse	1	20	0	0	0	–	–	0	64
Upper Weber River	2	6	18	0	2	–	–	0	155
Weber Canyon	12	7	8	0	9	–	–	0	63
Total	**77**	**54**	**190**	**96**	**22**	–	–	**0**	**512**
Echo Reservoir Watershed									
Chalk Creek Mainstem	28	–	22	6	1	0	–	0	84
Direct Drainage Echo	17	–	18	5	0	0	–	0	28
Huff Creek	8	–	36	2	0	21	–	0	38
Silver Creek	124	–	65	16	1	0	–	0	37
South Fork Chalk Creek	11	–	33	2	0	158	–	0	89
Upper Chalk Creek	1	–	3	0	0	0	–	0	64
Weber River between Rockport and Echo	15	–	50	33	3	28	–	279	297
Total	**205**	–	**226**	**63**	**6**	**207**	–	**279**	**638**

Note: Load delivered to reservoir from each subwatershed for summer season (April 1–September 30).

Table 19. Summary of Nitrogen Load Allocations for Nonpoint Sources (kg/season)

Subwatershed	Stormwater	Grazing Public	Grazing Private	Irrigation/ Fertilizer	Septic Systems	Channel Erosion	Three Mile Canyon Landfill	Upstream	Natural Background
Rockport Reservoir Watershed									
Beaver Creek	34	35	100	134	143	–	–	0	986
Direct Drainage Rockport	72	0	236	0	247	–	292	0	516
Lower Weber River	41	13	157	171	172	–	–	0	632
Smith and Morehouse	1	379	0	0	0	–	–	0	907
Upper Weber River	6	174	502	0	161	–	–	0	2,208
Weber Canyon	36	328	359	0	384	–	–	0	892
Total	**190**	**928**	**1,354**	**305**	**1,107**	**–**	**292**	**0**	**6,141**
Echo Reservoir Watershed									
Chalk Creek Mainstem	12	–	359	90	26	0	–	0	1,811
Direct Drainage Echo	13	–	6	2	6	0	–	0	180
Huff Creek	3	–	70	4	0	23	–	0	459
Silver Creek	68	–	136	34	39	0	–	0	461
South Fork Chalk Creek	5	–	133	7	1	129	–	0	1,072
Upper Chalk Creek	2	–	192	10	0	0	–	0	1,378
Weber River between Rockport and Echo	17	–	386	257	70	111	–	1,245	1,797
Total	**121**	**–**	**1,282**	**403**	**141**	**263**	**–**	**1,245**	**7,158**

Note: Load delivered to reservoir from each subwatershed for summer season (April 1–September 30).

2.3. Recommended Implementation Measures and Critical Areas (element c)

2.3.1. Point Sources

Point sources of nutrients in the study watershed include four existing WWTPs, a fish hatchery, and a series of mine tunnels originating in the Park City area. Blue Sky Ranch is a new point source with planned discharge into the watershed. Francis WWTP is an existing non-discharging lagoon system that may convert to a discharging system in the near future. Available information on current plans to meet load reductions by these point sources is discussed below.

2.3.1.1. BLUE SKY RANCH AND RESORT

The Blue Sky Ranch and Resort aims to begin construction on a WWTP in 2014 in the lower part of the Silver Creek watershed. The state has issued a UPDES discharge permit (UT0025763) for the on-site

WWTP, designed to treat 30,000 gallons per day. This WWTP is not yet operational and has no discharge. When the development is complete, the plant will discharge directly into Alexander Creek, a tributary to Silver Creek. Under the permit, Blue Sky Ranch and Resort will receive offsets for phosphorus because the developers plan to remove all cattle grazing on the property. The Blue Sky Ranch and Resort WWTP will be allowed to discharge 0.03 MGD with 1.0 mg/L TP, reflecting the phosphorus offset, and 1.0 mg/L total ammonia as N as monthly averages. Based on this design, the total seasonal load would be 21 kg TP/season and 208 kg TN/season.

2.3.1.2. COALVILLE CITY CORPORATION WASTEWATER PLANT

Construction is currently underway on a new WWTP in Coalville, Utah. The new facility will use activated sludge treatment technology with nutrient removal based on a Modified Ludzack-Ettinger process. The new facility will be designed to achieve TN and TP concentration of less than 10 mg/L and less than 1.0 mg/L, respectively. Wastewater treatment will occur in two 0.3-MGD process trains for a total maximum monthly treatment of 0.6 MGD. The new facility is expected to be completed and online by February 2015 (personal communication, email from James Goodley, Project Engineer, JUB, to Andrew Myers, SWCA, December 19, 2013).

2.3.1.3. SILVER CREEK WASTEWATER TREATMENT PLANT

The Silver Creek WWTP is currently planning to upgrade and expand their facility to meet growth projections and load allocations in this TMDL. The plans to upgrade and expand are currently underway, with construction planned for 2016–2020 (personal communication, email from Mike Lures, General Manager, Snyderville Basin Water Reclamation District, to Andrew Myers, SWCA, November 25, 2013). The upgrade and expansion will include modifying the existing process for biological nitrogen and phosphorus removal by tertiary filtration and increasing treatment capacity from 2.0 to 4.0 MGD (personal communication, Erica Gaddis, SWCA and Craig Ashcroft, Carollo Engineers, December 16, 2013).

2.3.1.4. OTHER WASTEWATER TREATMENT PLANTS

At this time, there are no active plans for upgrades or expansion for the Kamas WWTP or the Oakley WWTP. The DWR Kamas Fish Hatchery implemented BMPs in 2003 that reduced nutrient loads, and no further upgrades are planned or needed to meet the waste load allocation for that facility.

2.3.1.5. JUDGE TUNNEL, SPIRO TUNNEL, AND PROSPECTOR DRAIN

Waste load allocations for Judge Tunnel, Spiro Tunnel, and Prospector Drain are held at current estimated loads. Very little water from these point sources is delivered to Echo Reservoir because it is lost to the subsurface in the Silver Creek channel. Therefore, no upgrades are required or planned for these three sources to meet the waste load allocations identified in the TMDL. However, plans for upgrades to the biocell treatment structure are in progress; these are associated with an EPA-directed Comprehensive Environmental Response, Compensation, and Liability Act removal action in the foreseeable future. These upgrades may reduce nutrient loads.

2.3.2. Nonpoint Sources

All future implementation measures and recommended BMPs discussed herein were taken from standard practices developed by the NRCS and EPA. Specifically, all stormwater BMPs were taken from the EPA's stormwater menu of BMPs (EPA 2012), and all other BMPs were taken from NRCS standard conservation practices (NRCS 2013) and the *Chalk Creek Watershed Coordinated Resource Management Plan* (CRMP; U.S. Department of Agriculture [USDA] 1994).

2.3.2.1. PRIVATE LAND AGRICULTURAL SOURCES

The load analysis indicates that agricultural and grazing activities on private land contribute to a large portion of both nitrogen and phosphorus loading to Rockport Reservoir and Echo Reservoir watersheds. The nonpoint source nature of these activities and their occurrence on private land pose a challenge for addressing loads in a comprehensive and successful manner and requires active engagement and interest by local private landowners.

2.3.2.1.1.Existing Implementation Measures in the Study Watershed

There are several past and current efforts that address nutrient loading from agricultural practices in the study watershed. One of the more extensive and successful approaches was the 1994 CRMP that occurred in the Chalk Creek subwatershed in the Echo Reservoir watershed. In 1997, the EPA approved the Chalk Creek CRMP submitted by the Utah Division of Water Quality (DWQ) as a TMDL for sediment, phosphorus, and habitat impairment. The CRMP recommends a variety of BMPs to address grazing and erosion, the implementation of which resulted in greatly enhanced water quality for the mainstem of Chalk Creek and also portions of the Huff Creek tributary. Specific BMPs employed to address grazing practices included prescribed grazing, livestock exclusion from waterways, fencing, trough/tank installments, range plantings, and brush management. Erosion BMPs include streambank protection, riparian forest buffers, filter strips, channel bank vegetation, plantings in identified critical areas, sediment basins, riparian exclosures, and stream channel stabilization. Additionally, irrigation practices were addressed though BMPs such as sprinkler irrigation, irrigation water conveyance pipelines, and general irrigation water management. Although implementation measures were carried out over 15 years ago, the success of the project continues to resonate as the Chalk Creek subwatershed presently exhibits improved water quality (Figure 15).

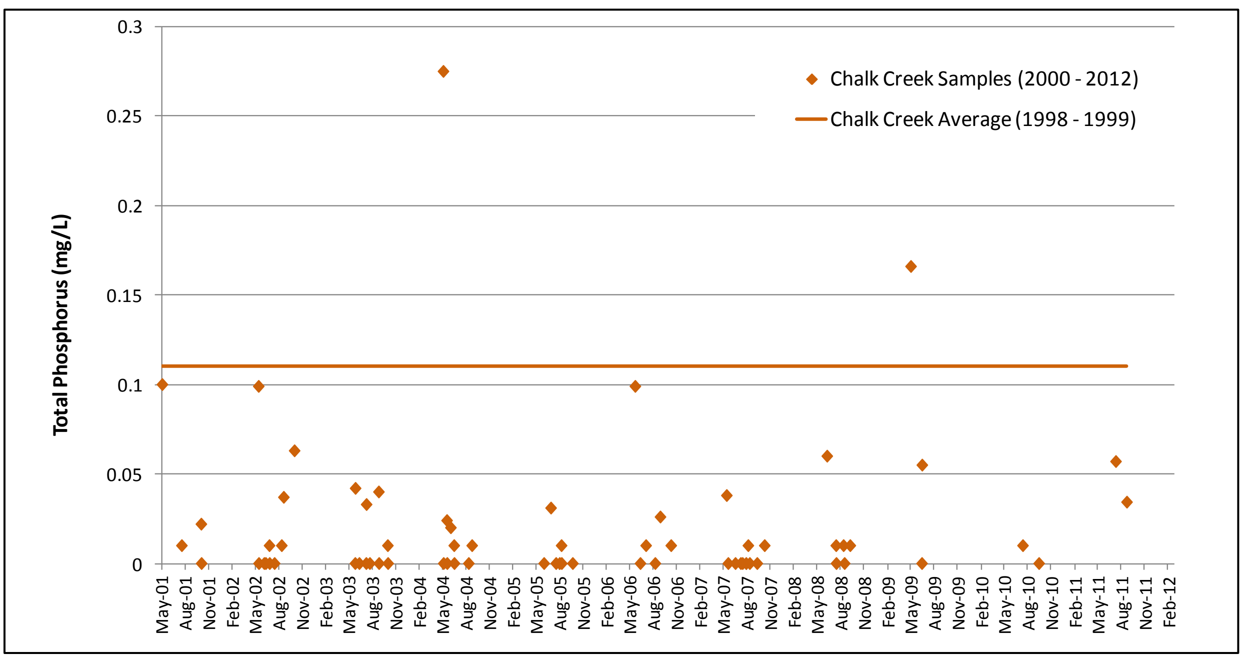

Figure 15. Average phosphorus concentrations in Chalk Creek from 1998 to 1999 versus present concentrations.

More recent efforts to address agricultural nutrient loading by Kamas Valley Conservation District (KVCD) and the NRCS are currently being conducted throughout various portions of the watersheds. Specific strategies include installing stream buffers, constructing fences around riparian zones, and stabilizing streambanks. In the South Fork Chalk Creek subwatershed, approximately 100 acres of land along the benches near the confluence of Fish Creek and South Fork have been converted from flood irrigation to sprinkler irrigation.

2.3.2.1.2.Future Implementation Measures

In addition to current efforts, there are several planned and proposed projects in place that will address nonpoint source pollution from agricultural activities. A CRMP has been funded by the Utah Department of Agriculture (UDAF) for the South Fork Chalk Creek subwatershed, and work will begin in 2014. The South Fork Chalk Creek subwatershed has been identified as being a significant contributor of both nitrogen and phosphorus as a result of grazing and channel erosion. The plan is still in its strategy development phase, but KVCD and UDAF will work closely with local landowners to implement the most cost-effective BMPs that address pollution as a result of agricultural activities.

Other planned efforts by the KVCD and NRCS include range management and erosion control on a portion of the mainstem Chalk Creek where overland erosion is occurring. The contributing area is approximately 1,000 acres and affects roughly 16,500 linear feet of stream. There are also plans by KVCD to develop watershed committees for the Middle and Upper Weber subwatersheds in the Rockport Reservoir watershed that would specifically address private land management strategies.

One of the larger planned efforts is the North Summit Pressurized Irrigation System occurring in the subwatershed of the Weber between Rockport and Echo Reservoirs. This is a collaborative project developed by a consortium of irrigation companies operating between Rockport and Echo Reservoirs (NSPIC 2010). The proposed plan would provide pressurized water to 380 users irrigating over 2,000 acres of farm and residential land. Currently, there are over 28 miles of unlined ditches in the valley (Figure 16), with 40% of the land using flood irrigation practices. Irrigation ditch companies divert an average of 9,500 acre-feet of water annually, with an estimated 40% loss due to evaporation, seepage, and return flow. The proposed system will replace ditches with 20 miles of pipeline (Figure 17) that enhance water efficiency for irrigators and act as a secondary system for Hoytsville Pipe Water Company. This system would decrease diversions by 3,800 acre-feet per year (Figure 18). Additionally, as a part of this project, private landowners are working with NRCS to convert approximately 800 acres to sprinkler irrigation. The construction contract for this project is tentatively scheduled to be awarded by March 1, 2014.

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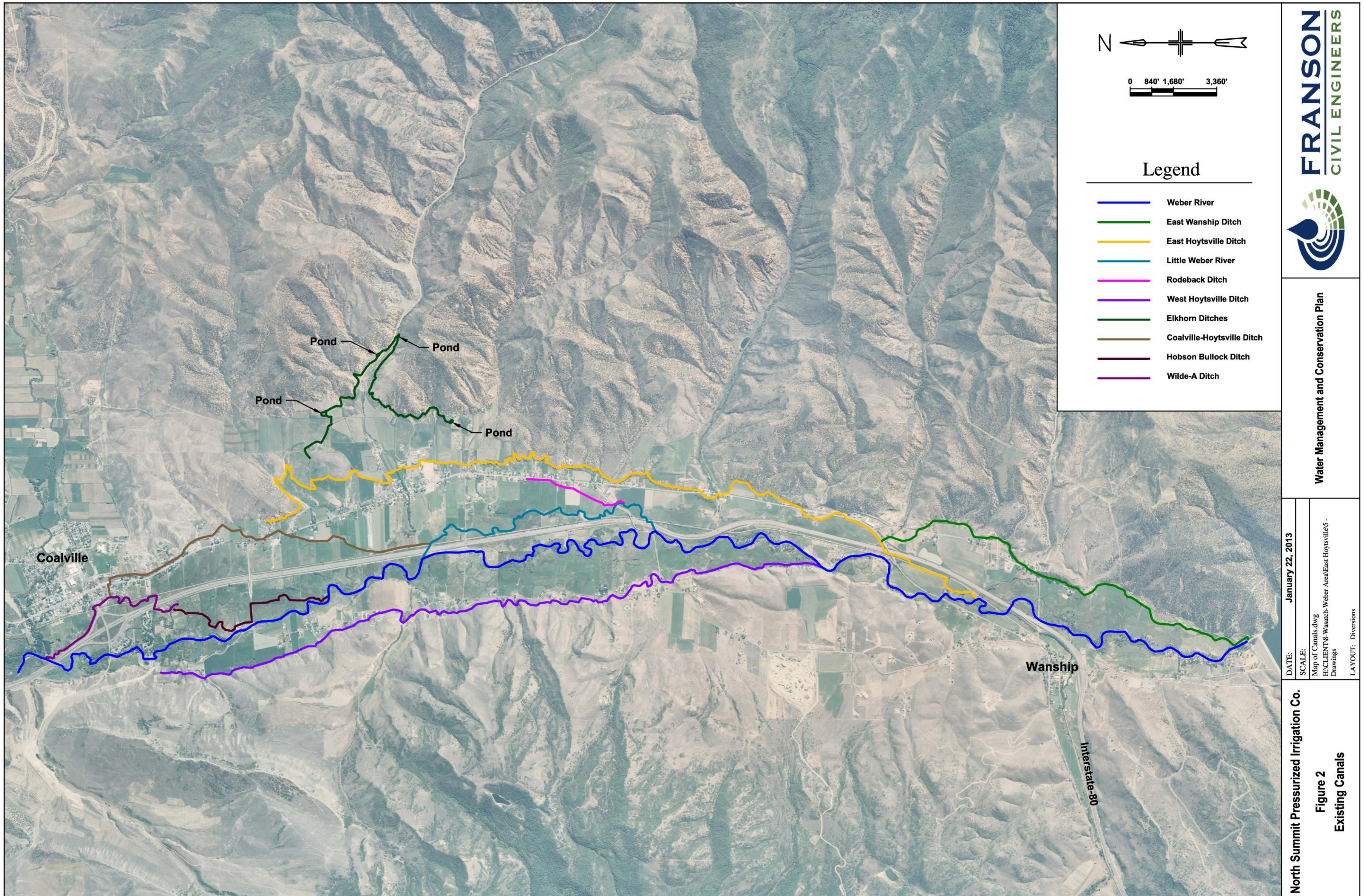

Figure 16. Existing irrigation ditch network in the valley between Rockport and Echo Reservoir watersheds (Source: Layne Jensen, Franson Civil Engineering, 2013).

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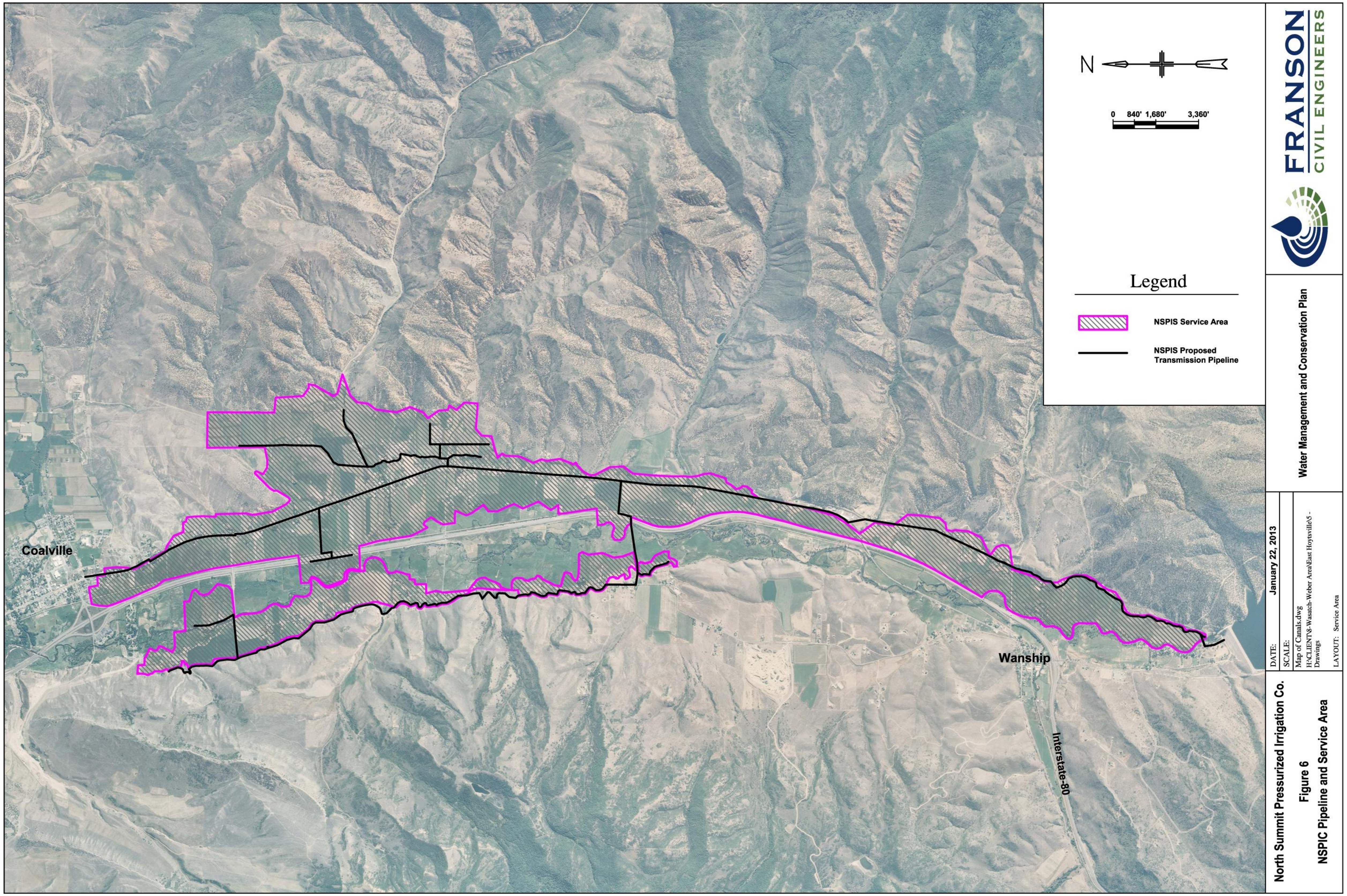

Figure 17. Proposed pipeline route and service area for North Summit Pressurized Irrigation System (Source: Layne Jensen, Franson Civil Engineering, 2013).

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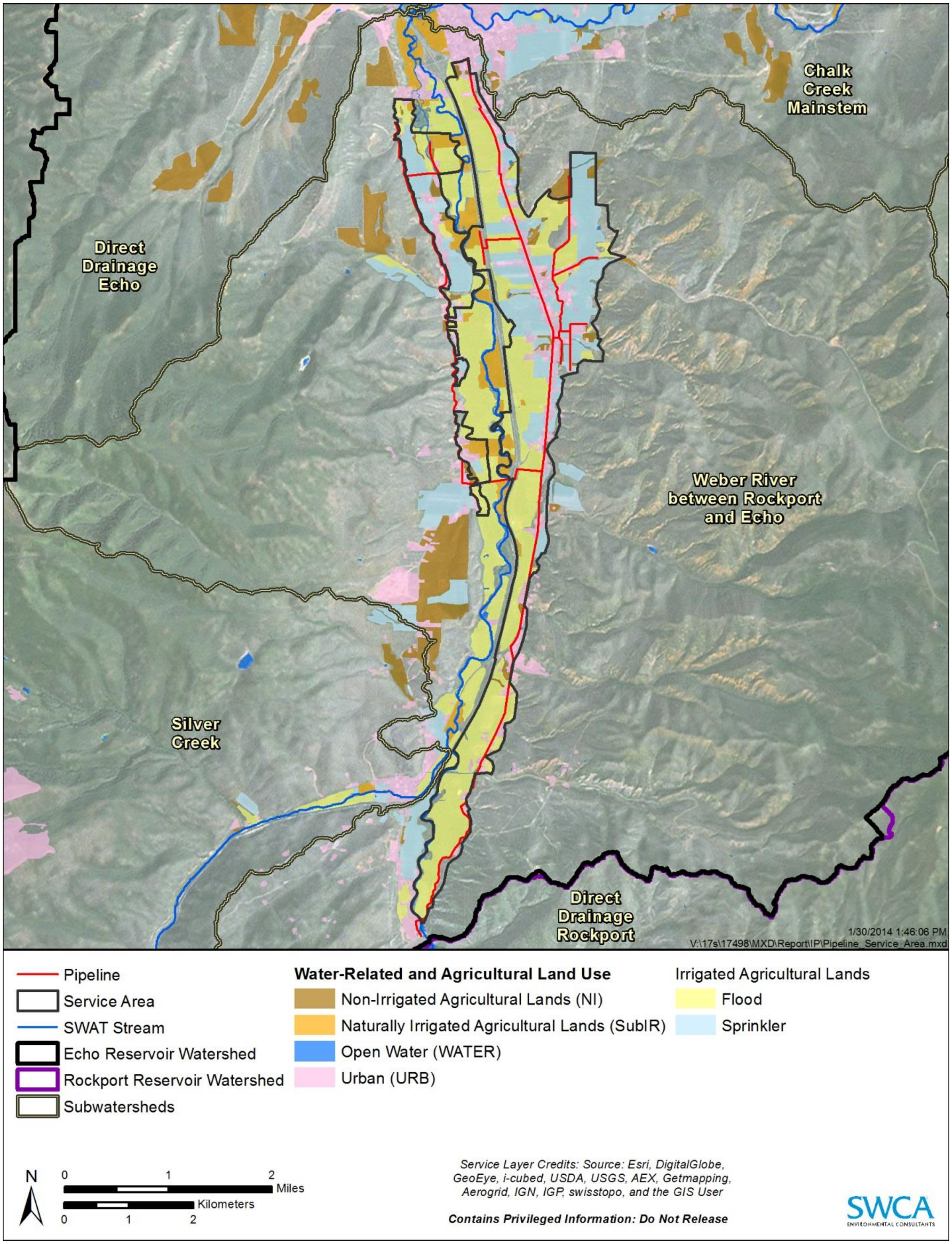

Figure 18. The Hoystville pipeline service area in relation to irrigated lands (Source: Layne Jensen, Franson Civil Engineering, 2013).

Reaching the target allocation goal will be a product of both current and future proposed strategies as well as additional nutrient reduction measures. Given the success of the Chalk Creek CRMP, it is recommended that a similar suite of BMPs be employed to other critical source areas. A comprehensive approach for implementing practices that address range management, riparian health, and irrigation/fertilizer application is critical for nutrient reduction success. Table 20 provides a list and description of those practices that have shown to effectively reduce nitrogen and phosphorus loading by 70% to 95%. It is recommended that approximately 69,243 acres and 228,182 acres be treated in Rockport and Echo Reservoirs using the BMPs listed below in order to achieve the target nutrient reduction.

Table 20. Recommended Implementation Measures for Agricultural Practices on Private Land

Agricultural Source	Acreage Needing Treatment	BMP	Description
Grazing	286,342	Prescribed grazing	Managing the harvest of vegetation with grazing animals to optimize landscape health
		Brush management	Managing and removing woody plants, including invasive and noxious species
		Range planting	Establishing adapted perennial and self-sustaining vegetation such as grasses, forbs, legumes, and shrubs
		Livestock exclusion	Excluding livestock from access to surface waters using fencing and rotational grazing
Irrigation	7,220	Sprinkler irrigation	Irrigating croplands through the more efficient use of sprinklers
		Irrigation ditch lining	Applying a lining of impervious material to irrigation ditches
		Irrigation water management	Determining and controlling the volume, frequency, and application rate of irrigation water in a planned and efficient manner
Fertilizer application	3,863	Nutrient management	Managing the amount, source, placement, and timing of fertilizer
		Riparian buffers	Creating an area of trees/shrubs located adjacent to and up gradient from waterways

2.3.2.1.3.Critical Areas

To attain the TMDL targets, implementation strategies should focus on those subwatersheds where the greatest nutrient loading is occurring and those areas where there is high nutrient loading per area. Fertilizer and irrigation practices primarily affect Beaver Creek, Lower Weber, and the Weber between Rockport and Echo Reservoir watersheds for both nitrogen and phosphorus loads. Private grazing is widespread throughout both watersheds; however, efforts should focus on the three previously mentioned subwatersheds as well as the direct drainage to Rockport, Weber Canyon, and South Fork Chalk Creek.

2.3.2.2. PUBLIC LAND AGRICULTURAL SOURCES

Grazing on public land represents a relatively small but important portion of nutrient loading to Rockport Reservoir. Almost all public grazing in the study watershed occurs in the Rockport Reservoir watershed (57,994 acres), compared to Echo Reservoir watershed (5 acres) (Figure 19), all of which are in the Uinta-Wasatch-Cache National Forest. Nutrient loading associated with public grazing is the result of animal waste being directly deposited into surface waters, manure transported from the landscape by surface runoff, and streambank erosion.

2.3.2.2.1.Existing Implementation Measures in the Study Watershed

The main management plans for the Uinta-Wasatch-Cache National Forest include the *Revised Forest Plan Wasatch-Cache National Forest* (USDA 2003) (name since changed to include Uinta National Forest), and the annual range operating plans for individual grazing allotments. The purpose of the revised forest plan is to guide all natural resource management plans for the forest based on desired future conditions. Similarly, individual annual range operating plans provide guidance specific for managing livestock grazing on public allotments.

The forest plan provides guidelines to encourage the management of healthy watersheds by maintaining the ecological integrity of aquatic ecosystems and supplying safe water for drinking and recreation (USDA 2003). Livestock grazing guidelines include forage utilization, adaptive management to attain desired conditions for vegetation and aquatic resources, and riparian habitat conservation.

The annual range operating plans vary by allotment but outline livestock management activities to protect the watershed and ensure future conditions. These plans include various management strategies such as forage levels to ensure adequate vegetation levels, which prevent accelerated erosion and sediment loss to surface waters; riparian value classes; grazing rotations; grazing capacity guidelines; and rules for how far salt should be placed from surface waters to reduce excessive time near water.

2.3.2.2.2.Recommended Implementation Measures for the Future

In conjunction with current efforts, the following BMPs are recommended to reduce pollution from excess nutrients resulting from grazing and to meet nonpoint source load reductions. The BMPs outlined in Table 21 represent various approaches with differing costs, and reported efficiencies between 70% and 95% N and P removal. Recommended BMPs range from prescribed grazing, which reduce grazing densities, to off-site water troughs, which limit animal contact with surface waters, to fencing that provides total livestock exclusion from surface waters. It is recommended that approximately 49,809 acres in Rockport Reservoir be treated using the BMPs listed below in order to achieve the target nutrient reduction.

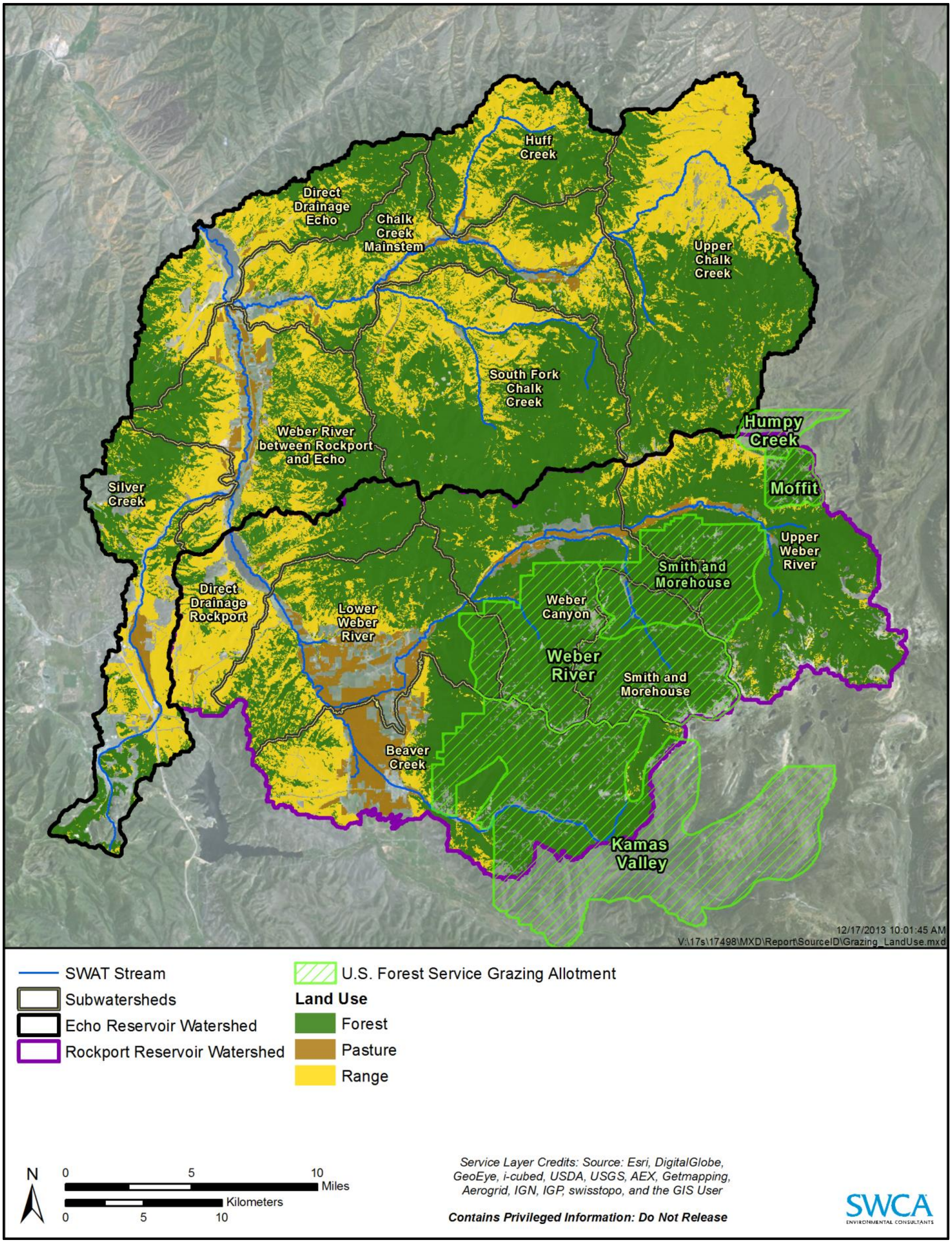

Figure 19. Grazing practices as a product of land use and land ownership in Rockport and Echo Reservoir watersheds.

Table 21. Recommended Implementation Measures for Livestock Grazing on Public Lands

Agricultural Source	BMP	Description
Grazing	Prescribed grazing	Managing the harvest of vegetation with grazing animals to optimize landscape health
	Fencing	Constructing barriers to prevent livestock from direct access to waterways
	Brush management	Managing and removing of woody plants, including invasive and noxious species
	Range planting	Establishing adapted perennial and self-sustaining vegetation such as grasses, forbs, legumes, and shrubs
	Stream crossing	Establishing stable stream access points and crossing to prevent excess damage from trampling to protect water quality and riparian areas
	Culverts	Providing stream crossings that exclude animals from surface waters while preventing excess damage from trampling to protect water quality and riparian areas
	Trough/tank watering	Providing artificial watering locations for livestock to avoid contact with surface waterways

2.3.2.2.3.Critical Areas

To attain the TMDL targets, implementation strategies should focus on those subwatersheds where the greatest nutrient loading is occurring, all of which are in the Rockport Reservoir watershed. According to an animal unit density analysis, the Kamas Valley and Weber River grazing allotments have the highest density of animal units per acre and stream foot (Table 22; Figure 20). Both allotments contain portions of the subwatersheds (Weber Canyon, Smith and Morehouse) that have also been identified as producing the highest nutrient loads (see Table 14 and Table 15).

Table 22. Animal Density by Allotment

Allotment Name	Allotment Area in the Watershed (acres)	Animal Density (animal units/acre/stream foot)
Rockport Reservoir Watershed		
Humpy Creek	973	0
Kamas Valley	25,299	$2.99*10^{-8}$
Moffit	2,747	0
Weber River	28,975	$2.85*10^{-8}$
Total	**57,994**	–
Echo Reservoir Watershed		
Humpy Creek	5	0
Total	**5**	–

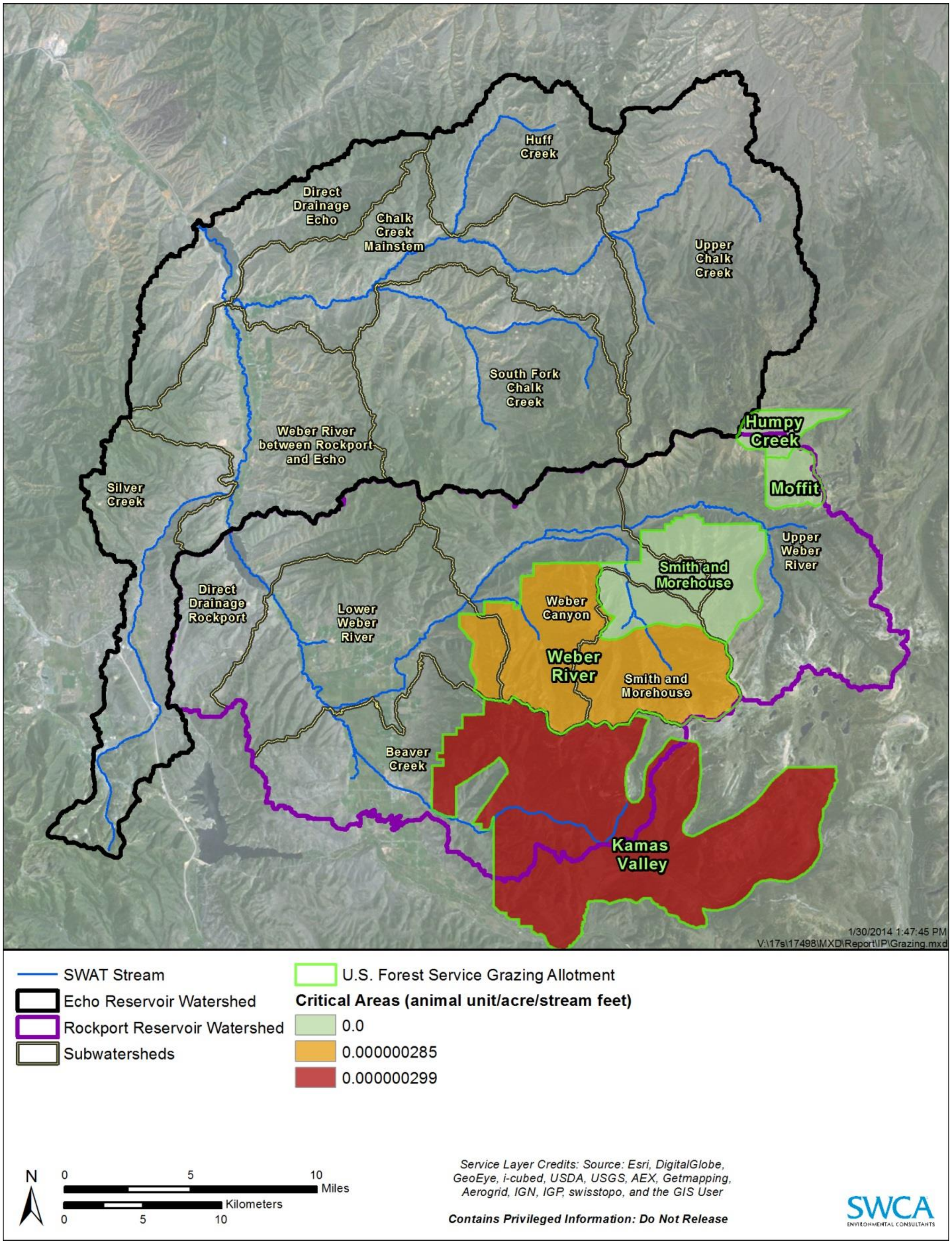

Figure 20. Animal unit density by USFS allotment.

2.3.2.3. STORMWATER

Stormwater is an important source of nutrient loads to both Rockport and Echo Reservoirs. Summit County, DWQ, and EPA are currently evaluating whether Summit County should be classified as a Municipal Separate Storm Sewer Systems (MS4). In the event that Summit County and Park City are designated as an MS4, stormwater will become regulated as a point source discharge, making it easier for loads to be managed and treated. However, due to the uncertainty surrounding this timeframe, it is recommended that nonpoint source nutrient load mitigation be performed at critical areas within the watershed in the interim.

2.3.2.3.1.Existing Implementation Measures in the Study Watershed

Current efforts to manage stormwater loads in the study watershed center on enforcement of the Summit County Erosion and Sedimentation Ordinance (Ordinance No. 381-A). The ordinance makes it illegal to perform any ground-disturbing activity (e.g., regrading or excavating) without first obtaining a Stormwater Pollution Prevention Plan (SP3) and Erosion Control Plan permits. Summit County also requires inspections to be completed before building permits are obtained. On lots greater than 1 acre, the owner or contractor must post a bond to revegetate disturbed areas. The SP3 and Erosion Control Plan require post-construction stormwater control for total suspended solids concentrations and erosion protection in the form of silt fence or straw wattle, erosion control blankets on steep slopes, and revegetation of all bare areas to 70% of background density. Additionally, on-the-ground inspectors watch for tracked dirt or misplaced erosion controls. Park City has recently focused on public and contractor education, as well as sampling/monitoring and implementing low impact development techniques (personal communication, Leslie Crawford, Park City, and Jake Diamond, (SWCA) on December 16, 2013). Park City is also currently working on a stormwater master plan that is planned to be available to the public in spring 2014 (personal communication, Erica Gaddis, SWCA, and Jim Blankenau, Park City, December 12, 2013).

The Utah Department of Transportation (UDOT) also has a stormwater management plan (SWMP) that is designed to limit the discharge of pollutants to UDOTs stormwater systems (UDWQ 2010). The plan addresses the following for Phase II designated areas and municipalities defined as those MS4s serving less than 100,000 people:

- Public education and outreach
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site stormwater runoff control (also for non-Phase II areas)
- Post-construction stormwater management in new development and redevelopment (also for non-Phase II areas)
- Pollution prevention/good housekeeping for municipal operations (also for non-Phase II areas)

Although current efforts are useful for reducing sediment loads associated with construction practices and stormwater from impervious surfaces, they do not directly address stormwater nutrient loads.

2.3.2.3.2.Future Implementation Measures

To achieve current load allocations for nitrogen and phosphorus to Rockport and Echo Reservoirs, it is recommended that additional measures be taken to reduce stormwater nutrient loads. Current sediment-control practices are beneficial for nutrient reduction because sediment is often a major source of phosphorus to receiving waterbodies. Additionally, present stormwater ordinances and practices are primarily aimed at reducing sediment loads from new development and construction. The recommendations outlined here supplement this approach by targeting existing developments and by specifically addressing nutrients loads in addition to sediment. The most effective measures for overall nutrient reduction are infiltration basins and trenches, as well as bioretention basins and wetlands. All of these aim to keep water on the land and reduce surface runoff. This helps to reduce mobilization of nutrients to waterways and also reduces instream erosion associated with flashy storm flows. A description of each of these measures is available at the EPA-sponsored BMP database and is summarized below (EPA et al. 2010).

Infiltration basins and trenches, bioretention (rain gardens), and wetlands are the BMPs with highest pollutant-removal efficiency. Other benefits to these practices include recharging groundwater, reducing peak flows, and providing habitat for wetland flora and fauna. Infiltration basins are generally shallow impoundments, whereas infiltration trenches are rock-filled trenches with no outlets. Infiltration basins can be designed as constructed wetlands by incorporating wetland plants into the shallow impoundment, offering both aesthetic value as well as improved pollution reduction. Rain gardens are landscaping features in small pockets of residential land uses that provide for on-site infiltration of groundwater. Another BMP option is the application of cementitious permeable pavement (CPP) to impervious surfaces within the watershed. CPP is a highly porous material with strength comparable to industrial cement that allows stormwater to infiltrate directly to the soil, reducing the need and size of additional stormwater control measures. CPP requires cleaning and maintenance to ensure that design permeability is maintained. Generally, these large-scale stormwater retention BMPs are recommended for high-density urban areas. In lower-density urban areas, it is recommended that fertilizer reduction and soil testing be employed to prevent unnecessary additions of nutrients to the soil, which are eventually mobilized to groundwater and surface water.

To achieve target nutrient reductions, it is recommended that 5,517 acres of developed lands in Rockport Reservoir watershed and 11,596 acres in Echo Reservoir watershed be treated using the BMPs listed above. More specifically, large-scale stormwater retention BMPs are recommended for 499 and 92 acres in the high-priority areas (see section 2.3.2.3.3) of Rockport and Echo Reservoir watersheds, respectively. Fertilizer reduction and soil testing are recommended for the 11,097 and 5,425 acres in the lower priority areas of Rockport and Echo Reservoir watersheds, respectively.

2.3.2.3.3.Critical Areas

The most critical areas for mitigating the effects of stormwater nutrient loads are high-density urban areas near or adjacent to the reservoirs or their major tributaries. A map of all urban areas in the study watershed is shown in Figure 21. The highest urban densities are also the areas with the greatest percentage of impervious surface, and thus the areas with highest priority for implementation measures. The I-80 corridor is a high-priority area because it runs parallel to Weber River between Rockport and Echo Reservoirs and does not currently have any stormwater retention infrastructure.

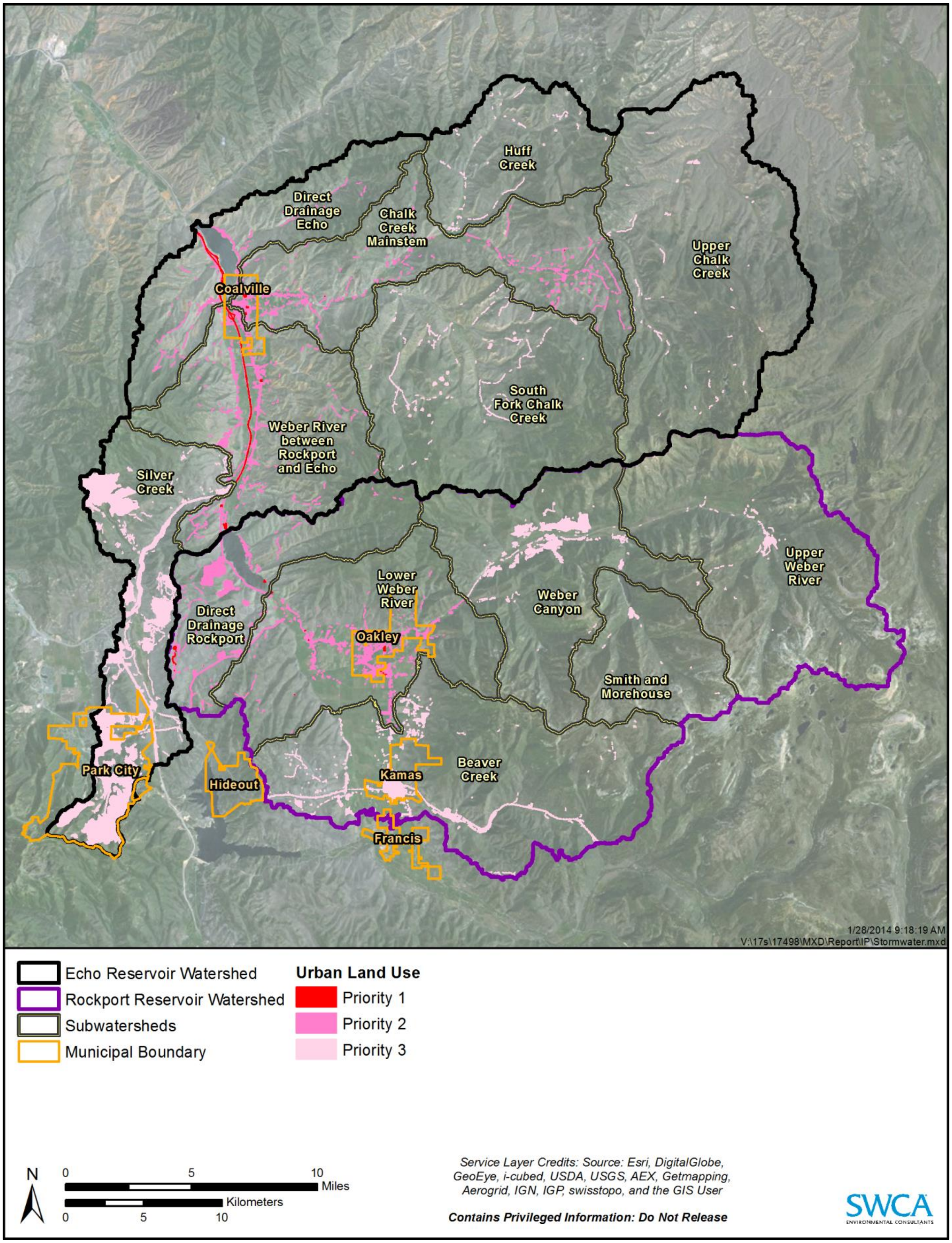

Figure 21. Critical areas for stormwater implementation measures.

2.3.2.4. SEPTIC SYSTEMS

Results from the load analysis show that septic systems represent a major load of nitrogen to Rockport Reservoir (19% of total load) and a lesser load to Echo Reservoir (3% of total load). Nitrate is a common and ubiquitous byproduct of on-site wastewater systems because conventional designs do not treat for it. Conventional leach fields are designed to provide processing capabilities for converting ammonium to nitrate. Nitrate is highly mobile, and once formed, it will leach into the subsurface landscape, which is often connected to surrounding streams, especially ones that are close by. More advanced systems will provide an anoxic processing step that allows for denitrification of nitrate, thus preventing it from reaching waterways.

2.3.2.4.1. Existing Implementation Measures in the Study Watershed

The SCHD permits on-site wastewater treatment systems as part of the building permit process. A new on-site wastewater policy was adopted in Summit County in 2013 that places more stringent criteria on the construction and use of septic systems. The seven new requirements covered in this policy are as follows:

- SCHD requires a percolation test ("perc test") for all operating septic systems. To pass the test, infiltration rates must not be greater than 1 inch per minute and not less than 1 inch per hour. SCHD will accept perc test results for a period of 2 years from the date the test was performed.
- At least one SCHD personnel must be present at all perc tests. Perc tests may only be scheduled by a certified tester.
- SCHD requires all on-site wastewater designs to be submitted by a certified level 2 or 3 designer or engineer.
- SCHD will not allow approved permits to be transferable to any other parties.
- SCHD will issue an on-site wastewater repair/remodel permit when a septic system is failing at a cost of $100 per permit.
- SCHD requires a residential home owner, with an on-site wastewater system applying for a building permit for the purpose of remodel/addition, to contact SCHD to determine if the existing system is adequate.
- SCHD requires that septic tanks be sized based on building square footage.

SCHD also provides information and education to homeowners about how to keep their septic systems working properly. The septic permitting process includes evaluating the soils at a site, reviewing and approving permit applications, and checking the installation of systems. However, there are not currently any rules or ordinances in place for the county to monitor and inspect septic systems on a periodic basis.

2.3.2.4.2. Recommended Implementation Measures for the Future

Although the new wastewater policy will reduce the number of failing septic tanks and generally improve overall wastewater disposal for new construction, it will not significantly reduce loads from existing septic systems nor will it control nitrate loads. This is because nitrate is a byproduct of the conventional septic system process, and without additional infrastructure, nitrate will continue to be produced even by properly functioning septic systems in the study watershed. This issue can be addressed for individual properties and at the subdivision or neighborhood scale. There are several advanced technologies available to homeowners for upgrading conventional systems, the selection of which may depend on local site specific conditions. Some examples include the following:

- Recirculating sand filter
- Anaerobic upflow filter
- Mounding
- Water separation system

Of these BMPs, several have already been installed and tested in Summit County. The recirculating sand filter system re-circulates septic effluent from the septic tank back through a pump tank for denitrification and has been extremely successful locally (personal communication between Ben Witt (Alternative Onsite Solutions) and Lucy Parham (SWCA) on January 28, 2014). Anaerobic upflow filters can also be coupled with systems to provide a denitrification processing step. Additionally the “mounding system” replaces the traditional septic system drain field and is useful in areas with highly permeable soils or down gradient of flood irrigation landscapes. It is recommended that these systems be installed in place of any conventional septic systems that are within 100 feet of a stream. Implementation of these measures will generally cost between $5,000 and $15,000 including maintenance over 10 years.

At the subdivision or neighborhood scale, cluster systems and/or sewering may be appropriate. A plan is in the works for the community of Hoytsville to be included in the Coalville sewer system; however, a specific timeframe has yet to be determined. Other recommended communities to sewer in both Rockport and Echo Reservoir watershed are listed below (section 2.3.2.4.3).

In addition to prioritizing and sewering communities, other recommendations include conducting a watershed-wide septic inventory and mapping exercise. This information could be used to create a planning database that the county could reference for identifying high-priority areas and further focusing remediation efforts. Figure 22 provides a step-by-step process for conducting an inventory and inspection protocol that can be used to create a database that will document progress and inform future mitigation strategies. More details for each step are provided after the figure.

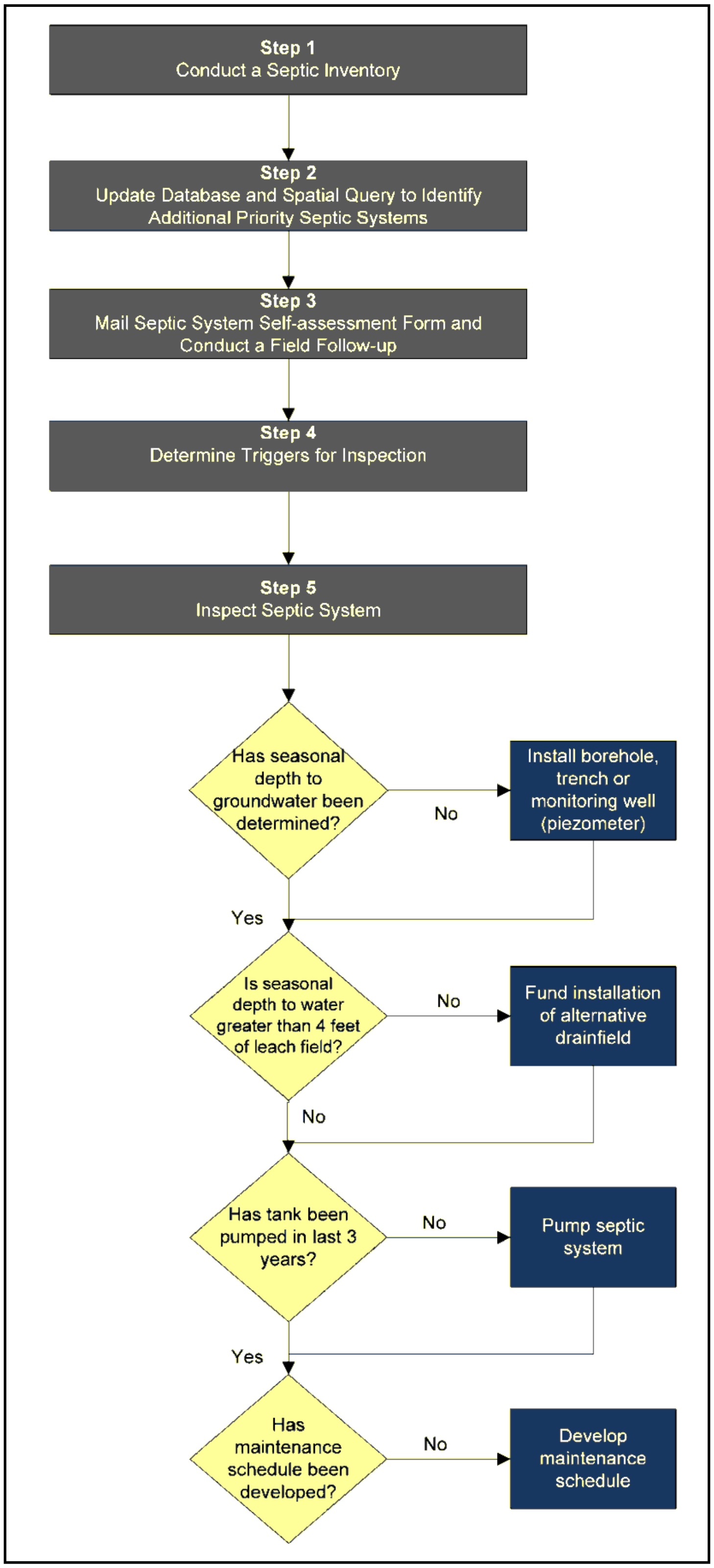

Figure 22. A systematic approach for developing a septic system inventory and inspection program.

Step 1. Conduct a Septic Inventory

A septic system inventory should be conducted and the county-wide database should be updated to include septic status, age, and priority for all existing septics in the study watershed. A preliminary septics database was obtained from Summit County and used for this implementation plan and TMDL but could be further updated in several ways. First, residences and businesses that have water-only utility bills could be correlated with the existing septic database to evaluate situations where occupancy and water supply are present, but where a septic system is not identified. Second, aerial imagery, combined with a geographic information systems (GIS) layer of known septic systems, could be used to identify developed parcels not already included in the database. Creating a septic tank inventory list would provide managers the information necessary to identify high-priority areas to focus project efforts and to maximize implementation effectiveness.

Step 2. Update Database and Spatial Query to Identify Additional Priority Septic Systems

Following the database creation and update, the next step would be identifying high-priority areas. An analysis has already been conducted using the preliminary database and includes the intersection of several GIS layers to identify the number and location of septic systems in priority areas based on three characteristics. These characteristics include septics within a 100 feet of streams, location within an irrigated landscape, and the age of septics (categorized as ≥ 20 years, 19–10 years, and ≤ 9 years). This initial analysis revealed that age is unknown for approximately 12% of the septics in the study watershed, 30 of which are located within 100 feet of a stream. Additionally, 87% of unknown septics are located within an irrigated landscape. Determining the age of these unknown septics should be a first priority in updating the current database.

Step 3. Mail Septic System Self-assessment Form and Conduct a Field Follow-up

Having homeowners complete a self-assessment septic form will further refine the septics database and identify high-priority areas. A septic system self-assessment form should be developed and mailed to land owners identified in Step 2. Initially, these mailings will focus on septic systems in critical areas that combine the three attributes: 1) within 100 feet of a stream, 2) within an irrigated landscape, and 3) older than 20 years. If the landowner does not complete and return the form, field visits will be necessary to assist the landowner in filling out the form.

Subsequent mailings should be sent to landowners that have septic systems that are in the next critical areas: 1) within 100 feet of a stream and 2) within an irrigated landscape, or 3) older than 20 years. Following these mailings would be mailings to landowners that have septic systems that are within an irrigated landscape and older than 20 years. Finally, mailings would be sent to all remaining landowners with septic systems.

Step 4. Determine Triggers for Inspection

A septic system inspection program should be initiated and would build on current protocol from the SCHD. Management is an important issue for the successful performance of any on-site septic system. Part of that management is having septic tanks inspected and pumped on a regular basis. The frequency of required maintenance will vary due to the capacity of the septic tank and water usage. Periodic inspections can determine the current conditions of the tank and whether maintenance is required to obtain proper functioning.

Inspection triggers would be determined from information gathered on the septic system self-assessment forms. Information that would trigger septic system inspections includes the following:

- The location of septic tank is unknown.
- The location of drain field is unknown.

- The depth to season high groundwater is less than 4 feet.
- The septic tank is undersized for the size of the household.
- The septic system is older than 20 years.
- There is an impermeable surface such as concrete, asphalt, or brick located over the drain field.
- Septic odors are present.
- Ponding or wastewater breakout is present.
- Burnt-out grass or ground staining is present over the drain field.
- Patches of lush green grass are present over the drain field.
- Pipes are exposed at or near the ground surface.
- Cracks or signs of leakage are present in risers and lids.
- There is an apparent cave-in or exposed component identified.
- The septic system was pumped/inspected over 3 years ago.
- The septic system is not permitted by Summit County.

Step 5. Inspect Septic System

This step includes a series of decision points used to evaluate the condition of the septic system. Using the information from Step 4, certain septic systems should be inspected. The first step in Step 5 is to determine if the seasonal high groundwater level has been determined. If not, a borehole, trench, or monitoring well (small 1-inch pipe, or piezometers) is needed. If the seasonal high groundwater level is less than 4 feet beneath the drain field, an alternative drain field should be designed and constructed. In addition to the alternative collection systems described in those references, water separation systems should be considered. One way to reduce septic system discharge is to reduce the volume of water passing through the system. This can be achieved by separating reusable water (e.g., showers, hand washing, sump pumps, and laundry) from highly contaminated water such as sewage. The next step is determining whether or not the septic tank has been pumped. The final step is determining a maintenance schedule for the septic system.

A successful and effective septic system management plan requires that the septic tank (or tanks) be accurately located on each property. This is particularly important for septic tanks in priority areas, as described above (e.g., within 100 feet of the stream, in irrigated areas). If the location of the septic tank (or tanks) is not known, a maintenance plan cannot be implemented. There are several methods available to locate a septic tank. The building permit for the home or the original septic system permit may show the location of the septic tank. If the septic tank is not shown on any permits, probes may be used to locate the tank. A probe (such as a metal rod) can be used to trace the pipeline from the house or by listening to the noise a plumber's snake makes when it contacts the tank inlet. Care must be used during probing to prevent damaging the inlet tees or piping. Another probing method used to locate septic tanks involves using a small diameter 0.5-inch galvanized pipe approximately 6 feet long and threaded to a garden hose. With the water turned on, the pipe is used to “jet” a hole into the ground and sound for the tank. If these methods fail, small radio transmitters can be used to locate the septic tank. The transmitters are flushed down the toilet, and a receiver is used to locate the transmitter inside of the tank. Once the tank is uncovered and opened, the transmitter can be retrieved.

Locating septic tanks can alert managers of improperly functioning systems or even illegal systems such as straight pipes. Creating an inventory and inspection, and developing a maintenance schedule of septic systems, can reduce nutrient loads without construction of new treatment facilities.

2.3.2.4.3. Critical Areas

The areas of greatest concern are those with high-density septic tanks close to streams and in flood irrigated landscapes. Older septic systems are also a priority for upgrades (Table 23). The series of maps below illustrates septic system locations and identifies proximity to stream (Figure 23), septics within an irrigated landscape (Figure 24), and septic system age (Figure 25). The last map (Figure 26) illustrates septics categorized by priority. There are 101 'very high priority' septics, defined as those within 100 feet of a stream, located in an irrigated landscape, and older than 20 years. There are 44 'high priority' septics defined as within 100 feet of a stream and within an irrigated landscape or older than 20 years. The 'medium priority' septics consist of those that are within an irrigated landscape and older than 20 years with a total of 1,995 systems throughout the study watershed. There are several communities in both Rockport and Echo Reservoir watersheds that should be prioritized for sewering or installing cluster systems. In the Rockport Reservoir watershed, Samak Country Estates, Samak Hills, and Samak Park located in the Beaver Creek subwatershed contain a total of 66 'very high priority' septics. Additionally, Aspen Acres and Pine Mountain subdivisions in the Weber Canyon subwatershed contain over 300 'medium priority' septics. In Echo Reservoir watershed, subdivisions to focus on would be Pine Meadow Ranch, Forest Meadow Ranch, and Silver Creek estates in the Silver Creek subwatershed which contain a total of 177 'medium priority' septics.

Table 23. Number of Priority Septic Systems

Subwatershed	Proximity to Stream (within 100 feet)	Irrigated Landscape	Septic Age (years)			Very High Priority	High Priority	Medium Priority	Critical Subdivisions
			0–9	10–19	≥ 20				
Rockport Reservoir Watershed									
Beaver Creek	88	583	80	163	325	67	21	301	Samak Country Estates, Samak Hills, Samak Park
Direct Drainage Rockport	0	125	35	33	44	0	0	43	Lake Rockport Estates
Lower Weber River	13	511	51	136	282	12	1	277	Weber Wild Estates
Upper Weber River	7	93	2	13	87	4	2	75	Alpine Acres
Weber Canyon	31	994	55	153	669	16	12	654	Aspen Acres, Beaver Springs Ranch, Hidden Lake, Pine Mountain Subdivision
Total	**139**	**2,306**	**223**	**498**	**1,407**	**99**	**36**	**1,350**	
Echo Reservoir Watershed									
Chalk Creek Mainstem	1	194	15	37	118	1	0	116	None identified
Direct Drainage Echo	0	6	0	5	22	0	0	4	None identified
Huff Creek	2	11	0	3	6	0	2	6	None identified
Silver Creek	2	556	105	187	268	1	1	246	Forest Meadow Ranch, Pine Meadow Ranch, Silver Creek Estates
South Fork Chalk Creek	0	6	0	2	4	0	0	4	None identified
Upper Chalk Creek	0	2	0	0	2	0	0	2	None identified
Weber River between Rockport and Echo	5	440	41	109	268	0	5	267	Wanship Cottage Sites
Total	**10**	**1,215**	**161**	**343**	**688**	**2**	**8**	**645**	

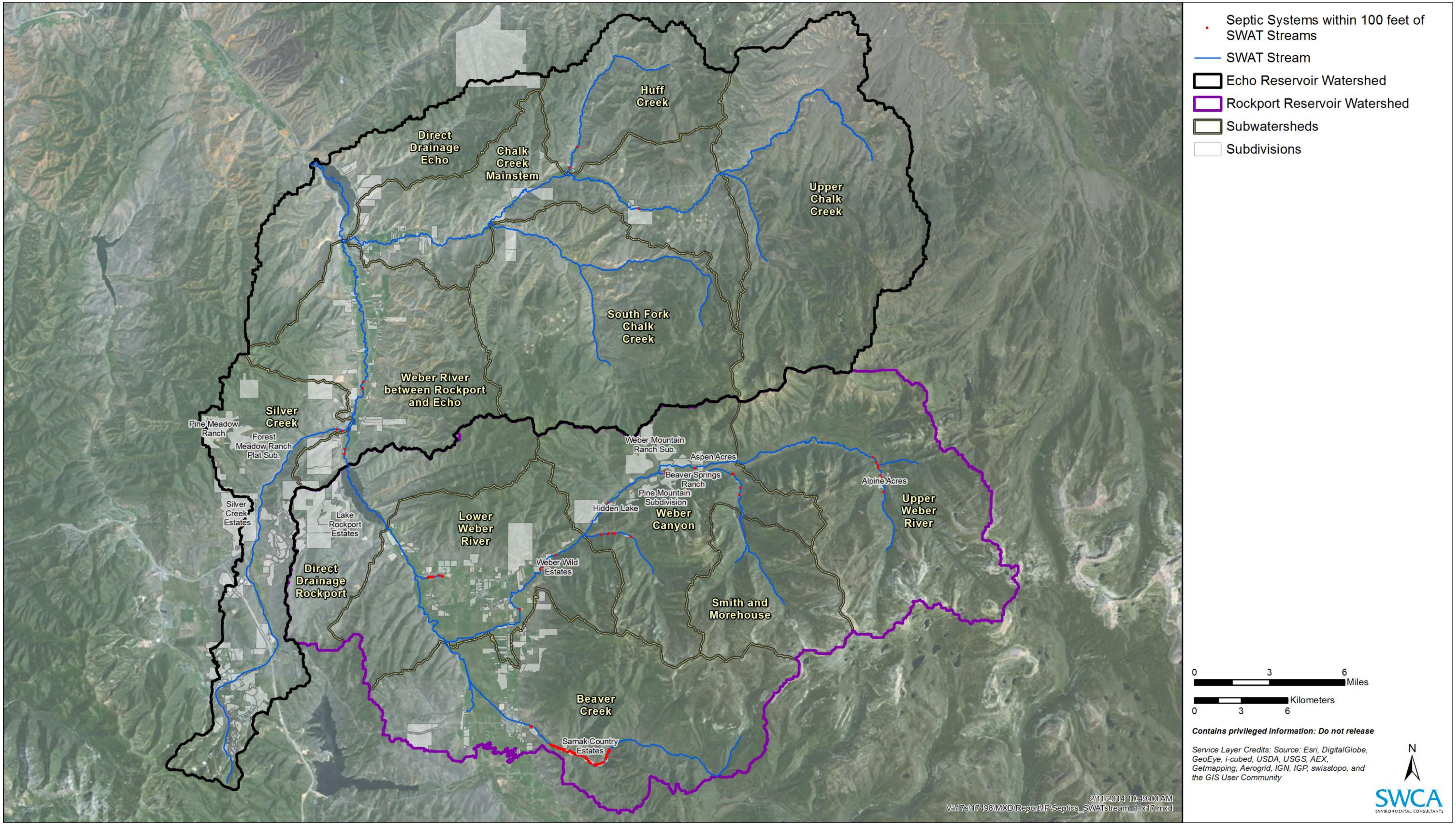

Figure 23. Septics within 100 feet of a stream. GIS layer available upon request.

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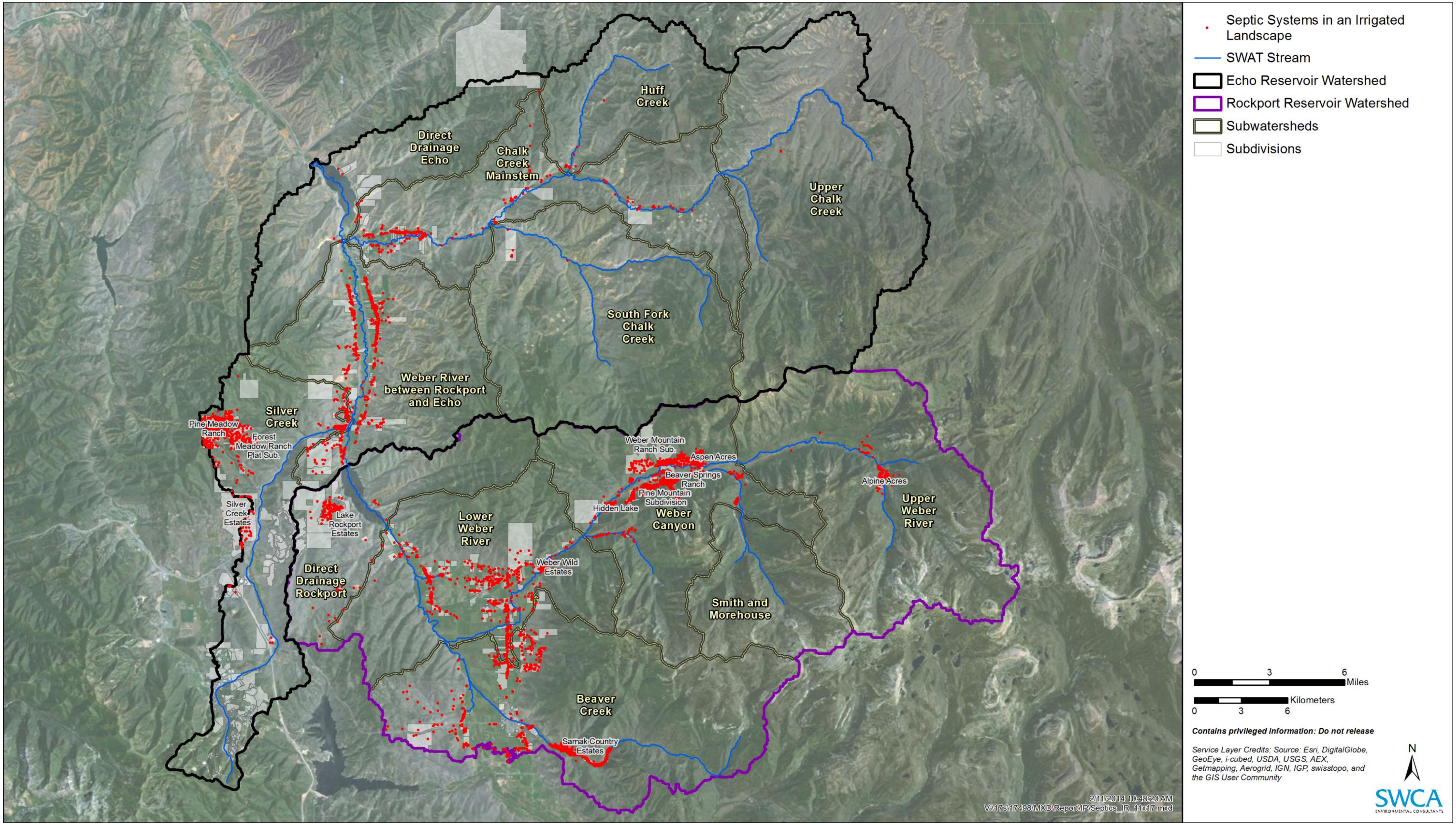

Figure 24. Septics within an irrigated landscape. GIS layer available upon request.

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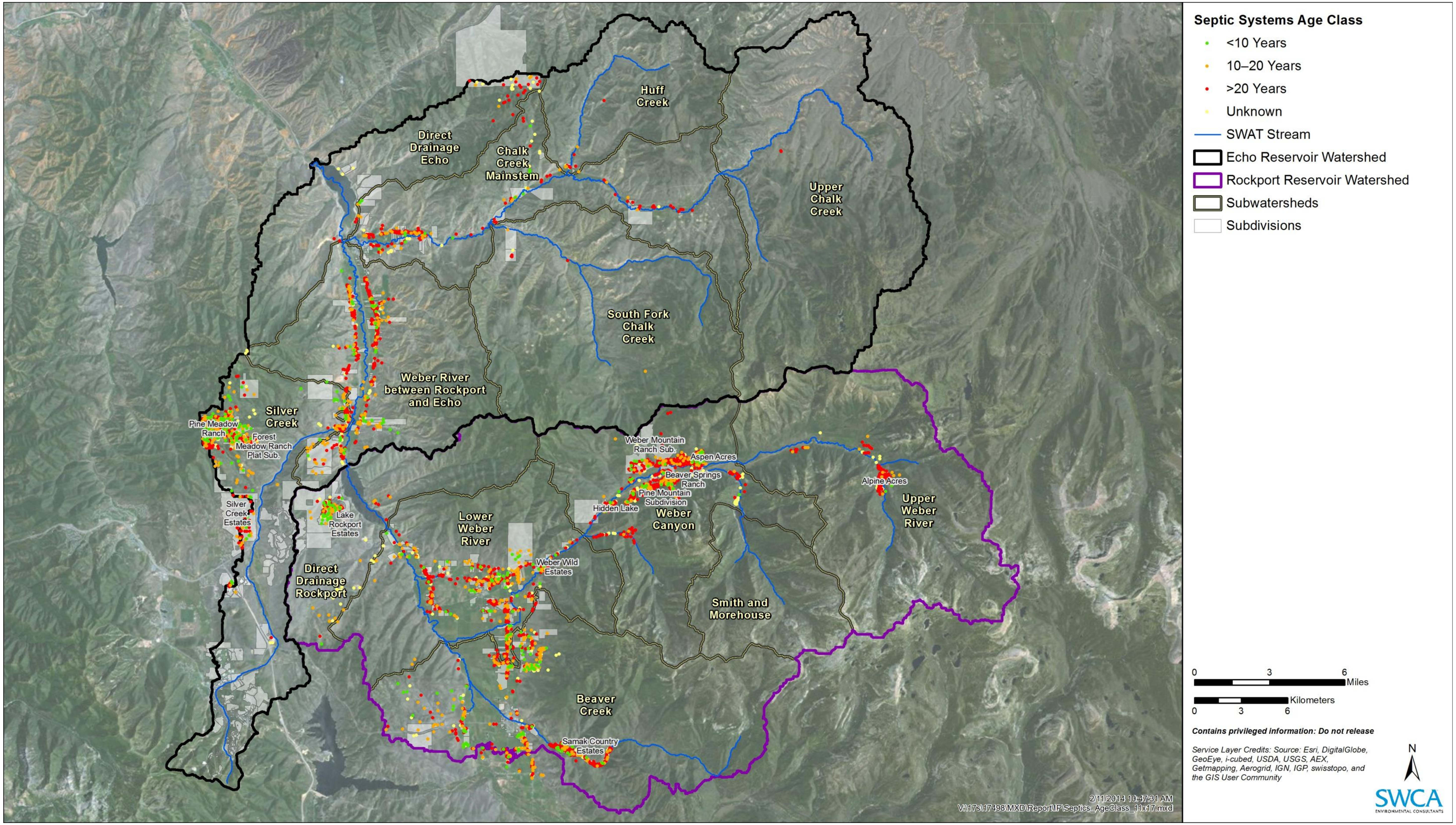

Figure 25. Septics age. GIS layer available upon request.

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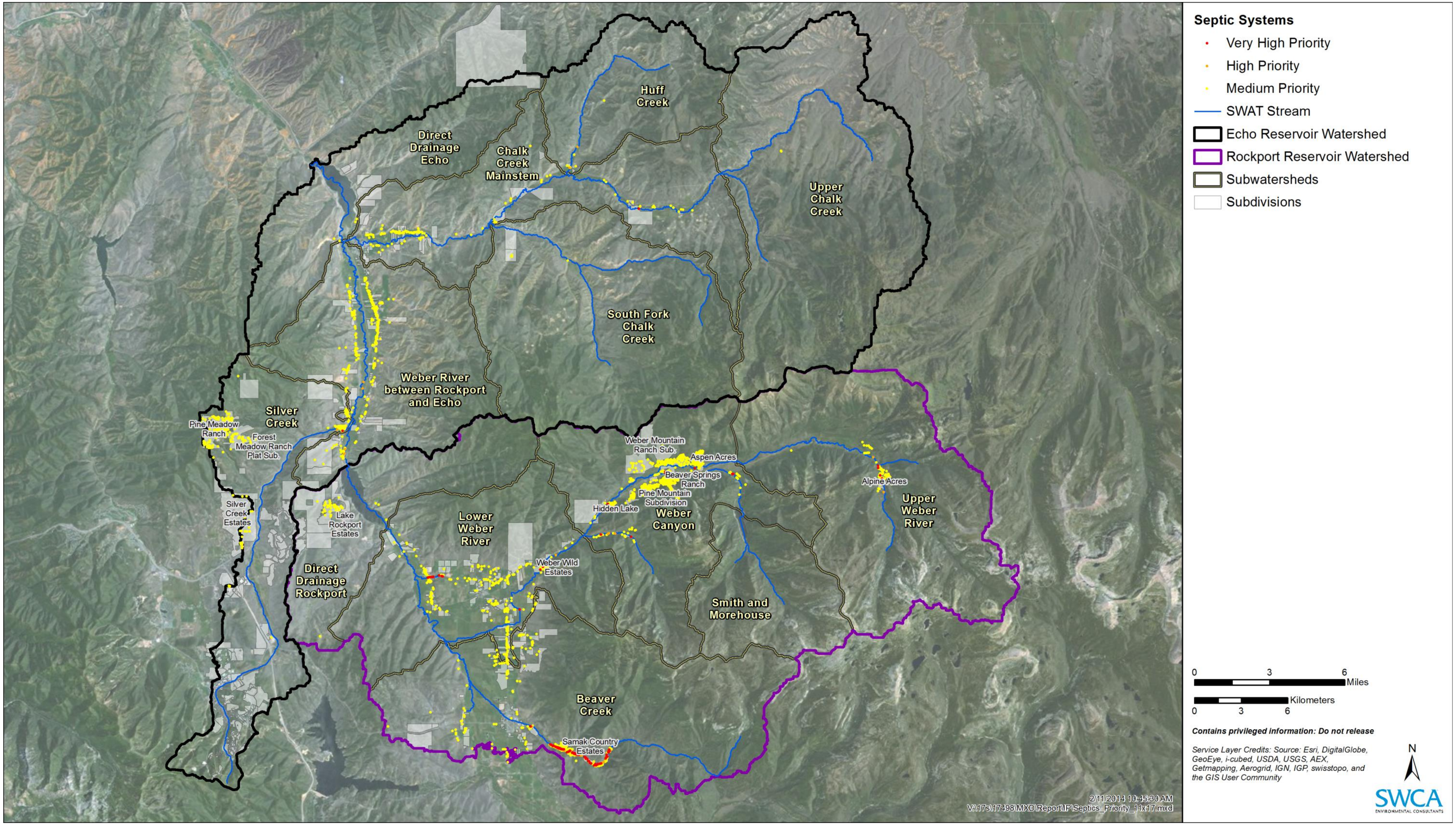

Figure 26. Septic priority. GIS layers available upon request.

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2.3.2.5. STREAMBANK EROSION

Channel erosion is the portion of total load associated with an increase in erosion beyond background sources. Although negligible in the Rockport Reservoir watershed, it represents approximately 6% of the TP and TN load to Echo Reservoir. Because this source is a result of both land management practices and stream channel health, there are a variety of measures available to reduce loading. Some of these measures are already included in the grazing management recommendations in previous sections.

2.3.2.5.1.Existing Implementation Measures in the Study Watershed

Many of the past and current efforts to reduce channel erosion are synonymous with those efforts being employed to reduce nutrient loading from agricultural lands. The aforementioned Chalk Creek CRMP greatly reduced sediment and nutrient concentrations through practices that protected riparian health as well as stream channel health. In addition to managing surrounding lands so that overland flow was reduced, techniques such as stream channel stabilization, channel vegetation, sediment basins, and grade stabilization structures were employed with great success. Current efforts by the KVCD and NRCS include enhancing the riparian zone and conducting streambank stabilization projects throughout various portions of the Echo Reservoir watershed.

2.3.2.5.2.Recommended Implementation Measures for the Future

Because phosphorus loading from South Fork Chalk Creek watershed is highest, the proposed CRMP for South Fork Chalk Creek (see section 2.3.2.1.1) will be immensely effective in reducing the total load. Erosion prevention practices that the plan will employ can be expected to have a similar impact as the CRMP in Chalk Creek. As was mentioned above, working with landowners to address overland erosion in mainstem Chalk Creek will also contribute to enhanced water quality. It is also recommended that the KVCD and NRCS continue to use BMPs such as those listed in Table 24 to further enhance water quality by reducing erosion and apply BMPs on approximately 701,977 feet of stream. The chosen BMPs have proven to be 75%–90% effective at reducing phosphorus loads. Of particular interest would be fencing riparian zones to allow regrowth because that has been reported to be successful in restoring stream health and is much needed, particularly in portions of lower Huff Creek and South Fork Chalk Creek.

Table 24. Recommended Implementation Measures for Agricultural Practices on Private Land

Best Management Practice	Description
Grade stabilization structure	Use a structure to control the grade and head cutting in natural or artificial channels.
Stream channel stabilization	Stabilize the stream channel particularly in areas of extreme down cutting.
Sediment basins	Construct a basin with an engineered outlet formed by an embankment to capture sediment laden runoff.
Riparian fencing	Fence off degraded riparian areas for a minimum of 5 years to allow regrowth.
Streambank protection	Use various treatments to stabilize and protect banks to improve stream corridor and maintain flow capacity.
Channel vegetation	Plant and cultivate a healthy vegetative community along the stream channel.

2.3.2.5.3.Critical Areas

Areas of concern for phosphorus loading from erosion are the South Fork Chalk Creek, Huff Creek, and the "Weber River between Rockport and Echo" subwatersheds in Echo Reservoir. Initial implementation efforts should focus in those three subwatersheds, particularly on any identified hotspots such as the streambank failure in South Fork Chalk Creek (Figure 27) and the lower part of Huff Creek where riparian vegetation is heavily degraded.

Figure 27. Streambank erosion occurring in the South Fork Chalk Creek subwatershed.

2.3.2.6. THREE MILE CANYON LANDFILL

Groundwater monitoring evidence from up gradient and down gradient wells is largely indicative of landfill-derived groundwater nutrient enrichment just 0.5 mile west of Rockport Reservoir. The load estimated from this source is 922 kg TN/season, and is probably the result of a lack of a designed liner and leachate-collection system.

2.3.2.6.1.Existing Implementation Measures

The Three Mile Canyon Landfill withholds runoff generated by storm and snow-melt events in an on-site evaporative basin, preventing any surface-water discharge to downstream waterbodies. It also uses litter fencing to prevent waste from being windblown outside of the landfill boundaries. Furthermore, Utah requires and specifies a groundwater detection monitoring plan for every landfill with a loading of more than 20 tons per day (Three Mile Canyon receives 135 tons per day; UDEQ 2008). If a landfill is found to have a statistically significant effect (through analysis of variance testing and an additional statistical test) on groundwater solute concentrations, then the owner must begin performing assessment monitoring, which is a more rigorous program than detection monitoring and requires the analysis of a greater number of solutes. Summit County has elected to perform the more rigorous assessment monitoring in their landfills. If assessment monitoring indicates that corrective action is necessary to prevent further pollution to groundwater, then the landfill must file a proposal for that corrective action that will

(A) be protective of human health and the environment;

(B) use permanent solutions that are within the capability of best available technology;

(C) attain the established ground water quality standard;

(D) control the sources of release so as to reduce or eliminate, to the maximum extent practicable, further releases of contaminants into the environment that may pose a threat to human health or the environment; and

(E) be approved by the Director. (Utah Administrative Code Title R315-308)

Groundwater well data are available for one well up gradient of the landfill and two wells down gradient of the landfill. Nitrate concentrations up gradient of the landfill are typically below detection limits (< 0.01 mg/L), whereas nitrate concentrations down gradient of the landfill range from 1 to 44 mg/L. There are no current corrective actions planned for this landfill.

2.3.2.6.2.Future Implementation Measures

Due to evidence indicating that the landfill is the cause of a statistically significant increase over background in multiple parameters, it is recommended that Three Mile Canyon take corrective action procedures as identified in Utah Administrative Code R315-308-3 and assess the most protective and permanent solutions for groundwater remediation. The solution could include a pump-and-treat method at wells down gradient of the landfill due to the prohibitive depth to the water table (greater than 50 feet) for other technologies, though bioremediation may also be feasible. Vegetative caps of closed cells could help reduce infiltration of water through the landfill. It is also recommended that contaminant fate and transport be modeled and/or monitored using predictions that maximize contaminant migration and consider impacts on the environment. In addition, it is recommended that any future disposal cells be lined and engineered for leachate treatment systems.

2.3.3.Reservoir Management

Although reducing external sources of nutrients to the reservoirs is the primary focus of the implementation plan aimed at ultimately improving oxygen conditions in the reservoir, there are also strategies that can be employed directly within the reservoir itself that will alleviate detrimental conditions. These would not replace nutrient reduction efforts but would supplement oxygen to the hypolimnion to further improve the health of the fishery. There are a variety of in-reservoir treatments that can facilitate aeration to increase oxygen concentrations in areas that are not supporting of fish habitat. In-reservoir treatments are only truly effective in the long term when they are combined with a reduction of external nutrient loads through the implementation measures outlined in the previous sections. No current in-reservoir treatments exist for either Rockport or Echo Reservoirs. Reservoir management could also be used to reduce erosion from the Weber River below Rockport Reservoir and to control the temperature and nutrient concentration of water released from Rockport.

2.3.3.1. RECOMMENDED IMPLEMENTATION MEASURES

2.3.3.1.1.Hypolimnetic Aeration

Hypolimnetic aeration aims to raise the oxygen level of the hypolimnion while preserving stratification (maintaining the thermocline), thus not releasing nutrients into the epilimnion (Cooke et al. 1993; Ryding and Rast 1989; Singleton and Little 2006). Oxygenation of anaerobic sediments disrupts the sediment-water interface and provides oxygen to microorganisms that break down organic sediments (Moore et al. 1996). This results in an increased sediment oxygen demand (SOD) for some time until organic sediments become saturated with oxygen and SOD levels taper off (Moore et al. 1996). In both Rockport and Echo Reservoirs, this process could provide immediate habitat and food supply for cold water fish species. Furthermore, aerobic sediments do not release iron-bound phosphorus. Hypolimnetic aeration is restricted to lakes deeper than 12–15 meters (Cooke et al. 1993).

Hypolimnetic aeration can be accomplished with the use of airlifts, diffusers, or injection of compressed air (Singleton and Little 2006). Medium bubble diffusers would provide sufficient oxygen transfer in Rockport and Echo Reservoirs, because the reservoirs are quite deep. The design of a hypolimnetic aeration system depends on the bathymetry of the reservoir, the extent of anoxia (across the reservoir during summer and winter), and specific project goals. The model developed by McCord et al. (2000) could be used to design an effective aeration system that maintains stratification in the summer and also prevents winter fish kills. Hypolimnetic aeration would enhance the cold water fishery habitat while external nutrient loading efforts in the watershed take effect. Aeration should be used primarily when the reservoir is stratified in the summer season. Aeration is only recommended where the deep hypolimnion experiences extended periods of anoxia, from the dam through the mid-lake.

2.3.3.1.2. Rockport Reservoir Releases

Dam release flow from Rockport Reservoir was investigated as a potential source of excessive erosion in the “Weber River between Rockport and Echo” subwatershed. Information provided by the Weber Basin Water Conservancy District (WBWCD) identifies that the highest and therefore most damaging flows occur every 3–5 years on average in conjunction with a large snowpack. Operationally, the only realistic solution would be to enlarge the size of the reservoir (personal communication, Scott Paxman, WBWCD, and Lucy Parham, SWCA, December 16, 2013), which is not financially or technically feasible at this time. Furthermore, these TMDLs are constructed around a normal flow year where dam release is less likely to cause instream erosion. However, avoiding large, fast releases during normal flow years when it is more feasible to regulate releases is a recommended strategy and will help to alleviate additional erosion. A second strategy would be to install a multi-level offtake structure that has the capability of releasing water from various depths. The existing structure releases from the bottom only and phosphorus concentrations in the bottom of the reservoir are higher, particularly during times of stratification.

2.3.4. BMP Implementation Summary

Below is a summary of recommended BMP suites by source as well as the potential combined effectiveness and the recommended units for application (Table 25). Those subwatersheds throughout both Rockport and Echo Reservoir watersheds that are currently contributing to higher loads are also highlighted. Generally speaking, within each identified subwatershed, landscapes (or septics) close to streams should be high priority for BMP implementation.

Table 25. Summary of BMP Application in Rockport and Echo Reservoir Watersheds

Nutrient Source	Recommended BMP Suite	Combined BMP Effectiveness		Required Units of Application	Critical Subwatersheds
		Phosphorus	Nitrogen		
Stormwater from high-density urban areas	Stormwater retention	20%–90%	30%–75%	591 acres	Direct Drainage Rockport, Silver Creek
Stormwater and fertilizer from urban areas	Soil testing and fertilizer reduction	45%–55%	45%–55%	16,522 acres	Direct Drainage Rockport, Silver Creek
Private land grazing and flood irrigation	Prescribed grazing, livestock exclusion, and fencing	70%–95%	70%–95%	3,795 acres	Direct Drainage Rockport, Weber Canyon, South Fork Chalk Creek
Private land grazing	Prescribed grazing, livestock exclusion, and fencing Sprinkler irrigation	80%–90%	80%–90%	286,342 acres	Direct Drainage Rockport, Weber Canyon, South Fork Chalk Creek
Private land fertilizer	Nutrient management planning and buffer strips	60%–80%	60%–80%	3,863 acres	Silver Creek, Beaver Creek, Lower Weber, and Weber between Rockport and Echo
Irrigation/fertilizer	Nutrient management planning, buffer strips, and sprinkler irrigation	80%–90%	80%–90%	3,425 acres	Beaver Creek, Lower Weber, and Weber between Rockport and Echo
Public land grazing	Prescribed grazing, livestock exclusion, and fencing	70%–95%	70%–95%	49,809 acres	Beaver Creek, Weber Canyon (Weber River and Kamas Valley Allotments)
Septic systems	Upgrades Sewering Inspection	30%–80%	40%–90%	1,834 systems	Direct Drainage Rockport, Weber Canyon, Silver Creek, Weber River between Rockport and Echo
Channel erosion	Streambank protection Grazing BMPs	70%–80%	60%–70%	701,977 feet	Weber River between Rockport and Echo, South Fork Chalk Creek, Huff Creek
Three Mile Canyon Landfill	Pump and treat Vegetative cap	100%	100%	1 landfill	Direct Drainage Rockport

2.4. Technical and Financial Needs (element d)

Successful implementation relies on various technical and financial needs as well as a strong foundation of plan sponsors that will be responsible for actual on-the-ground work. A thorough understanding of these needs is essential for creating a clear path forward that will ensure long-term operation and maintenance of management measures, information and educational activities, and monitoring.

Implementation of the management measures and BMPs necessary to meet the water quality goals outlined in the TMDL will require a significant allocation of financial and technical resources from multiple sources. Cost-benefit studies are recommended as a tool for identifying the most cost-effective strategies to prioritize throughout the study watershed. The implementation plan and costs outlined here (Table 26) are a general guide and are not intended to be a comprehensive list of costs associated with all potential BMPs or required resources. The estimated total cost for implementing recommended BMPs throughout Rockport and Echo Reservoir watersheds is $28,750,000. Costs were calculated with a non-linear generalized reduced gradient algorithm (Solver in Microsoft Excel 2010) that was set to minimize costs while also achieving required nutrient load reductions. Total costs were calculated as the average of the sum of the minimum and maximum costs for selected BMPs applied to the areas determined by the generalized reduced gradient algorithm. Total nutrient reductions were calculated as a weighted average of the minimum and maximum BMP effectiveness (see Table 25). Averages were weighted in a ratio of 5:2, maximum to minimum, and multiplied by the total nutrient load from each source. Final decisions on project implementation will be made by land managers and owners based on their intimate knowledge of specific areas of the study watershed.

Table 26. Summary of Financial and Technical Needs to Implement BMP Suites for the Rockport and Echo Reservoir TMDLs

Nutrient Source	Recommended BMP Suite	Technical Needs	Financial Needs	Estimated Government Portion	Estimated Private Portion	Project Sponsors	Sources of Potential Funding
Private flood irrigated agricultural land	Nutrient management planning, buffer strips, and sprinkler irrigation	Professional technical advisory on placement	$3,430,000	$2,286,667	$1,143,333	NRCS, KVCD, Summit County Conservation District (SCCD), private landowners, local irrigation companies	Environmental Quality Incentives Program (EQIP)/NRCS; 319/EPA WaterSMART/U.S. Bureau of Reclamation (USBR)
Private non flood irrigated agricultural land	Nutrient management planning and buffer strips	Professional technical advisory on placement	$230,000	$153,333	$76,667	NRCS, KVCD, SCCD, private landowners, local irrigation companies	EQIP/NRCS; 319/EPA
Public grazing land	Prescribed grazing, livestock exclusion, and fencing	Professional technical advisory on critical areas	$750,000	$500,000	$250,000	USFS	EQIP/NRCS; 319/EPA
Private grazing land	Prescribed grazing, livestock exclusion, and fencing	Professional technical advisory on critical areas	$4,350,000	$2,900,000	$1,450,000	NRCS, KVCD, SCCD, private landowners	EQIP/NRCS; 319/EPA
High-density urban area	Stormwater retention	Professional technical advisory on critical areas	$70,000	$46,667	$23,333	Summit County Engineering Department, Park City	EQIP/NRCS; 319/EPA
Low- and medium-density urban areas	Soil testing and fertilizer reduction	None	$330,000	$220,000	$110,000	Summit County Engineering Department, Park City	EQIP/NRCS; 319/EPA
I80 and US40	Stormwater retention	Engineering, permitting, maintenance	$2,400,000	$1,600,000	$800,000	Summit County Engineering Department, Park City	EQIP/NRCS; 319/EPA
Parks	Stormwater retention	Engineering, permitting, maintenance	$3,440,000	$2,293,333	$1,146,667	Park City, City of Coalville	EQIP/NRCS; 319/EPA
Stream channel erosion	Streambank protection	Engineering, permitting, maintenance	Varies	Varies	Varies	NRCS, KVCD, SCCD, private landowners, WBWCD	EQIP/NRCS; 319/EPA
Three Mile Canyon Landfill	Pump and treat	Engineering, permitting, maintenance	Varies	Varies	Varies	SCHD	EQIP/NRCS; 319/EPA

Table 26. Summary of Financial and Technical Needs to Implement BMP Suites for the Rockport and Echo Reservoir TMDLs

Nutrient Source	Recommended BMP Suite	Technical Needs	Financial Needs	Estimated Government Portion	Estimated Private Portion	Project Sponsors	Sources of Potential Funding
Septic systems	Upgrades	Engineering, permitting, maintenance	$13,750,000	$9,166,667	$4,583,333	SCHD	EQIP/NRCS; 319/EPA
Internal	In-reservoir treatment	Engineering, permitting, maintenance	$250,000–$1,000,000	$166,700–$666,700	$68,300–$333,300	WBWCD	UDEQ

2.4.1. Plan Sponsors and Resources

Stakeholders that will be involved in technical assistance and execution of the implementation plan include the following:

- UDEQ, DWQ
- Summit County Conservation District
- NRCS
- KVCD
- WBWCD
- SCHD
- Park City
- Summit County Engineering Department
- Snyderville Basin Water Reclamation District
- City of Coalville
- Local irrigation companies

Interagency coordination between local, state, and federal entities is an integral part of this implementation plan. NRCS along with KVCD and Summit County Conservation District (SCCD) will assist in coordination between the State of Utah and private landowners to address source issues on private land. For agriculture, BMP implementation is a voluntary, incentive-based program. Federal cost-share incentives are available through programs such as the NRCS Environmental Quality Incentive Program (EQIP) as well as EPA 319 funding that specifically address nonpoint sources. From a regional scale, U.S. Bureau of Reclamation offers WaterSMART funds to address improving efficiency and operation of a water delivery system such as the Hoytsville irrigation pipeline. Participation from private landowners, managers, and all stakeholders in the watershed is important to the successful outcome of this implementation plan.

2.5. Information and Education (element e)

2.5.1. Purpose and Approach

The purpose of the information and education component is to attain water quality standards through implementation of TMDL target nitrogen and phosphorus load reductions by educating the public and encouraging participation in the implementation plan. The methodology for this process is built on identifying various stakeholder groups and developing targeted outreach strategies that will be most effective for encouraging groups to participate. Within each target audience, related sources are identified and solicitation strategies such as outreach, training, information, and assistance to specific demographics throughout the Rockport and Echo Reservoir watersheds are presented.

2.5.1.1. PRIVATE LANDOWNERS

Given that agricultural-related nonpoint source pollution is the biggest contributor to nutrient loading in the study watersheds, successful engagement of private landowners has the potential to significantly reduce nutrient loading. The NRCS field office in Coalville in conjunction with KVCD continues to have a strong presence with private landowners in several of the Rockport and Echo subwatersheds. It is recommended that they continue to target an audience that consists of individuals who own land that is used for grazing and/or crop production, particularly those that have land directly adjacent to surface waterways and are not currently engaged in suitable land use practices. Furthermore, conducting a survey of streams where cattle have direct access to waterways and focusing implementation efforts there will increase the likelihood of restoring stream health. The objective of this goal is to educate agricultural managers on good land stewardship using appropriate BMPs, resources available to them to make improvements, and also on the potential watershed degradation caused by poor land use practices.

2.5.1.2. AFFILIATES OF THE AGRICULTURAL INDUSTRY

In addition to private agricultural landowners, there is also a need to focus on individuals that have contact or relationships with the greater agricultural community in the study watershed (extension agents, veterinarians, Future Farmers of America, county commissioners), specifically local conservation districts such as KVCD and SCCD. KVCD and SCCD have the capacity to expand outreach to communities in which they already have established working relationships. Regional agricultural affiliates should be included on planning and outreach committees to broaden the networking of education and outreach to individual agricultural operators. Developing and delivering an education program to affiliates of the agricultural industry concerning effective local BMPs would go a long way in reaching individual private landowners.

2.5.1.3. CONTRACTORS AND BUILDERS

Individuals responsible for the day-to-day operation of construction sites or other building projects in the study watershed have great potential to affect nutrient loading rates from stormwater runoff. The objective here would be to educate these individuals (contractors and builders) about BMPs that minimize the potential stormwater impacts during development and construction. Conducting local training sessions for contractors and builders on stormwater BMPs and assembling and distributing literature that highlights major sources and transport mechanisms will increase awareness.

2.5.1.4. RESIDENTIAL OUTREACH

Citizens living in suburban and urban areas should also be targeted and educated about nonpoint source pollution, particularly with regard to fertilizer use and pet waste. Both factors contribute to nutrient loading by storm runoff, but can be effectively managed with proper educational outreach. Focus should be placed on residents managing lands adjacent to streambanks or the stream channel itself, and whose actions or inactions have a direct impact to the water quality of the stream.

Educational seminars and informational brochures emphasizing proper fertilizer use, disposal of grass clippings, and pet waste disposal should be distributed locally. Distribution of free soil tests would also be helpful with the aim to reduce unnecessary fertilization of urban lawns. City ordinances implementing pet waste management at local parks would be beneficial. Additionally, park signage should be used to designate where dogs are prohibited, where waste must be recovered, or where dogs can roam freely. In areas where dog waste must be recovered, cleanup stations should be provided for park visitors.

2.5.1.5. SEPTIC SYSTEM OWNERS

Encouraging homeowners to participate in an inventory, inspection, and upgrade plan for septic systems throughout the subwatersheds will be helpful for reducing septic load contribution. The systematic approach described in section 2.3.2.4.2 will make it easier to organize and increase participation among local watershed residents.

2.5.1.6. SUMMIT COUNTY HEALTH DEPARTMENT/COUNTY COUNCIL

SCHD currently plays a large role in providing information to local residents on septic system upkeep and possible alternative solutions. They work closely with the county council to make decisions about possible solutions regarding septics regulations as well as ultimately overseeing actions at the landfill. Watershed managers would work closely with SCHD and the city council to ensure that they are adequately informed on the implementation process and also to present new ideas and solutions that could be put into action.

2.5.1.7. LOCAL SCHOOL EDUCATION PROGRAMS

Educating and involving future residents of the watersheds surrounding Rockport and Echo Reservoirs about watershed health is important for the continued success of implementation efforts. Visiting local schools and presenting data in a fun and creative way can generate excitement and ownership of local water resources. Encouraging the use of online applications such as EPA's "How's My Waterway" would be one method for encouraging budding environmentalists.

2.5.1.8. TOURS OF SUCCESSFUL RESTORATION/ENHANCEMENT PROJECTS

The target audience for this goal consists of citizens of the study watershed who may be interested in volunteering time or property for future restoration projects. The objective of this goal is to increase awareness and benefits of stream restoration projects. There are several successful implementation projects conducted by private agricultural land owners in conjunction with KVCD and NRCS that could be used as an example of proper land use practices. The successful projects along Chalk Creek would make a great tour for landowners in other parts of the watershed and would also provide an opportunity for landowners to exchange concerns and experiences with one another directly.

2.5.1.9. LOCAL WATERSHED GROUPS

Local watershed groups can provide a platform for organizing citizens in the region to conduct implementation and for acting as a centralized housing unit for watershed data and regulations specific to the Rockport Reservoir and Echo Reservoir watersheds. Organizing and centralizing information is crucial for conducting a concerted and successful effort.

One strategy would be to create watershed committees that consist of stakeholders and local community leaders, particularly for subwatersheds that have been identified as a critical area for nutrient loading. This committee could then act as a vehicle for developing specific strategies, conducting implementation work, and monitoring results.

2.5.2. Create the Message

Although specific targeted messages will be developed for each stakeholder group, there are primary messages that will be distributed across all audiences. The following are the primary messages that will be communicated throughout all information and education plan efforts:

- Excess nutrient loading to surface waters contributes to DO impairments observed in Rockport and Echo Reservoirs.
- Nitrogen and phosphorus load reductions rely on both point and nonpoint source management measures.
- Watershed residents must work together and become good stewards of the land to overcome nutrient loading issues.
- Information concerning all watershed activities should be made accessible to watershed residents online.
- Those entrusted with oversight and regulation authority will be trained to provide accurate land use and watershed information to the public.

2.5.3. Distribute the Message

A variety of methods are available for successfully distributing messages throughout the watersheds. Workshops, trainings, informational materials, presentations, and lectures are all ways to engage local stakeholders and successfully deliver both primary and secondary messages related to pollution management. Specifically, developing brochures that condense the issue and relay it in a way that is easy for watershed residents to digest will be a critical component for successful implementation. In the East Canyon Reservoir watershed, distributed educational material was produced that creatively and simply illustrates the impairment and provides strategies and contact information for concerned citizens. This grass-roots approach is relatively inexpensive but can be hugely effective for mobilizing residents. Implementation becomes most effective when stakeholder groups work together to identify and execute practices that are agreeable to all parties. Successful efforts such as those of the KVCD, SCCD, and NRCS in reaching out to private landowners to encourage proper land use are essential for achieving information and education goals.

2.6. Implementation Schedule (element f and g)

To ensure that water quality targets are attained, a series of milestones and a schedule for their completion are necessary to track progress as implementation is carried out in the study watershed. Identified milestones and the corresponding schedule are presented in Table 27.

Table 27. Implementation Milestones and Schedule for the Rockport and Echo Watersheds

Implementation Tasks	Indicator	Milestone (short term–2016)	Indicator (medium term–2019)	Target Completion Date (long term–2023)
GOAL: Reduce Stormwater Contribution to Impairment				
Treat approximately 17,000 acres in the study watershed with stormwater BMPs	Number of acres treated	1,700	8,500	17,000
GOAL: Assist Private Landowners in Obtaining Funding to Implement Specific Recommendations in Individual Grazing Management Plans				
Complete a survey of all creeks in the study watershed to identify those segments that are accessed directly by livestock.	Creek survey in GIS format identifying locations of livestock with access to creek	1 survey	0	0
Implement stream channel and pasture management improvement for approximately 290,000 acres.	Number of acres treated	29,000	145,500	290,000
GOAL: Alter irrigation practices to be more efficient				
Convert approximately 7,300 acres from flood irrigation to sprinkler irrigation.	Number of acres converted	730	3,650	7,300
GOAL: Assist the USFS in Implementing Specific Recommendations for Grazing on Public Lands				
Implement stream channel and pasture management improvement for approximately 73,000 acres.	Number of acres treated	7,300	36,500	73,000
GOAL: Reduce Septic Tank Contributions to Impairments				
Conduct a septic inventory for the entire watershed using aerial photographs and ground-truthing, and update septic database. Refine spatial queries for final priority septic map.	Updated spatial database of all septic permits.	1 updated database	0	0
Mail self-assessment forms to 1,834 septic permittees and follow decision matrix described in Figure 22 to determine upgrades.	Number of septic systems contacted and addressed voluntarily using steps identified in Figure 22	183	917	1,834
Sewer priority communities identified by SCHD.	Number of communities sewered	1	3	5
GOAL: Reduce Channel Erosion Contribution to Impairments				
Implement stream channel BMPs for 701,977 feet of stream.	Number of stream footage treated	70,197	350,989	701,977

Table 27. Implementation Milestones and Schedule for the Rockport and Echo Watersheds

Implementation Tasks	Indicator	Milestone (short term–2016)	Indicator (medium term–2019)	Target Completion Date (long term–2023)
GOAL: Reduce Landfill Contributions to Impairments				
Model transport and fate of contaminants.	Transport and fate model	1 model	0	0
Conduct remediation efforts such as pump and treat or vegetative caps.	Number of efforts	0	1	1
GOAL: Information and Education				
Conduct annual stormwater trainings to demonstrate proper installation and maintenance of construction stormwater control for construction projects.	Number of trainings held per year	1	1	1
Create public education program for pet waste management.	Number of signs and bag dispensers to control pet waste at parks	10	10	10
Develop subwatershed committees to engage private landowners and encourage BMP use.	Number of committees	1	2	3
Host septic system workshops.	Number of septic system workshops per year	1	1	1
Develop a materials check-out program for local schools to access water quality and watershed management materials.	Number of teachers that check out materials	2	10	50
Conduct annual training sessions for municipal personnel.	Number of training sessions	1	1	1

2.7. Loading Reduction Targets (element h)

A series of water quality criteria was selected to determine if load reductions are sufficient to support designated beneficial uses (Table 28). The primary indicator is DO concentrations because high concentrations of DO (6.0–8.0 mg/L or greater) are necessary for the health and viability of fish and other aquatic life. Low DO concentrations (less than 4.0 mg/L) cause increased stress to fish species, lower resistance to environmental stress and disease, and result in mortality at extreme levels (less than 2.0 mg/L). The selection of 4 mg/L as a 1-day minimum is consistent with the State of Utah standard.

Table 28. Criteria to Assure Implementation Plan will Achieve Water Quality Targets

	Target Value	Medium-term (2019)	Long-term (2023)
Rockport Reservoir Watershed			
DO (mg/L)	4.0 as a 1-day minimum in metalimnion at end of stratification season	4.0 as a 1-day minimum in 1 meters of metalimnion	4.0 as a 1-day minimum in metalimnion at end of stratification season
Metalimnetic oxygen depletion ($mg/m^3/day$)	36.5	43.6	36.5
TP (mg/L)	0.014	0.016	0.014
TN (mg/L)	0.239	0.316	0.239
Chlorophyll *a* (µg/L)	3.3	5.1	3.3
Echo Watershed			
DO (mg/L)	4.0 as a 1-day minimum in the metalimnion at end of stratification season		4.0 as a 1-day minimum in the metalimnion at end of stratification season
Metalimnetic oxygen depletion ($mg/m^3/day$)	36.5	43.6	36.5
TP (mg/L)	0.018	0.021	0.018
TN (mg/L)	0.266	0.327	0.266
Chlorophyll *a* (µg/L)	3.6	5.4	3.6

µg/L = micrograms per liter

2.8. Monitoring (element i)

The monitoring goals of this project are to document progress in achieving improved water quality conditions in the Rockport and Echo Reservoirs as nonpoint source control management strategies are implemented. Specifically, the objectives are as follows:

- Obtain information necessary to ensure that nutrient loading and concentration targets for DO are met.
- Obtain a detailed record of water quality data to assess whether the established target levels and threshold values are protective of designated uses.
- Evaluate BMP effectiveness and load reductions that result from implementation efforts.

Successful development and implementation of the monitoring plan will provide flexibility for adapting to new information and changes in the study watershed.

To document this progress, a monitoring program is needed to examine and report on the performance of each management strategy. Two types of performance monitoring are proposed in this implementation plan: 1) implementation monitoring and 2) effectiveness monitoring. Implementation monitoring assesses whether the proposed management strategies were implemented and, if they have been implemented, the progress that has been achieved. Effectiveness monitoring is used to check if the selected strategies are effectively reducing pollutant loading. The following subsections present implementation and effectiveness monitoring methods proposed for organizations that will be involved in execution of this implementation plan.

2.8.1. Implementation Monitoring

Each organization should monitor implementation of management strategies by tracking the progress and accomplishments of each activity. A centralized database should be used by organizations to monitor implementation of the proposed management strategies. The database should initially be constructed around existing water quality data and landscape characteristics as well as the implementation strategies proposed in this plan. Additionally, maintaining a status column for each strategy that indicates current progress would also be useful. Other types of information should include the following:

- Implementation strategy lead/coordinator
- Source being addressed and subwatershed where it is occurring
- Resources procured, spent, or still needed
- Possible funding sources
- Timeline for implementation

Success of this type of monitoring will rely heavily on appointing a single agency/entity to be responsible for both building and updating database content as work is conducted.

2.8.2. Effectiveness Monitoring

Effectiveness monitoring is used to check if the selected strategies are reducing pollutant loading. Effectiveness monitoring may be quantitative (e.g., laboratory analysis of pathogen concentrations in water from specific catchments, or in water exiting private property or developments) or qualitative (e.g., visual observation of sediment reduction in the water passing through a fenced riparian area), depending on the BMP implemented and the overall scope of the project. Although quantitative monitoring methods will document progress toward improved conditions, qualitative methods can also provide an effective measurement of implementation progress. Techniques such as photo-documentation of a site pre- and post-implementation or documenting relative sediment volume (i.e., high, medium, or low) collected from a detention pond will illustrate progress and can be combined with other monitoring efforts to show success of implementation activities. Quantitative effectiveness monitoring is required to document actual progress toward improved water quality conditions and can only be achieved through water quality assessments. Therefore, the success in reducing the load of nitrogen and phosphorus will be measured by contributions monitored at or near the mouths of major tributary points.

2.8.2.1. SAMPLING DESIGN AND PARAMETERS

Effective quantitative monitoring will require a temporal sampling regime that captures five primary time frames: early spring, late spring, summer, summer storm, and winter. Any additional samples taken during these time periods are encouraged, particularly during summer storm events and before and after BMP implementation. Spatially, all major subwatersheds should be sampled as well as Rockport and Echo Reservoirs. Parameters to analyze for include DO, nitrogen (both organic and inorganic fractions), phosphorus, chlorophyll *a*, dissolved organic carbon (DOC), biological oxygen demand (BOD), and total suspended sediment. Within the reservoirs, temperature, DO, nitrogen, and phosphorus samples should be taken at varying depths in order to generate depth profiles and further understand parameter relationships. Other than the recommendations for seasonal sampling, new sampling sites, and additional parameters, the existing monitoring plan used by DWQ for these watersheds is sufficient to evaluate progress toward water quality improvement.

2.8.3. Other Data Collection Needs

Instream and reservoir monitoring is scheduled to occur periodically throughout the year by UDEQ and includes physical, chemical, and biological parameters. It is recommended that the additional parameters mentioned above be sampled as well, including DOC, BOD, and water quality during storm events.

2.8.3.1. DISSOLVED ORGANIC MATTER

Oxygen depletion by dissolved organic matter (DOM) decomposition was not accounted for in the current TMDLs due to lack of data on DOM concentrations. As such, the BATHTUB models were calibrated to oxygen depletion rates assumed to be driven by algal growth and nutrients only, even though organic matter loading to the hypolimnia from the watersheds could also contribute to oxygen depletion. It is likely that during the summer season, DOM is flushed from the landscape and delivered to the reservoirs where it bypasses the surface and sinks to the hypolimnion on account of colder river temperatures versus reservoir temperatures. Quantifying DOM loading would allow for additional analysis to understand it as a potential driver of oxygen depletion. Many of the recommended BMPs to reduce nitrogen and phosphorus loading could also apply to DOM; however, it is still important to understand its individual contribution so that realistic targets are set.

2.8.3.2. STORMWATER

Stormwater runoff has the potential to create nutrient loading events that deviate dramatically from baseline conditions. Stormwater essentially collects contaminants from a wide range of sources and transports them to a central location. Therefore, having a robust quantitative characterization of nutrient behavior during these events is critical for minimizing uncertainty and more accurately calibrating watershed models that can then refine implementation focus areas. Sampling from each of the 13 subwatersheds during a storm event and analyzing for the above-stated suite of parameters would assist in beginning to understand how nutrient loading is affected by changing hydrology.

3. REASONABLE ASSURANCE

Enhancing water quality and protecting beneficial uses in Rockport and Echo Reservoirs will rely heavily on nonpoint source load reductions. Implementation of the suite of BMPs described in this plan for each nonpoint source provides reasonable assurance that load reductions will be achieved. There is strong evidence that recommended BMPs will be implemented given the future proposed water quality enhancement work detailed above coupled with the high level of engagement and participation from stakeholders. Projects such as the Hoystville pipeline (section 2.3.2.1.2), which will provide pressurized irrigation for 2,000 acres, is slated to begin in early 2014. The CRMP for the South Fork of Chalk Creek led by UDAF and KVCD has already secured funding and will begin in 2014 as well. Both of these projects have strong support from local residents and are occurring in subwatersheds that have been identified as critical areas for addressing excessive nutrient loading. Additional support for water quality enhancement comes from Summit County and Park City, both of which have a vested interest in environmental stewardship and have documented that interest through environmental plans that address water quality. Ample opportunity exists for funding BMP implementation in these watersheds through NRCS ($1.5 million), 319 funds, as well as UDEQ's nonpoint source funding. The Weber River watershed is scheduled to be the priority watershed for nonpoint source funding from 2018 through 2021. UDEQ estimates that upward of $1.5 million will be available in state nonpoint source funds, and 319 grants will be available for implementation in the Rockport and Echo Reservoir watersheds over the next 10 years (2014–2024). There are also low interest loans available to point sources in the watershed that can be used for funding of WWTP upgrades. BMP effectiveness monitoring will be employed to ensure that the proposed BMP suite is reducing nutrient loads and the plan will be modified as needed. This monitoring and modification process provides further assurance that estimated load reductions will be achieved by continuing implementation of BMP suites.

4. CONCLUSIONS

Addressing nonpoint sources in the manner detailed in this implementation plan and summarized below (Table 29) will result in nutrient load reductions that are necessary for enhanced water quality and that support beneficial uses in the Rockport Reservoir and Echo Reservoir watersheds. The detailed approach outlined in this plan provides a comprehensive, effective formula that builds on current stakeholder efforts and infrastructure to address each nonpoint source successfully. Furthermore, the cost analysis and identification of sponsors provides a clear path forward for carrying out recommended BMP suites and ensuring that work will be efficiently completed. It is the hope that this plan will be utilized by enthusiastic, engaged stakeholders as a roadmap for working together to restore quality and health of both Rockport and Echo Reservoirs as well as improving the management of the watersheds that support them.

Table 29. Summary of BMP Application in Rockport and Echo watersheds

Nutrient Source	Current TP Load (kg TP/season)		Current TN Load (kg TN/season)		Project Sponsors	Recommended Information and Education	Recommended BMP Suite	Combined BMP Effectiveness		Required Units of Application	Estimated Cost ($$ over 10 years)	Critical Subwatersheds	TMDL TP Load (kg TP/season)		TMDL TN Load (kg TN/season)	
	Rockport	Echo	Rockport	Echo				Phosphorus	Nitrogen				Rockport	Echo	Rockport	Echo
Stormwater	278	683	601	993	Summit County Park City	Stormwater training workshops; pet waste management	Stormwater retention, soil testing, and fertilizer reduction	20%–90%	30%–75%	17,113 acres	$6,240,000	Direct Drainage Rockport, Silver Creek	77	205	190	121
Private land grazing	688	755	4,275	9,903	NRCS/KVCD, DAF, private landowners, irrigation districts	NRCS and KVCD outreach to private landowners that are not currently implementing BMPs	Prescribed grazing, livestock exclusion, and fencing	70%–95%	70%–95%	286,342 acres	$4,580,000	Direct Drainage Rockport, Weber Canyon, South Fork Chalk Creek	54	0	928	0
Irrigation/fertilizer	350	211	962	3,117	NRCS/KVCD, DAF, private landowners, irrigation districts	NRCS and KVCD outreach to private landowners that are not currently implementing BMPs	Nutrient management planning, buffer strips, and sprinkler irrigation	80%–90%	80%–90%	11,083 acres	$3,430,000	Beaver Creek, Lower Weber, and Weber between Rockport and Echo	190	226	1,354	1,282
Public land grazing	196	0	2,929	0	USFS	Provide support to USFS	Prescribed grazing, livestock exclusion, and fencing	70%–95%	70%–95%	49,809 acres	$750,000	Beaver Creek, Weber Canyon (Weber River and Kamas Valley Allottments)	96	63	305	403
Septic systems	79	19	3,496	1,093	Summit County Health Department	Inspection and upgrade program	Upgrades, advanced systems	30%–80%	40%–90%	1,834 systems	$13,750,000	Direct Drainage Rockport, Weber Canyon, Silver Creek, Weber River between Rockport and Echo	22	6	1,107	141
Channel erosion	0	691	0	2,035	WBWCD KVCD/NRCS	NRCS and KVCD outreach to private landowners that are not currently implementing stream BMPs	Streambank protection	70%–80%	60%–70%	701,977 feet	Varies	Weber River between Rockport and Echo, South Fork Chalk Creek, Huff Creek	0	207	0	263
Three Mile Canyon Landfill	0	0	922	0	SCHD	Technical support	Pump and treat	100%	100%	1 landfill	Varies	Direct Drainage Rockport	0	019	292	0

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