JORDAN RIVER WATERSHED *E. COLI* TMDL

Main Report

UTAH DEPARTMENT *of* ENVIRONMENTAL QUALITY

WATER QUALITY

Executive Summary

Section 303(d) of the federal Clean Water Act (CWA) requires states to develop Total Maximum Daily Loads (TMDL) for waters that do not meet water quality standards. The TMDL process establishes allowable loadings of pollutants or other quantifiable parameters for a waterbody. This TMDL addresses the *Escherichia coli (E. coli)* impairment in 14 impaired assessment units (AUs) within the Jordan River watershed.

The Jordan River Watershed *E. coli* TMDL uses a concentration-based approach, with allowable levels of bacteria set as a concentration expressed in bacteria counts/100 mL of water. The goal is that all discharges to surface waters (point and nonpoint source) meet the water quality criteria so standards are met throughout the waterbody. This approach is a shift from previously completed *E. coli* TMDLs that were based upon necessary load reductions to meet instream water quality standards. Several states have had success with this concentration-based approach. The Utah Division of Water Quality (DWQ) believes this approach has several benefits for the impaired AUs in the Jordan River watershed. A concentration limit is easier for stakeholders to understand and implement compared to a load-based limit. This approach is also equitable for all Utah Pollutant Discharge Elimination System (UPDES) permittees within the impaired AUs, as all are held to the same limit and permit requirements related to best management practice (BMP) implementation regardless of area of responsibility.

The main body of the report includes general information on the pollutant of concern *(E. coli)*, applicable Utah water quality standards, the technical approach taken for this TMDL, possible pollutant sources in the watershed, and an implementation plan that will serve as a guide for implementing water quality improvement projects. Impaired AUs are discussed in individual appendices that include details specific to the hydrology, data analysis, land use, and potential sources of *E. coli* in that area.

DWQ believes *E. coli* loading will be reduced and beneficial uses restored and protected through implementation of this TMDL study.

Table of Contents

List of Tables

List of Figures

Chapter 1. TMDL Overview

This report represents the Total Maximum Daily Load (TMDL) analyses for the impaired assessment units (AUs) in the Jordan River watershed in fulfillment of Clean Water Act (CWA) requirements.

A TMDL analysis determines the amount of an identified pollutant (i.e., the load or concentration) that a waterbody can receive and still support its beneficial uses and meet state water quality standards. Once the location and magnitude of exceedances, as well as all potential sources, are identified, controls are implemented to reduce pollutant loading until the waterbody is brought back into compliance with water quality standards. Upon completion of the TMDL analysis, the TMDL is submitted to the Utah Water Quality Board and the Environmental Protection Agency (EPA) for final approval.

The purpose of the CWA is to improve and protect the physical, chemical, and biological integrity of the nation's waters. The CWA requires EPA, or delegated authorities such as states, tribes, and territories, to evaluate the quality of waters, establish beneficial uses, and define water quality criteria to protect those uses. Section 303(d) of the CWA requires each state to publish a list of waterbodies that fail to meet state water quality standards as part of its biannual Integrated Report process. This list is made available for public review and is subject to EPA approval. Waterbodies placed on the 303(d) list are known as impaired waters. The CWA requires a TMDL analysis for 303(d) impaired waters for each pollutant responsible for the impairment of their designated use(s).

DWQ collects water quality data as part of the Integrated Report process and assesses whether a waterbody is meeting water quality standards for its designated beneficial uses. The 2022 Integrated Report identified 14 assessment units (AUs) in the Jordan River watershed, including portions of the main stem and tributaries, for inclusion in Utah's 2022 303(d) list of impaired waters for not meeting drinking water (1C) and infrequent primary contact recreation (2B) designated beneficial uses between 2006 to 2022 due to exceedances of water quality standards for *E. coli* bacteria (Figure 1).

The impairments addressed by this TMDL are part of the DWQ prioritization plan to meet EPA's Long-term Vision for Assessment, Restoration, and Protection under the CWA Section 303(d) Program. This report defines the TMDL and water quality targets that, when attained, will bring the river into full support of its drinking water and recreational beneficial uses. This TMDL uses a concentration-based approach in which allowable levels of bacteria will be set as a concentration expressed as the most probable number of bacteria per 100 milliliters of water (MPN/100 mL). The most probable number is a statistical method used to estimate the viable numbers of bacteria in a sample. The goal is that all discharges to surface waters from point and nonpoint sources meet water quality criteria so standards are met at all points throughout the waterbody.

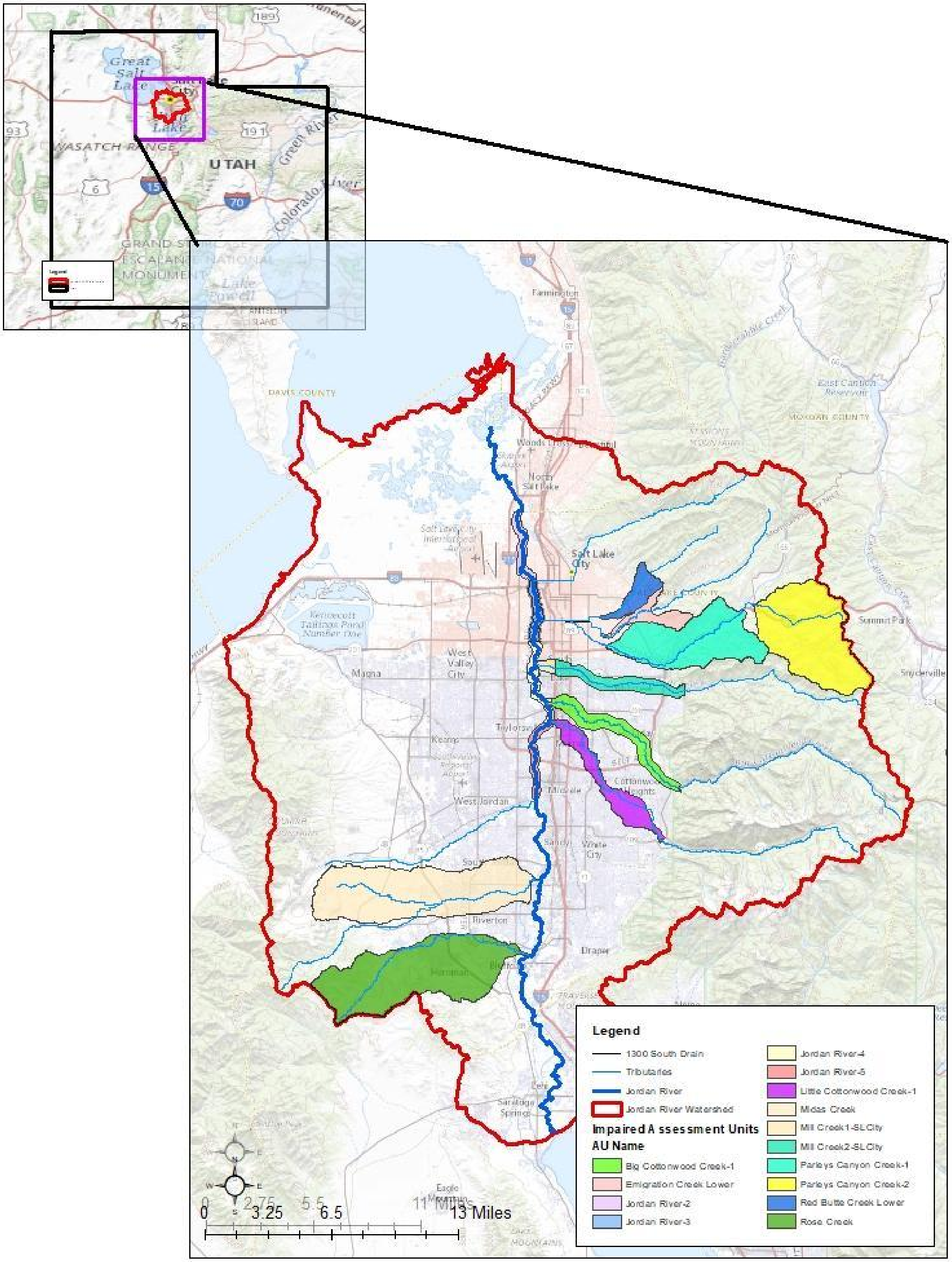

Figure 1. *E. coli* impaired assessment units within the Jordan River watershed.

Chapter 2. Bacteria Pollution

Routine monitoring of surface waters paired with assessment programs ensures the protection of public health and other beneficial uses. Surface waters are monitored as part of Utah's waterborne pathogen program for microorganisms that originate from fecal pollution from human and animal waste. It is not feasible to monitor for all pathogens in water, but by analyzing for certain indicator organisms, it is possible to assess potential health risks. Utah samples for *E. coli* concentrations in surface waters using EPA guidelines (EPA 2012).

The use of indicator organisms as a means of assessing the presence of pathogens in surface waters has been adopted by the World Health Organization (WHO) and EPA (WHO 2001). *E. coli* are the most abundant coliform bacteria present in human and animal intestines. Their presence can be attributed primarily to fecal origin, and their presence in water can be an indication of recent contamination. Some common sources of waterborne pathogens (*E. coli*) include failing septic systems, leaking sewer lines, grazed pastures, confined feedlots, wildlife, and dog parks (Benham 2006). Pathogenic bacteria are washed into surface waters during rainfall or snowmelt or are deposited directly in the water. These bacteria pose a threat to human health from incidental ingestion.

The potential sources of *E. coli* that may be contributing to the water quality impairments in a watershed are characterized as either point or nonpoint sources. Point sources are spatially discrete and regulated under Utah Pollutant Discharge Elimination System (UPDES) permits. Nonpoint sources are spatially distributed and not regulated. Stormwater discharges can be either nonpoint source or point source, depending on whether they are regulated under a permit program.

There are three main transport pathways for *E. coli* to enter surface waters: surface water runoff, shallow groundwater leaching, and direct deposition. Figure 2 shows a schematic of possible contamination routes.

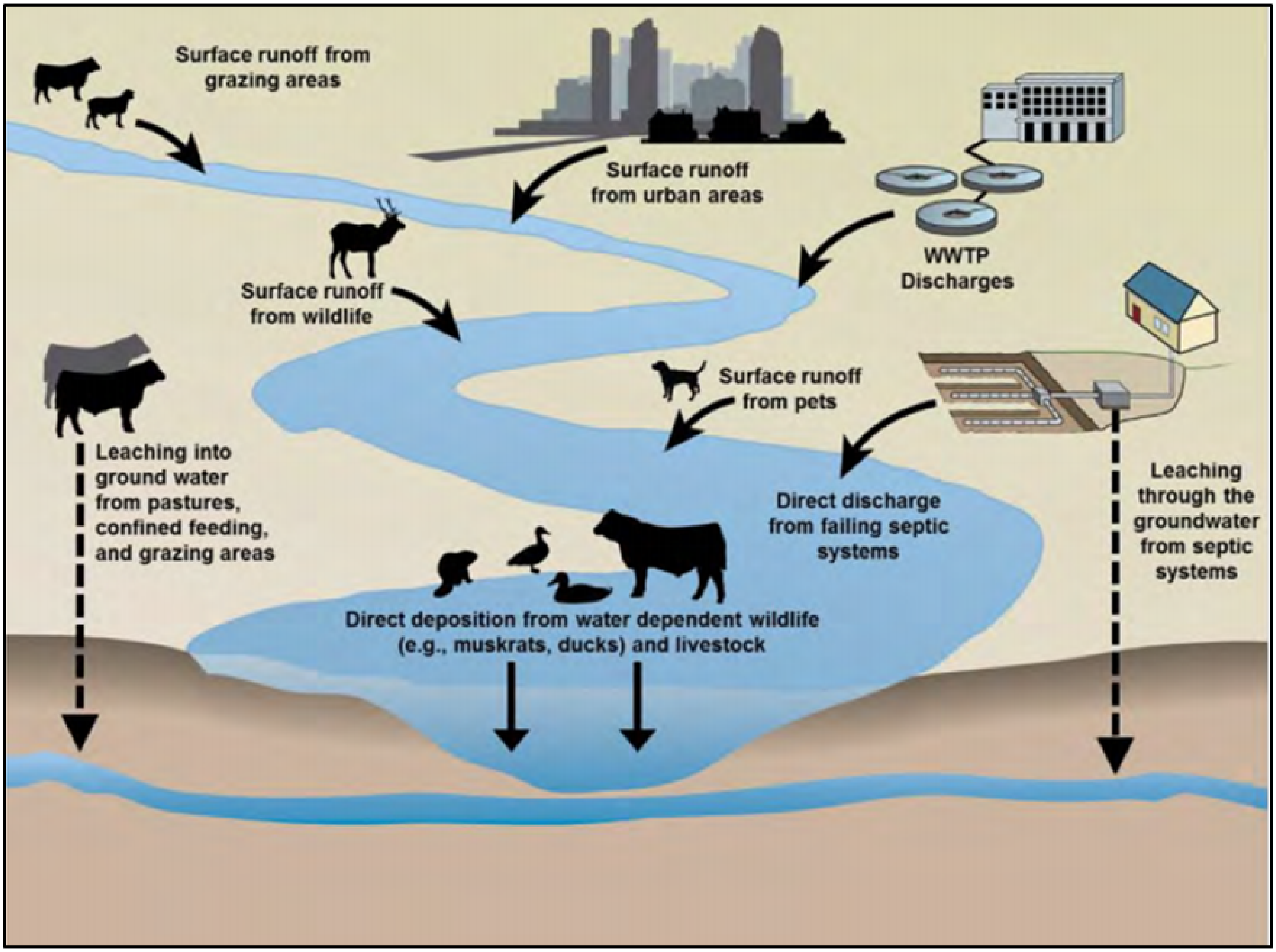

Figure 2. Possible bacteria transport pathways schematic (WY DEQ 2018).

Surface water runoff can transport *E. coli* to a waterbody when the water flowing over the ground does not filter into the soil. This potential pathway includes sources such as stormwater runoff and irrigation return flows.

Leaching occurs when precipitation or irrigation water carries pathogens downgradient through the soil. While soil generally has a filtering effect on contaminants, areas with shallow groundwater tables may increase subsurface *E. coli* loading to adjacent streams from sources such as failing onsite septic systems. This subsurface flow eliminates the exposure to direct sunlight and other limiting factors that reduce pathogen counts (USGS 2005). The potential for subsurface flow varies throughout the year, but is typically more common in spring, co-occurring with melting snow, increased river flows, and saturated soils.

Direct deposition occurs from illicit discharges or when wildlife, livestock, or humans defecate directly into surface water. Often, there is no reduction in *E. coli* loading between the source and receiving water body.

Water not absorbed by the soil has the potential to flow directly to the river and accumulate *E. coli* when it encounters fresh fecal material. Precipitation events carrying water over impervious surfaces with little opportunity for infiltration are a likely source of *E. coli* loading to nearby surface waters.

Chapter 3. Water Quality Standards

3.1 Designated Beneficial Uses

Utah waters are assigned beneficial uses that delineate existing uses of the water in Utah Administrative Code (UAC) R317-2-6.All designated beneficial uses have numeric criteria associated with them that must be met to ensure the use is supported. The designated beneficial uses for Utah waters are provided in Table 1. Utah assesses surface waters of the state at the monitoring site level, then summarizes the site-level assessment up to a larger spatial scale known as an assessment unit (AU).

Table 1. Designated uses of Utah's waters based on UAC R317-2-13.

Beneficial Use	Description
1C	Protected for domestic water systems
2	Protected for recreational uses and aesthetics
3	Protected for use by aquatic wildlife
4	Protected for agricultural uses including irrigation of crops and stock watering
5	The Great Salt Lake

3.2 Applicable Water Quality Standards

Standards of Quality for Waters of the State are contained in UAC R317-2. The water quality standards are intended to protect Utah's waters and improve its quality to support beneficial uses. There are three parts of water quality standards: beneficial uses, water quality criteria (numeric and narrative), and antidegradation policy. Utah's narrative water quality criteria protect waters from contamination that cannot be expressed quantitatively. The criteria state that waters shall be free from floating debris, scum, and other nuisances.

Numeric criteria vary based on the beneficial use assignment of the waterbody. Table 2 summarizes the *E. coli* water quality standards that apply to the 303(d) impaired AUs within the Jordan River watershed. These criteria will serve as the water quality endpoints or targets of this concentration-based TMDL.

Table 2. Applicable *E. coli* water quality standards for impaired AUs in the Jordan River watershed (MPN/100 mL).

Beneficial Use	Description	*E. coli* Geometric Mean (MPN*/100 mL)	*E. coli* Not to Exceed (MPN*/100 mL)
1C	Drinking water	206	668
2B	Infrequent primary contact recreation	206	668
*MPN/100 mL = Most probable number [of colonies] per 100 milliliters of water			

The *E. coli* numeric criteria for designated beneficial use Class 1C (drinking water) and 2B (infrequent primary contact recreation) waters state that sample concentrations may not exceed 206 MPN per 100 milliliter (mL) as a 30-day and recreation season geometric mean, or a maximum of 668 MPN per 100 mL in more than 10% of samples collected during the recreation season. The 30-day geometric mean is based on no less than five samples collected more than 48 hours apart within 30 days.

The three assessment scenarios for *E. coli* in Utah's waters are shown below.

1. For years with ≥ 5 collection events no less than 48 hours apart in any recreation season (May 1 through October 30), no more than 10% of samples collected from May 1 through October 30 should exceed 668 MPN/100 mL.

2. For recreation seasons with ≥ 5 collection events no less than 48 hours apart, no 30-day interval geometric mean should exceed 206 MPN/100 mL.

3. For recreation seasons with ≥ 10 collection events, the geometric mean of all samples should not exceed 206 MPN/100 mL.

The likelihood of becoming ill when recreating in waters increases with elevated *E. coli* concentrations. EPA published guidance that recommends both a geometric mean criterion and a statistical threshold value for assessing recreational waters (EPA 2012). These values, which correspond with DWQ's numeric criteria, are based on an estimated illness rate of 36 illnesses per 1,000 primary contact recreationalists. Although *E. coli* is an indicator species and does not directly measure all waterborne pathogens, it is an indicator of recent fecal contamination of surface water that may pose a risk to human health.

Utah's antidegradation component of the water quality standards (UAC R317-2-3) is designed to protect existing uses and maintain high-quality waters. The numeric water quality criteria denote where beneficial uses become impaired, whereas the antidegradation policy protects high-quality waters where the water quality is above or better than the criteria. Antidegradation rules also apply for any proposed new or expanded point source discharge that is likely to degrade water quality. This TMDL supports the antidegradation component of the standards because it is written to meet numeric *E. coli* criteria to support the full attainment of the drinking water and recreational beneficial uses.

3.3 Identification of Impaired Waterbodies

The Jordan River watershed is a part of the Great Salt Lake Basin, which incorporates much of northern and western Utah as well as portions of Idaho, Wyoming, and Nevada (Figures 1 and 3). The total area of the Great Salt Lake Basin is about 35,000 mi^2. The Jordan River watershed comprises the downstream end of the Provo/Jordan River Basin and is one of three river basins that contribute flow to the Great Salt Lake, a hypersaline, terminal lake. The watershed has been heavily hydrologically modified to convey water across the valley, primarily for agricultural and municipal uses. Utah Lake is the single largest source of flows to the Jordan River. Other tributaries contribute flow from both the east and west, but these are subject to a complex network of diversions, return flows from canals, stormwater discharge, and exchange agreements between culinary and agricultural users. The Jordan River watershed incorporates all of Salt Lake County and some of the most densely populated areas of Utah.

Fourteen individual AUs within the Jordan River watershed were included on the 303(d) lists for *E. coli* exceedances. Table 3 includes AU descriptions, the impaired beneficial uses, and the year they were first listed in the Integrated Report.

Table 3. Impairment summary of the Jordan River watershed.

Assessment Unit Name	Assessment Unit ID	Description	Impaired Beneficial Use	Year First Listed
Jordan River-2	UT16020204-002_00	Jordan River from Davis County line upstream to North Temple Street	2B	2006
Jordan River-3	UT16020204-003_00	Jordan River from North Temple to 2100 South	2B	2006
Jordan River-4	UT16020204-004_00	Jordan River from 2100 South to the confluence with Little Cottonwood Creek	2B	2014
Jordan River-5	UT16020204-005_00	Jordan River from the confluence with Little Cottonwood Creek to 7800 South	2B	2006
Mill Creek1-SLCity	UT16020204-026_00	Mill Creek from confluence with Jordan River to Interstate 15 crossing	2B	2014
Mill Creek2-SLCity	UT16020204-017_00	Mill Creek and tributaries from Interstate 15 to USFS Boundary	2B	2002
Little Cottonwood -1	UT16020204-021_00	Little Cottonwood Creek and tributaries from Jordan River confluence to Metropolitan WTP	2B	2014

Big Cottonwood-1	UT16020204-019_00	Big Cottonwood Creek and tributaries from Jordan River to Big Cottonwood WTP	2B	2014
Emigration Creek Lower	UT16020204-033_00	Emigration Creek and tributaries from 1100 East (below Westminster College) to stream gauge at Rotary Glen Park (40 44 58.49N, 111 48 36.29W) above Hogle Zoo	2B	2014
Parleys Canyon Creek-1	UT16020204-025_00	Parleys Canyon Creek and tributaries from 1300 East to Mountain Dell Reservoir	1C/2B	2010
Parleys Canyon Creek-2	UT16020204-013_00	Parleys Canyon Creek and tributaries from Mountain Dell Reservoir to headwaters	1C/2B	2022
Red Butte Creek Lower	UT16020204-035_00	Red Butte Creek and tributaries from 1100 East to Red Butte Reservoir	2B	2022
Rose Creek	UT16020204-029_00	Rose Creek and tributaries from confluence with Jordan River to headwaters	2B	2014
Midas Creek	UT16020204-024_01	Midas Creek and tributaries from confluence with Jordan River to headwaters	2B	2014

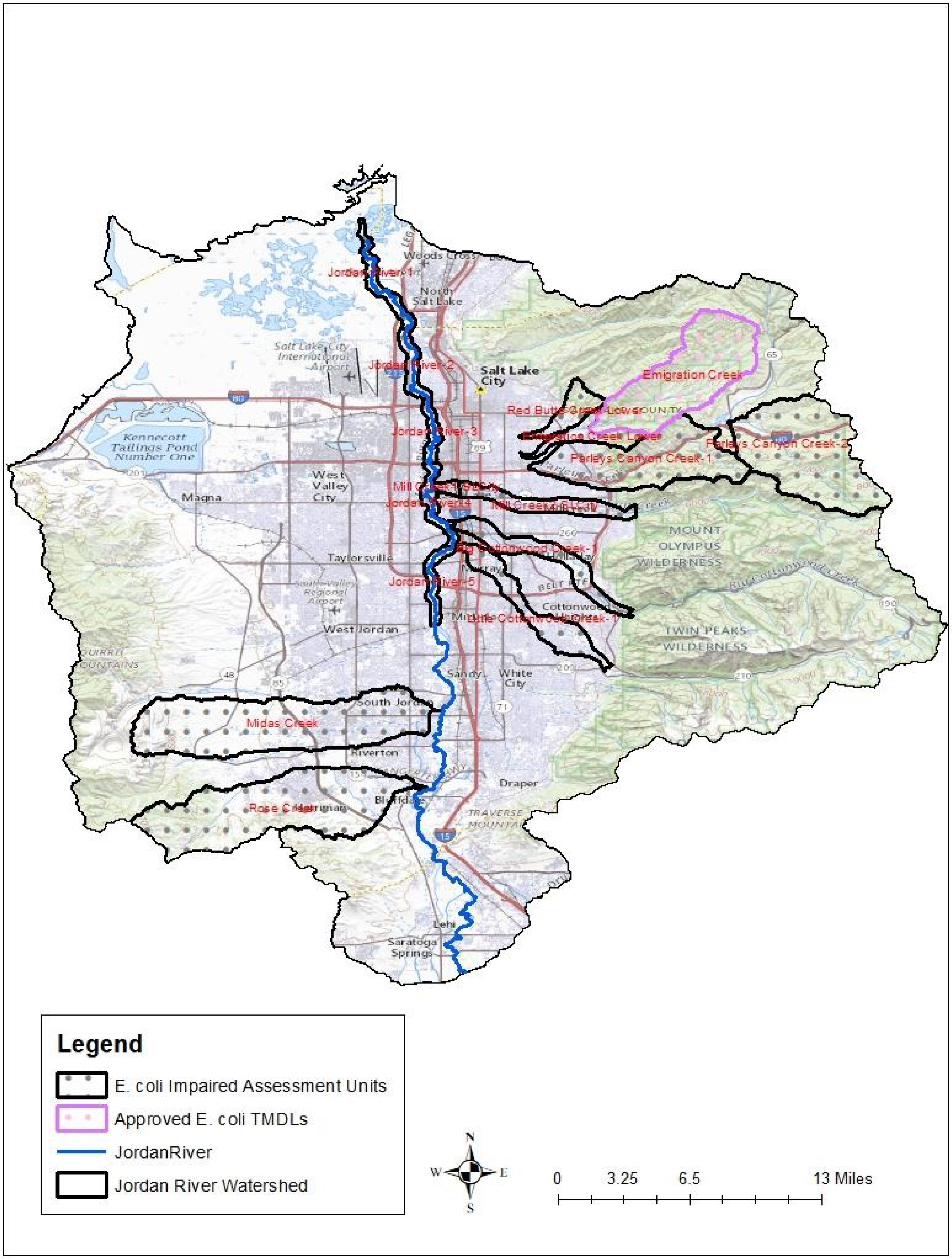

Figure 3. Location of Jordan River watershed E. coli impaired assessment units.

The focus of the Jordan River Watershed *E. coli* TMDL is on the impaired AUs that do not support the drinking water (1C) and infrequent primary contact recreation (2B) beneficial uses due to exceedances in *E. coli*. Additional impairments at various locations throughout the watershed include arsenic, cadmium, chromium, selenium, zinc, total dissolved solids, pH, dissolved oxygen, total phosphorus, total ammonia, and benthic macroinvertebrate bioassessments (DWQ, 2022 Integrated Report). DWQ will address these impairments in the future.

Chapter 4. TMDL

4.1 Concentration-based TMDLs

The state is required to develop a TMDL to reduce pollutant levels in impaired waters following a 303(d) listing. Typically, a TMDL is mass-based, with a calculation of the maximum amount of a pollutant that a waterbody can receive on a daily basis and still meet water quality standards. It is synonymous with the term "loading capacity" that the EPA defines as "the greatest amount of loading that a waterbody can receive without violating water quality standards" (EPA, 2007). A TMDL is the sum of individual wasteload allocations (WLAs) from point sources, load allocations (LAs) from nonpoint sources, and natural background levels. It includes a margin of safety (MOS), either defined implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. This sum is calculated through the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

In some cases, particularly when addressing *E. coli* impairments, a concentration-based TMDL is appropriate. The concentration-based TMDL uses the water quality numeric criteria as the daily TMDL target such that all sources are expected to meet the water quality criteria at the point of discharge. This approach eliminates reliance on dilution and other instream processes such as bacteria die-off to meet the TMDL and assumes that if all sources are at or below the water quality criteria, then the receiving water will attain water quality standards. For concentration-based TMDLs, the equation is revised to:

TMDL = Loading Capacity = Water Quality Criteria

For the Jordan River Watershed *E. coli* TMDL, all sources, both point and nonpoint, within the impaired assessment units must meet the following water quality criteria:

206 MPN/100 mL as a 30-day geometric mean,

206 MPN/100 mL as a recreational season geomean, and

668 MPN/100 mL as a daily maximum during the recreational season.

There are many benefits of a concentration-based TMDL approach, including a TMDL target that is easy to understand and communicate to stakeholders, does not require robust flow data or complex modeling, and is equitable in terms of assigning responsibility to reduce instream *E. coli* concentrations. Section 4.8 describes the process of converting this concentration-based TMDL to a load-based target.

4.2 Wasteload Allocation (WLA)

The WLA refers to the point source component of the TMDL that includes all permitted facilities and discharges in the watershed. Because the Jordan River Watershed *E. coli* TMDL takes a concentration-based approach, the WLA for point sources is equal to the water quality criteria of 206 MPN/100 mL as a 30-day geomean, 206 MPN/100 mL as a recreational season geomean, and 668 MPN/100 mL as a daily maximum during the recreational season. For municipal separate storm sewer systems (MS4) permittees, the expectation of the TMDL is for permittees to address the TMDL WLAs for stormwater through the iterative implementation of programmatic best management practices (BMPs) that are further outlined in the implementation section in Chapter 7 and in the associated permits. For publicly owned treatment works (POTWs) permittees, *E. coli* limits are included in the Utah Pollutant Discharge Elimination System (UPDES) permit and are set at 126 MPN/100 mL as a maximum monthly average and 157 MPN/100 mL as a weekly maximum average, which is below the *E. coli* water quality criteria for the Jordan River and tributaries. Please see Chapter 5 for more information on the point-source discharges.

4.3 Load Allocation (LA)

The LA refers to the nonpoint source component of the TMDL. Because the Jordan River Watershed *E. coli* TMDL is concentration-based, the LA for nonpoint sources is equal to 206 MPN/100 mL as a 30-day geometric mean, 206 MPN/100 mL as a recreational season geomean, and 668 MPN/100 mL as a daily maximum during the recreational season. Please see Chapter 5 for more information on the nonpoint source discharges.

4.4 Margin of Safety

The margin of safety (MOS) refers to a required component of the TMDL that accounts for uncertainty in the relationship between the pollutant loads and the quality of the receiving waterbody (CWA Section 303(d)(1)(C)). The MOS can be implicit through the use of conservative assumptions and values for calculations, or explicit as a certain percentage of the loading capacity. An implicit MOS is warranted for a concentration-based TMDL because the TMDL is equal to the *E. coli* water quality criteria and assumes no decrease in bacteria due to other physical processes such as die-off or dilution. Use of the water quality criteria as the TMDL target is a much more conservative approach than developing an explicit MOS and readily accounts for any uncertainty in the connection between water quality and pollutant loading.

4.5 Seasonality

The Jordan River Watershed *E. coli* TMDL is equal to the *E. coli* criteria that are applicable at all times throughout the recreational season. Therefore, the TMDL is protective of water quality under all conditions.

4.6 Percent Reduction

DWQ calculated the percent reduction in *E. coli* required to meet appropriate water quality criteria for the 14 impaired AUs using a monthly geometric mean ("geomean") during the recreation season (May–October). The calculation was based on the more stringent criterion of 206 MPN/100 mL to be more protective of beneficial uses. Calculation of necessary reductions is not a required part of a concentration-based TMDL but helps to illustrate the magnitude of impairment for each AU and to prioritize areas for project implementation.

DWQ took *E. coli* data collected at each monitoring location within each AU during the recreation season across all years and aggregated it into monthly geomeans. The single monitoring location within each AU with the highest monthly geomean was selected for the percent reduction calculation. This metric was chosen because it is the most conservative value that is protective of public health. The equation is as follows:

$$\text{Percent Reduction} = ((\text{Geomean}_{\text{month}} - 206)/\text{Geomean}_{\text{month}}) * 100$$

Detailed data analysis, including monitoring location statistics, *E. coli* concentrations through time, and monthly geomeans for each AU, are presented in the appendices for each impaired AU.

Table 4. Percent reduction per impaired AU.

Assessment Unit Name	Assessment Unit ID	Monitoring Location ID	Month	Geometric Mean (MPN/100 mL)	Percent Reduction (%)
Big Cottonwood Creek-1	UT16020204-019_00	4992972	August	1243	83
Emigration Creek Lower	UT16020204-033_00	4992135	July	920	78
Jordan River-2	UT16020204-002_00	4991900	July	672	69
Jordan River-3	UT16020204-003_00	4992320	July	862	76
Jordan River-4	UT16020204-004_00	4992880	August	816	75
Jordan River-5	UT16020204-005_00	4994100	August	765	73
Little Cottonwood Creek-1	UT16020204-021_00	4993580	August	792	74
Midas Creek	UT16020204-024_01	4994420	September	1659	88
Mill Creek1-SLCity	UT16020204-026_00	4992505	August	1202	83
Mill Creek2-SLCity	UT16020204-017_00	4992560	September	1205	83
Parleys Canyon Creek-1	UT16020204-025_00	4992205	August	270	24
Parleys Canyon Creek-2	UT16020204-013_00	4992278	October	431	52
Red Butte Creek Lower	UT16020204-035_00	4992091	August	1041	80
Rose Creek	UT16020204-029_00	4994660	September	1222	83

Note: Detailed data analysis for each AU is available in the individual appendices.

4.7 Reasonable Assurance (RA)

EPA requires TMDLs with pollutant-load reductions from both point and nonpoint sources to provide reasonable assurance (RA) that LAs will be achieved in cases where the WLA is based on the assumption that nonpoint source load reductions will occur. This requirement prevents excessive assumptions about reductions to nonpoint source pollution and enhances the TMDL's defensibility. RA is typically implemented through ordinances, state rules, discharge permits, and watershed planning guidance documents.

RA is not a requirement for this TMDL because the WLAs are not less protective based on assumed nonpoint source reductions for the Jordan River Watershed *E. coli* TMDL. Assurance that both point and nonpoint source load allocations will be achieved is documented through several activities, including compliance through UPDES permits and local ordinances for point sources as documented in the 2015 Salt Lake County Integrated Watershed Plan, the state nonpoint source reduction program, and partnerships with stakeholders for nonpoint sources. A detailed description of these assurances is provided below.

4.7.1 Point Sources

Wastewater

Wastewater discharges that operate under a UPDES permit are required to disinfect wastewater to reduce *E. coli* concentrations to 126 MPN/100mL as a monthly average and 157 MPN/100mL as a weekly average. UAC R317-8 authorizes this permit limit. The primary function of a bacterial effluent limit is to ensure that the effluent is being adequately treated with a disinfectant to maximize a complete or near-complete kill of bacteria prior to discharge.

Stormwater

All stormwater in the Jordan River watershed is regulated under one of three stormwater permit types (see Section 5.1.1). The permitting process requires a reduction of pollutants in stormwater runoff through implementation of six minimum control measures for MS4s and Stormwater Pollution Prevention Plans (SWPPPs) for construction and industrial activities. Upon completion and approval of this TMDL by EPA, MS4 permits will be modified and reissued with updated guidance on *E. coli* reduction measures that will include development of TMDL compliance plans for permitted MS4s (see Chapter 7).

Concentrated Animal Feeding Operations

Currently, none of the impaired AUs addressed in this TMDL contain any permitted Concentrated Animal Feeding Operations (CAFOs). If new feeding operations arise that meet the requirements of the UPDES General Permit for CAFOs, they will be required to obtain a permit. UAC R317-8-2.5 and UAC R317-8-10 authorize the issuance of this general permit to protect water quality from potential pollution sources resulting from CAFO operations.

4.7.2. Nonpoint Sources

There are several nonpoint sources identified in this report that can support reductions of *E. coli* loading into the impaired AUs throughout the Jordan River watershed. These sources and associated programs identify and prioritize BMPs via ordinances, initiatives, and dedicated funding programs. Chapter 7 outlines a strategic implementation plan to address nonpoint sources in the watershed.

Monitoring and reporting will be conducted to determine the effectiveness of BMPs in reducing *E. coli* loading into the Jordan River and tributaries. If monitoring shows that load reductions are not occurring to the extent necessary, BMPs will be modified accordingly. This monitoring and the BMP modification "feedback loop" provide further assurance that estimated load reductions will be achieved through a suite of BMPs. The monitoring plan is included in Chapter 6.

Onsite Septic Systems

Onsite septic systems are permitted and managed by the Salt Lake County Health Department (SLCHD) per Utah Code Ann. 26A-1-121(1) and Chapter 9.04, Salt Lake County Code of Ordinances. The health department oversees the design, approval, construction, installation, inspection, and maintenance of these disposal systems and requires a separation from groundwater and soil percolation test. UAC R317-4 also lists considerations and requirements to ensure proper system function, including a table of the required setback distances between onsite septic systems and critical water resources.

Agriculture

Utah Code 17D-3 authorizes local conservation districts to work with local landowners to promote and conserve soils, wildlife, forests, and water resources by addressing natural resource concerns at a local scale. The Utah Department of Agriculture and Food (UDAF), in cooperation with DWQ, manages the Agricultural Voluntary Incentive Program (AG VIP). This program incentivizes producers to develop Comprehensive Nutrient Management Plans (CNMPs) that help maximize crop yields while staying in compliance with state water quality regulations. These plans could help reduce nonpoint source pollution in the impaired AUs with livestock and other agriculture practices.

Domestic Pets

Salt Lake County enforces dog-leash laws and canine exclusion in many of the impaired AUs and stipulates conditions and penalties for noncompliance. Dog-waste stations can help pet owners clean up after their pets, and an outreach and education campaign can educate dog owners on the potential impacts of pet waste on water quality.

4.8 Converting Concentrations to Loads

While this TMDL is concentration-based and includes a concentration-based target for both point and nonpoint sources as described above, this TMDL also provides the method to translate the concentration-based target into a daily load to comply with federal guidelines. Daily loads are generated by multiplying stream flow at any given time by the applicable water quality criteria (daily maximum or geometric mean). Figure 4 and Table 5 provide daily loads for the range of flows that include both the minimum and maximum flow observed in each AU and based on the 30-day and recreational season geomean of 206 MPN/100 mL. More information on flow ranges for each AU can be found in the appendices.

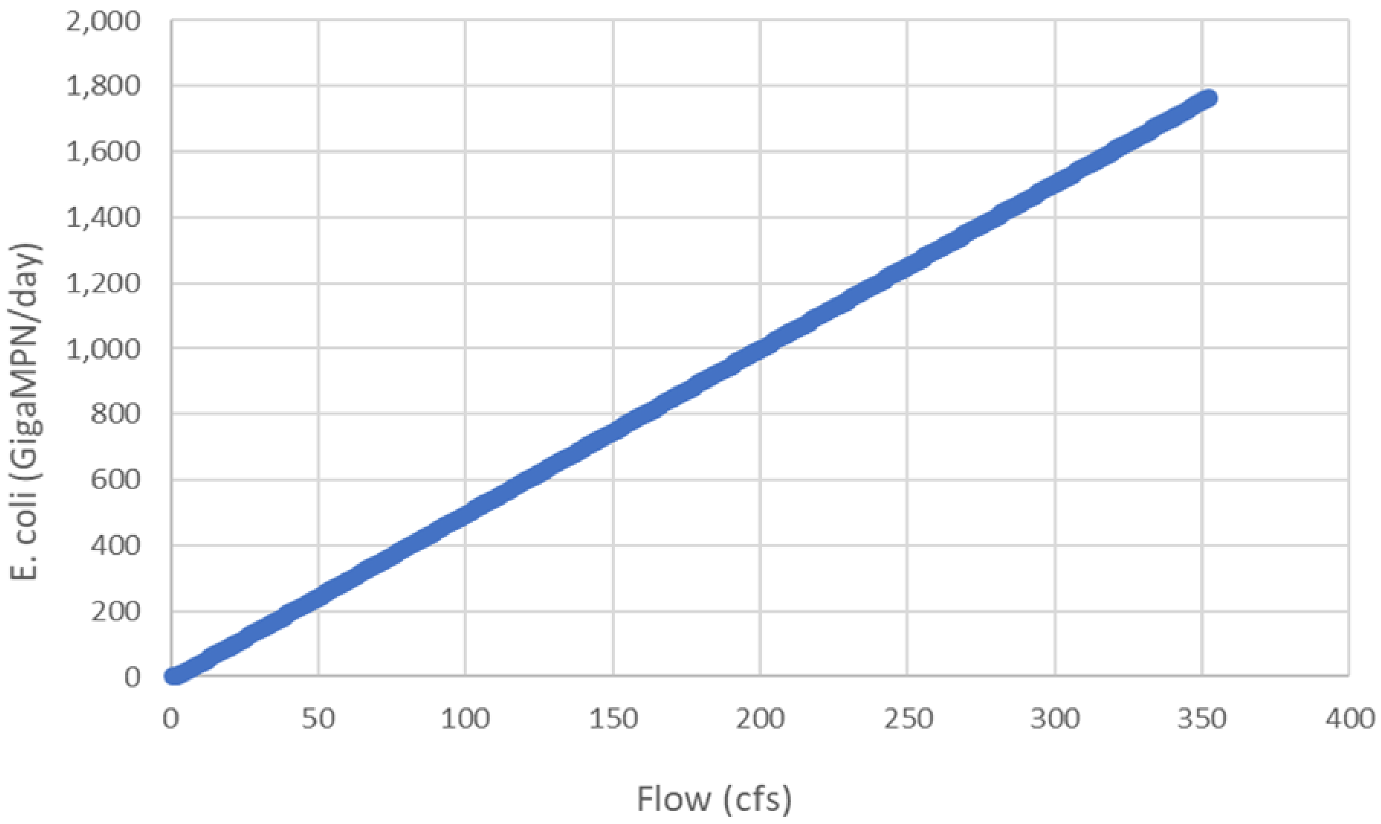

Figure 4. *E. coli* daily loads for the impaired AUs based on the geometric mean of 206 MPN/100 mL and the observed range of flows.

Table 5. Example *E. coli* daily loads for the impaired AUs.

Flow (cfs)	TMDL (GigaMPN/day)
0.1	1
25	126
50	252
75	378
100	504
125	630
150	756
175	882
200	1008
225	1134
250	1260
275	1386
300	1512
325	1638
350	1764

Chapter 5. Sources

Pollutant sources within a watershed are characterized as either point or nonpoint sources. Point sources are spatially discrete and regulated in UPDES permits, while nonpoint sources are spatially distributed and not regulated. A summary of each source is provided below.

5.1 Point Sources

A point source is defined by CWA Section 502(14) as "any discernible, confined and discrete conveyance, including any ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agriculture stormwater discharges and return flow from irrigated agriculture."

A point source may discharge to a waterbody if the discharge is covered by a National Pollutant Discharge Elimination System (NPDES) permit. Effluent discharges are illegal when they violate the terms and conditions of an NPDES permit or if they are not covered by a NPDES permit. In Utah, EPA issues NPDES permits for point sources on federal property and tribal lands, and DWQ issues UPDES permits for discharges from all other point sources.

NPDES and UPDES permits are reissued every five years or may be modified at any point due to updated regulations or to account for alterations to the point source. When permits are reissued, they must be consistent with the water quality endpoints developed in the TMDL process to protect waterbodies from receiving more pollutant loading than the waterbody can assimilate.

5.1.1 Utah Pollutant Discharge Elimination System

The many permittees within the Jordan River watershed are covered under various individual and general UPDES permits. Individual permits are site-specific permits typically issued to a single discharger for industrial or municipal publicly owned treatment works (POTW) wastewater or to large MS4s (population of 100,000). General permits are permits authorizing a category of discharges. There are general permits associated with stormwater (construction, industrial, and municipal), pesticides, construction dewatering and hydrostatic testing, concentrated animal feeding operations (CAFOs), concentrated aquatic animal production facilities (CAAPFs), coal mine operations, treated groundwater and surface water, and drinking water plants that discharge to waters of the state.

Based on the known makeup of each of these types of discharges, it is not likely that industrial stormwater, pesticides, CAAPFs, or coal mine permits contribute notably to *E. coli* loading in waterways.

Two POTWs directly discharge to impaired waters in the AUs evaluated as part of the Jordan River Watershed TMDL: South Valley Water Reclamation Facility that discharges to the Jordan River-5 AU and Central Valley Water Reclamation Facility that discharges to the Mill Creek-1 AU. Additional information on each facility can be found in the relevant appendices.

Figure 5 shows the location and number of UPDES permits within each impaired AU (data downloaded from the DEQ Interactive Mapping Tool on March 1, 2022).

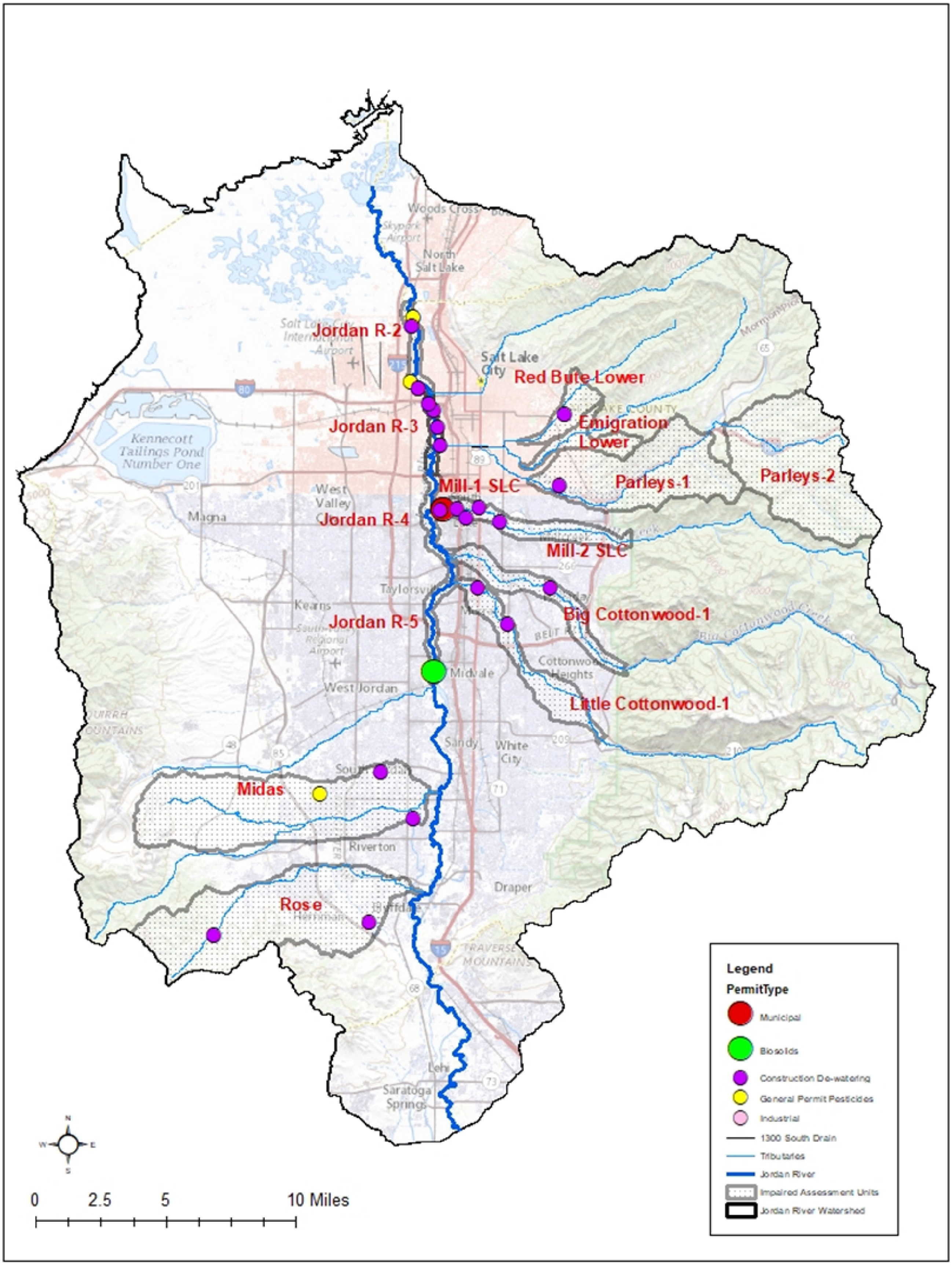

Figure 5. UPDES dischargers in the impaired AUs within the Jordan River watershed.

Stormwater

Utah's Stormwater Program regulates stormwater discharges from three potential sources of pollutants: municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. A description of each potential source is provided below.

MS4 Discharges

An MS4 is a conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains, that is 1) owned by a state, city, town, county, district, association, or other public body that discharges to waters of the state; 2) designed to collect and convey stormwater; 3) not a combined sewer; and 4) not a part of a publicly owned treatment works (POTW). Stormwater runoff in MS4s often flows into the conveyance system directly from roads and parking lots, leading to discharges of untreated water into local waterbodies that can be a potential source of *E. coli* loading. MS4 operators in areas meeting the U.S. Census Bureau's definition of an urbanized area are required to obtain a UPDES MS4 permit and develop a stormwater management program that implements a set of measurable goals, actions, and activities designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.

MS4s are further delineated as either Phase 1 or Phase 2, where Phase 1 permits are for medium and large municipalities serving over 100,000 people, and Phase 2 MS4 permits are for smaller municipalities and non-traditional MS4s (e.g., universities, hospitals, or prisons) that serve less than 100,000 people. Both Phase 1 and Phase 2 permittees are required through their permit to address six minimum control measures: 1) public education and outreach on stormwater impacts; 2) public involvement/participation; 3) illicit-discharge detection and elimination; 4) construction site stormwater runoff control; 5) long-term stormwater management in new development and redevelopment; and 6) pollution prevention and good housekeeping for municipal operations (DWQ 2021). Phase 1 permittees are required to develop a wet-weather monitoring program that includes a sampling plan that commits to a minimum sampling frequency of twice per year (fall and spring). All regulated MS4s are required to conduct dry-weather screening inspections (monitoring done in the absence of storm events) at all outfalls at least once during the five-year permit term. Dry-weather screenings are used to identify illicit connections and improper disposal of wastes.

There are currently three Phase 1 MS4s in the Jordan River watershed (Salt Lake City, Jordan Valley Municipalities, and the Utah Department of Transportation (UDOT)) and 27

Phase 2 MS4s covered under two different permits (Figure 6). The General Permit for Discharges from Small MS4s covers the University of Utah and the Veterans Affairs Medical Center. The Jordan Valley Municipalities permit covers:

- Salt Lake County
- Bluffdale City
- Cottonwood Heights
- Draper City
- Greater Salt Lake Municipal Service District
- Herriman City
- Holladay City
- Midvale City
- Millcreek
- Murray City
- Riverton City
- Sandy City
- South Jordan City
- South Salt Lake City
- Taylorsville City
- West Jordan City
- West Valley City

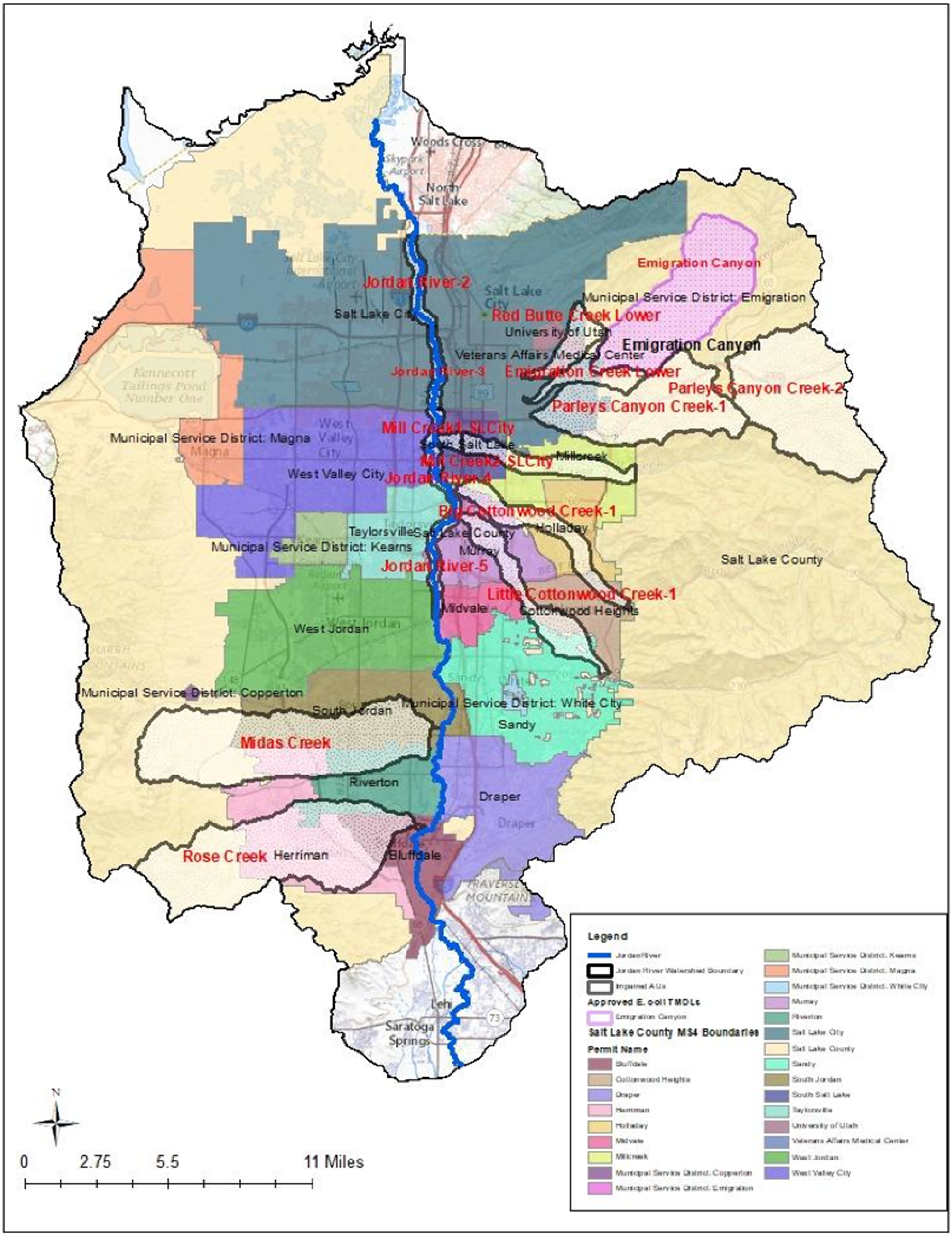

Figure 6. Permitted MS4s in the Jordan River watershed.

Construction and Industrial Discharges

Construction projects and industrial facilities are also regulated under UPDES permits. As of March 1, 2022, there were 389 construction stormwater permits and 28 industrial stormwater permits in the impaired AUs (Figure 7). Construction projects that disturb greater than or equal to one acre, including sites less than one acre that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre of land, require a either a Construction General Permit or Common Plan Permit for construction stormwater. These projects are unlikely to be a major source of *E. coli* loading, with possible sources being portable toilets located on site and projects that work on or install sewer lines. Municipalities in the watershed oversee installation of new sewer lines within city boundaries to ensure proper connection. Ensuring that existing lines are not damaged during project activities and that installation of new lines are properly connected to the existing sewer network are important for reducing potential loading events. Additionally, permittees must develop a Stormwater Pollution Prevention Plan (SWPPP) that describes all components of the project such as personnel involved, nature of activities, detailed site map, description of stormwater controls, and procedures for inspection, maintenance, and corrective action.

Industrial facilities such as manufacturing facilities, mining operations, landfills, steam-electric plants, automotive recyclers, waste and metal recycling, larger wastewater treatment plants, and transportation facilities are required to obtain coverage under the Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activities if the facility is one of the 29 regulated industrial sectors. Possible sources of *E. coli* loading from these project types are limited and could include nuisance wildlife congregating around and in open water or ponds on site. Similar to construction activities, permittees are required to develop a SWPPP that details stormwater control measures to minimize the discharge of pollutants.

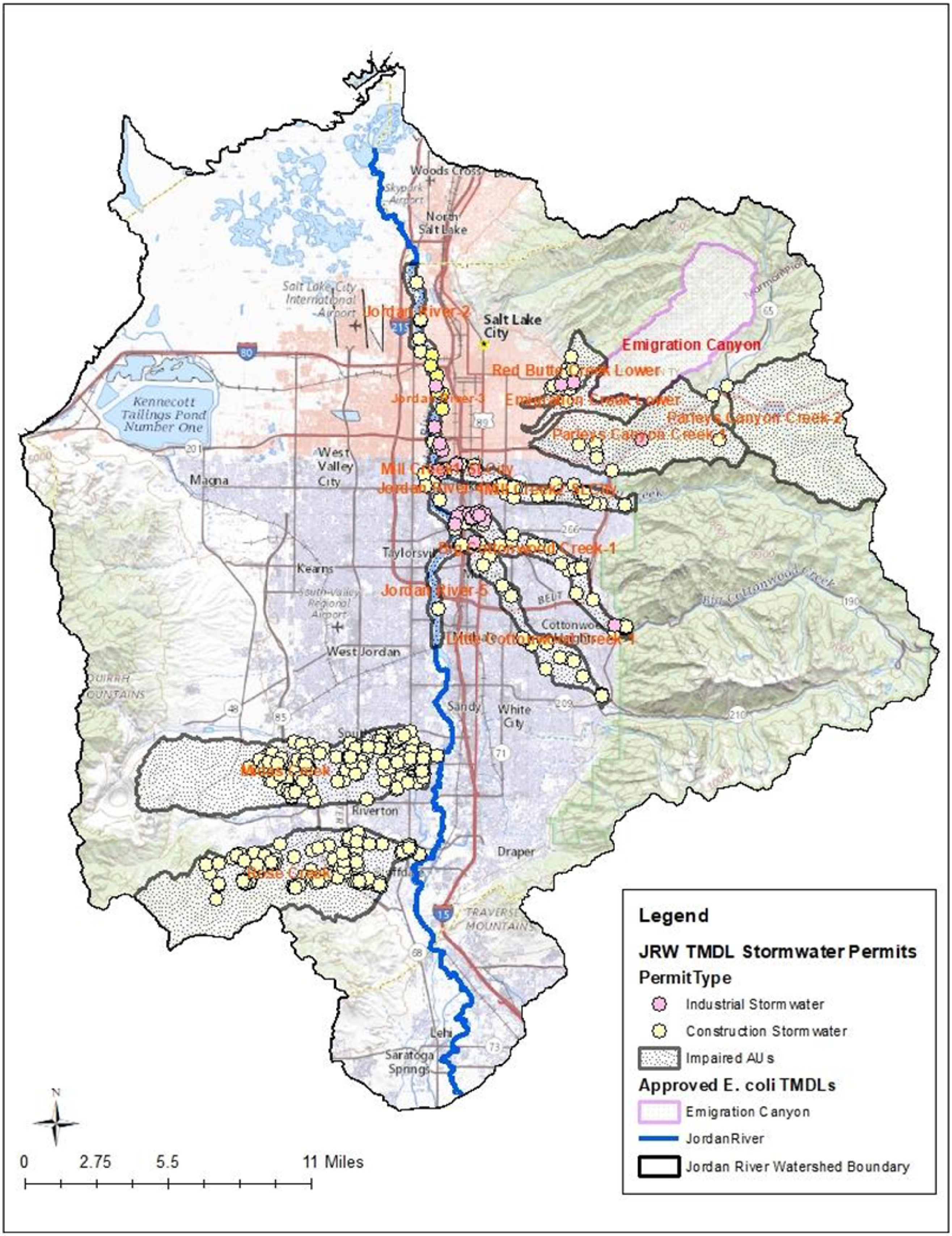

Figure 7. Stormwater discharge permits in the Jordan River watershed as of March 1, 2022.

Stormwater Monitoring

Salt Lake County monitored *E. coli* concentrations during baseflow and stormflow conditions at nine locations throughout the watershed from 2008 through 2016. The geomean of *E. coli* at baseflow was 127 MPN/100 mL (n = 41) compared to a geomean of 1,027 MPN/100 mL for stormflow (n = 62) indicating that stormwater discharge is a contributing source of *E. coli* loading in the Jordan River watershed (Figure 8).

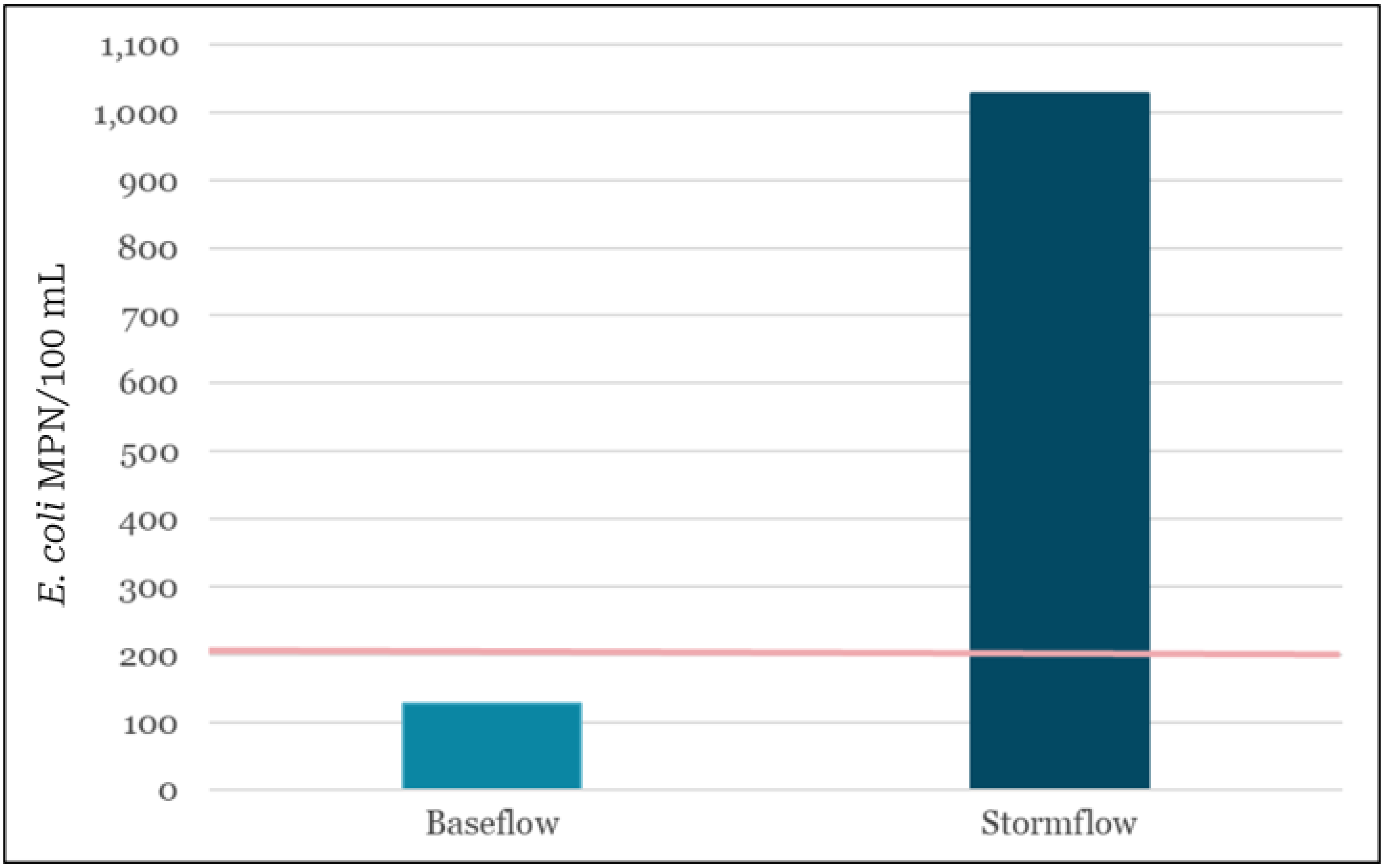

Figure 8. ***E. coli*** **geomean during baseflow and stormflow conditions from several locations monitored by Salt Lake County from 2008-2016. The red line denotes the** ***E. coli*** **criteria of 206 MPN /100 mL.**

5.1.2 Sanitary Sewer Overflows

Sanitary sewer systems collect and transport various sources of wastewater to treatment facilities for appropriate treatment. Occasionally, these systems may release raw sewage in events called sanitary sewer overflows (SSOs). SSOs can contaminate surface waters either through direct deposition or through discharges into the storm drain system that then discharges into a waterway. A variety of factors may contribute to an SSO, including blockages, line breaks, improper waste disposal, and vandalism.

There are four primary collection systems overlapping the impaired AUs, some of which contain additional satellite systems. The four primary systems are the Central Valley Water Reclamation Facility with seven satellite systems, Salt Lake City, South Valley Sewer District, and South Valley Water Reclamation Facility with five satellite systems. Central Valley's seven satellite systems include Mt. Olympus, Granger-Hunter, Cottonwood, Kearns, Taylorsville-Bennion, Murray and South Salt Lake. The five satellite systems associated with South Valley include South Valley Sewer District, West Jordan City, Midvalley Improvement District, and Midvale City.

SSOs occur in the Jordan River watershed, although they tend to be uncommon. A search of Utah's Environmental Incidents Database for the past 10 years revealed approximately 27 events that occurred in the watershed that either directly impacted surface waters or entered storm drains. Generally, when an SSO occurs in the Jordan River watershed, it is either due to malfunctioning equipment or human error rather than debris impacting the collection system. When debris does impact the system, it is typically a result of users discharging waste that should not be discharged to the sewer system rather than a lack of system cleaning and maintenance. If these events are large enough, they could dominate the riverine system, especially during low flow conditions.

Utah manages sanitary sewer collection systems through the Utah Sewer Management Program (USMP) that are not affiliated with the UPDES program. The USMP was developed by a group of stakeholders from the regulated community and DWQ and is authorized under rule R317-801. The goal of the USMP is to encourage improved management of sanitary sewer collection systems. There is a general permit that regulates collection systems through reporting and required BMPs to minimize SSO occurrences and reduce their impact through rapid communication and clean-up procedures.

5.1.3 Animal Feeding Operations (AFOs)

EPA defines animal feeding operations (AFOs) as agricultural enterprises where animals are kept and raised in confined situations. It is a facility or lot where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period.

- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

Some AFOs that meet the regulatory definition of a concentrated animal feeding operation (CAFO) are regulated under the UPDES program. CAFOs are point sources as defined by the CWA Section 502(14). To be considered a CAFO, a facility must first be defined as an AFO and meet the criteria established in the CAFO regulation. Both types of operations have the potential to be a source of *E. coli* loading to any nearby waterbodies if runoff is not properly controlled.

There are no permitted CAFOs located within the impaired AUs addressed by this TMDL (email correspondence between Don Hall, DWQ CAFO Program Manager, and Amy Dickey, 12/7/21). Based upon visual inspection, however, cattle, sheep, horses and chickens are present in the watershed. One goal of the implementation plan of this TMDL is to identify areas where livestock waste has the potential to enter waterways.

5.2 Nonpoint Sources

Nonpoint source pollution comes from diffuse sources in the watershed rather than a single source. Nonpoint source pollution enters waterbodies through surface water runoff such as rainfall or snowmelt, or is deposited directly into streams. Potential contributors of nonpoint source *E. coli* pollution within the Jordan River watershed impaired AUs include humans, wildlife, pets, and livestock.

5.2.1 Onsite Septic Systems

Onsite septic systems pose no significant threat to surface water quality when properly designed and maintained. However, failing or improperly designed or maintained systems can be a potential source of bacteria to waterways. Salt Lake County Assessor's office records show 2,296 parcels with onsite septic systems throughout the county, accounting for 0.6% of the total parcels within the county. The majority (97%) are sewered and deliver wastewater to treatment facilities prior to discharge into waters of the state. Table 6 lists the number of onsite septic systems that are within each impaired AU and Figure 9 shows where they are located. Of the impaired AUs, Parleys Canyon Creek-2 has the highest percentage (42%) of parcels with onsite septic systems.

Ideally, updated and accurate data would exist for the location of all individual onsite septic systems, but county records don’t capture the transition from onsite septic systems to sewer systems. The Salt Lake Assessor's office is mandated to revisit each property every five years, and this inspection is now often done virtually using high-resolution aerial imagery. As a result, the current count is likely an overestimate of onsite septic systems in impaired AUs because many onsite septic systems have been abandoned for sewer connection. The sewer code assigned to each parcel is typically set at the creation of the parcel and not changed unless an assessor is notified.

The Salt Lake County Health Department (SLCHD) has the authority to establish measures to promote and protect the health and wellness of county residents. The health department requires soil exploration tests, percolation tests, plot plans, and other items be submitted before a building permit is issued, and approval is only given when SLCHD determines the system will not have a negative impact on public health or the environment. UAC R-317-4 also lists considerations and requirements to ensure proper system function, including a table of the required setback distances between onsite septic systems and critical water resources. DWQ issues basic operating permits for large underground wastewater disposal systems (LUWDS). These large systems typically consist of a building sewer, a septic tank, and a subsurface disposal system, with daily flows ranging from 5,000 to 15,000 gallons or more. LUWDs work well when maintained and not overused. There are four LUWDS within the TMDL study area (email from Robert Beers, DWQ, 11/18/21). Three are located in Herriman City and associated with Rio Tinto Kennecott Copper. The fourth LUWD is for treatment in the Emigration Oaks subdivision located in Emigration Canyon. All LUWDS are required to conduct a minimum of one annual inspection and submit the results to DWQ.

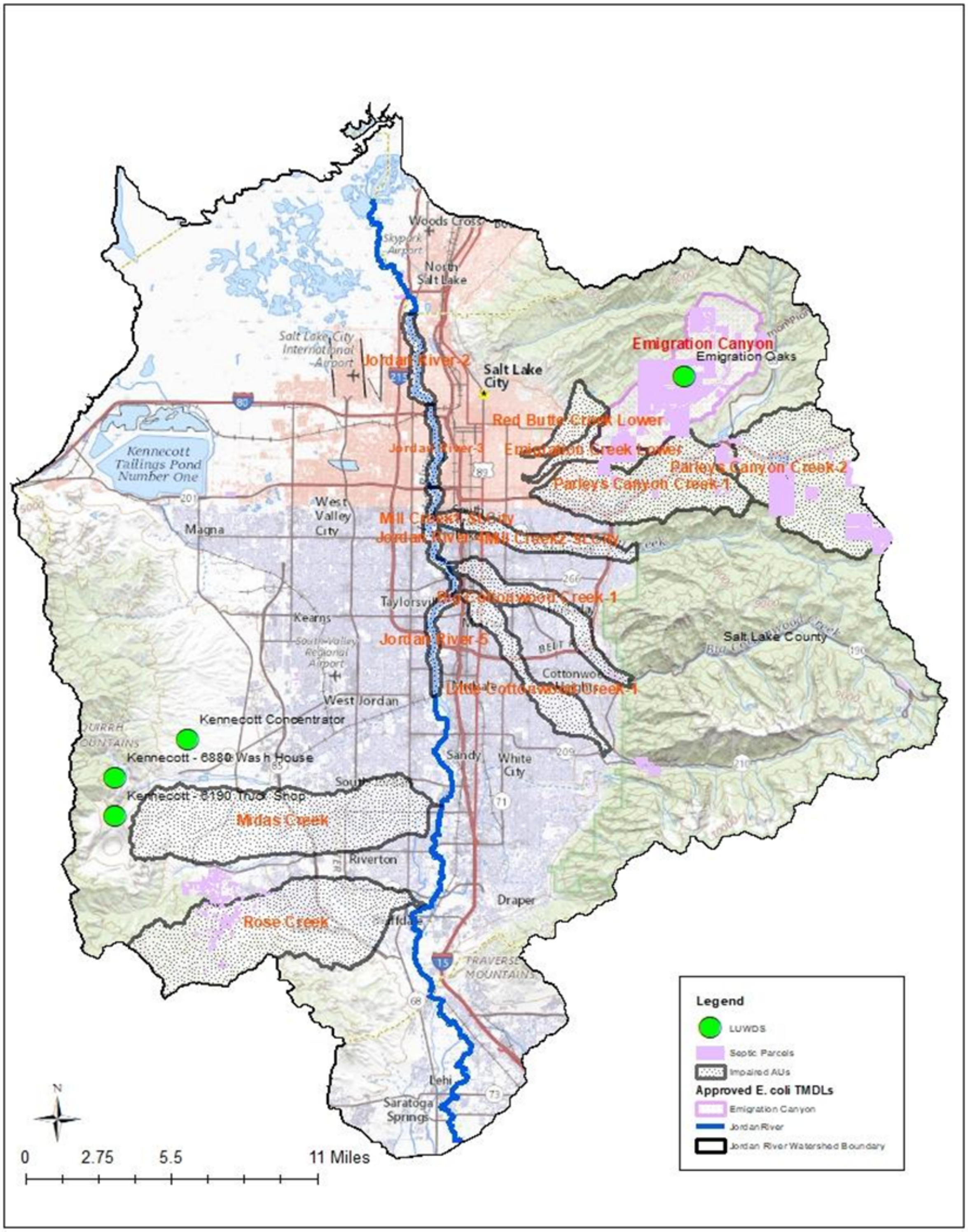

Figure 9. Location of large underground waste disposal systems (LUWDs) and parcels with onsite septic systems in the Jordan River watershed impaired AUs.

Table 6. Parcel onsite septic system numbers for the Jordan River watershed impaired AUs.

Assessment Unit	Total Parcels	Onsite Systems	% Onsite for AU
Big Cottonwood Creek-1	7,334	29	0.40%
Little Cottonwood Creek-1	9,200	3	0.03%
Rose Creek	12,979	260	2%
Midas Creek	22,540	1	0.01%
Jordan River-2	1,965	0	0%
Jordan River-3	2,223	0	0%
Jordan River-4	928	8	0.86%
Jordan River-5	2,168	1	0.05%
Parleys Canyon Creek-1	6,155	102	1.66%
Parleys Canyon Creek-2	346	146	42.20%
Mill Creek 1-SLCity	83	0	0%
Mill Creek 2-SLCity	8,223	13	0.16%
Emigration Creek Lower	2,144	12	0.60%
Red Butte Creek Lower	1,419	0	0%

****Note that these numbers are based on the best data available, which is likely an overestimation.*

5.2.2 Agriculture

Agricultural activities such as dairy farming, raising livestock and poultry, and producing crops can be sources of *E. coli* loading to waterways through direct deposition of fecal matter from farm animals standing or swimming in surface waters and from the runoff of farm-animal waste from pastures and corrals adjacent to surface waters. Agricultural discharges are considered nonpoint sources unless regulated through the CAFO program.

Land application of manure is a common agricultural practice in Utah. If done properly and timed right, land application of manure can be a cost-effective source of fertilizer for producers. However, *E. coli* has the potential to make its way to surface waters and impact water quality if fields are frozen or improperly sloped, if manure is applied prior to rainfall, or if the ground is already saturated when the manure is applied.

There are no permitted AFOs or CAFOs in the Jordan River watershed, and according to staff with the Utah Department of Agriculture and Food (UDAF), land application of manure is not occurring within the TMDL study area. While agricultural activities do occur widely throughout the state, they are less common within the predominantly urban impaired AUs addressed by this TMDL (Figure 10). Areas of row crops are present primarily in the south and west side of the Jordan River watershed, and there are many very small areas of pasture/hay scattered throughout the valley. In some instances, parks and open space are identified as pasture/hay on the land use map.

Another potential source of *E. coli* is the extensive system of constructed irrigation canals that traverse the watershed. Water rights exchange agreements exist between Salt Lake City and the agricultural community such that high-quality water is diverted from tributaries at the valley edge for culinary use and replaced with lower quality water from Utah Lake. These exchange flows are delivered to canals providing water to irrigation shareholders and not to the stream itself, so many of the perennial streams are dewatered during the irrigation season.

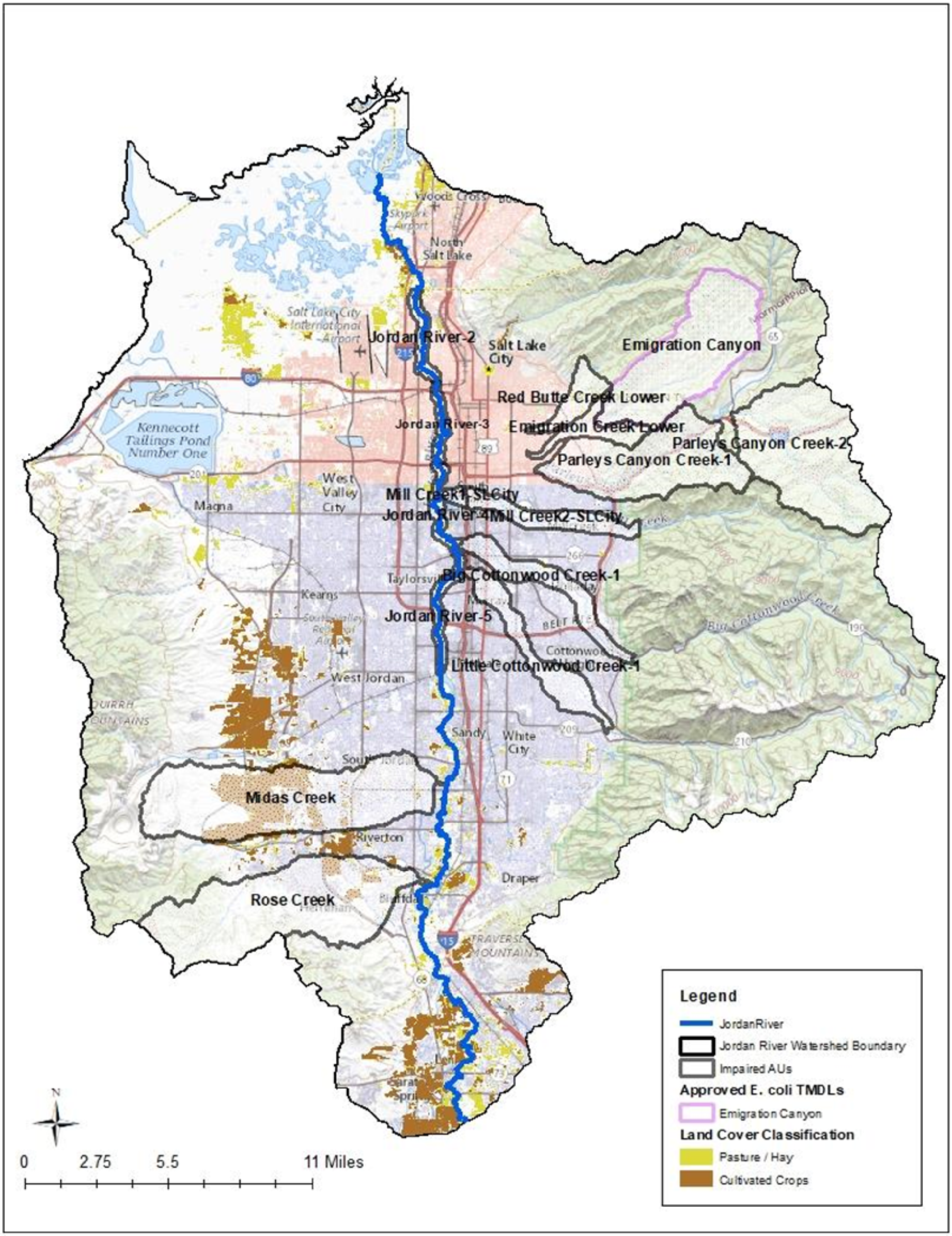

Figure 10. Land use map showing agricultural areas (Dewitz and USGS 2021).

5.2.3 Domestic Pets

Improper management of domestic pet waste is another potential source of *E. coli* loading into waterbodies. Dog waste in the immediate vicinity of a waterway can contribute to local water quality impacts.

There are many fenced dog parks and off-leash areas in multipurpose parks throughout Salt Lake County and an extensive network of trails that allow dogs off-leash adjacent to waterways. These areas have a variety of surface materials, access, and drainage potential, with some facilitating *E. coli* loading to adjacent waterbodies. Efforts are in place at many of those locations to encourage proper management of pet waste through placement of collection bags and trash bins placed in high-use areas, but many locations could benefit from improved pet-waste management information and supplies.

5.2.4 Wildlife

Wildlife can be a source of *E. coli* loading to surface waters. Transport of animal waste to surface waters is dependent on animal habitat and proximity to surface waters. Waterfowl and wildlife often deposit waste directly into streams or in the floodplain where it can be transported to surface waters by runoff during precipitation events. Animal waste deposited in upland areas can be transported to canals, streams, and rivers, but due to the distance from uplands to surface streams, only larger precipitation events can sustain enough runoff to transport upland animal waste to surface waters.

Resources (DWR) 2019 Utah Big Game Annual Report estimates that there are 3,000 deer, 800 elk, and 200 moose in the Wasatch Mountains West (17a) Wildlife Management Unit (WMU), which overlaps the Jordan River watershed. While the WMU extends well beyond the area of focus for this TMDL, and big-game species preferred habitat is forested high-elevation locations, it is probable that all of the impaired AUs contain wildlife of some sort that contribute to the *E. coli* loading. Deer are plentiful in many areas in the valley bottom near the Jordan River. Waterfowl, including ducks and geese, are known to congregate in areas along the Jordan River and tributaries.

5.2.5 Recreation

Individuals recreate throughout the watershed, and it is likely that a small percentage of those people are not properly disposing of human waste. The Jordan River trail system is a

45-mile, multiple-use trail that parallels the Jordan River through much of the Salt Lake valley. The trail links urban fishing ponds, playgrounds, picnic areas, shopping areas, and neighborhoods. A substantial amount of walking and biking traffic occurs along the trail, as well as horse traffic on segments that allow for it. Trail networks are also established along some of the tributaries to the Jordan River.

The Jordan River Commission is working with local governments and watershed stakeholders to encourage and facilitate safe canoeing and kayaking on the Jordan River from Utah Lake to the Great Salt Lake. This will draw recreators to the waterway during the warmer summer months. There are restroom facilities located at many of the trailheads, but it's likely that a percentage of the recreators are leaving solid human waste along the trail adjacent to the river.

Individual appendices include maps indicating location of parks and high-use areas in the impaired AUs.

5.2.6 Unhoused Population

According to the Jordan River Commission website, there has been a significant increase in the number of homeless camps along some areas of the Jordan River and its tributaries. Besides being illegal in most locations, camping along the river has detrimental impacts to the area. Human waste is often left behind or dumped directly into the river.

It is challenging to quantify the number of unhoused that live along the river because that number is continuously changing and dependent on the season. The time of year with the highest numbers of unhoused along the waterways coincides with the recreation season months when the *E. coli* standard applies, so it is likely that there is some human contribution to the *E. coli* loading.

5.3 Source Assessment Approach

DWQ used a multiple-lines of evidence approach to identify and catalog sources of *E. coli* specific to each AU (see Appendices). This approach ensured that the impairment and source of impairment are characterized as best as possible. DWQ used an AU-specific analysis of land cover, load duration curves, and microbial source tracking to characterize sources of *E. coli*.

5.3.1 Land Cover

Land cover is an important characteristic to consider when determining sources of *E. coli* to a receiving waterbody. A breakdown of developed, natural, and cultivated lands can provide insight into the sources most likely contributing to the impairment. There is an increase in stormwater runoff quantity, energy, and pollutant loads in urbanized watersheds with greater areas of impervious surface. According to the EPA, impervious surfaces that reach 10–20% of land cover causes the surface runoff to double, and at 100% impervious surface coverage, runoff is five times greater than a forested watershed (EPA, 2020). In urbanized watersheds, stormwater sources of *E. coli* are more likely than in rural areas where agricultural practices are a more likely source.

Data from the 2019 National Land Cover Dataset (NLCD) were used to analyze land cover in the Jordan River watershed. This dataset provides 30-meter resolution data with a 16-class breakdown of different land cover types. As shown in Figure 11, the impaired AUs in the Jordan River watershed have a mix of developed, cultivated, and forested land cover. For the purpose of this TMDL, land cover types in each impaired AU were collapsed into four categories: developed (high, medium, low, and open space), natural (forest, grasslands, wetlands, shrubland, and barren), cultivated (pasture and crops), and open water. To identify sources in each impaired AU, an AU-specific analysis of land cover types is provided in the appendices.

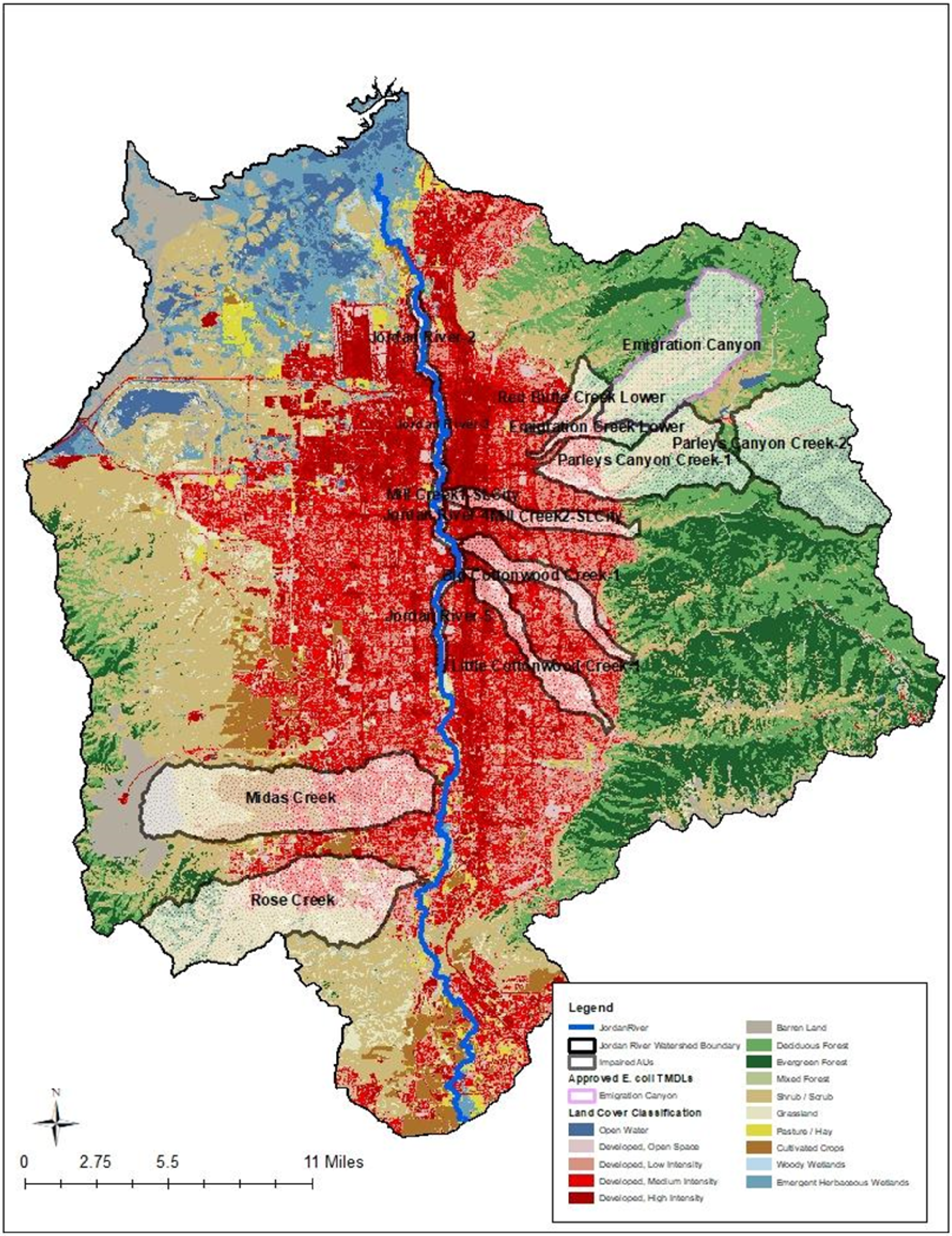

Figure 11. Land use in the Jordan River watershed (Dewitz and USGS 2021).

5.3.2 Load Duration Curves

While the target for this TMDL is concentration-based, the calculation of bacterial loads, particularly in the form of load duration curves (LDCs), is helpful to discern patterns of impairment and possible sources across different hydrologic flow conditions. In general, an LDC is constructed by multiplying the flows from a flow duration curve by a numeric water quality target. Flow duration curves illustrate the percentage of time or probability that flow will equal or exceed a particular value over a given historical period where flow duration intervals are expressed as a percentage, with 0% corresponding to the highest stream flow in the record and 100% to the lowest flow. The numeric water quality target for a pollutant of concern is used to determine the loading capacity for that pollutant in TMDL studies. When instantaneous loads, calculated from ambient water quality and flow data, are plotted with the load capacity curve, necessary load reductions can be visualized across a full range of flow conditions.

Loads plotted above the load duration curve represent exceedances of the loading capacity. Loads plotted below the curve represent allowable daily loads and are in attainment of water quality standards. Loads that plot above the allowable load curve in the 1–10% flow ranges (rare high-flow conditions) represent hydrologic conditions of flooding. Loads plotting above the curve between the 10%–40% (moist) and 40%–60% (mid-range) flow ranges likely reflect precipitation-driven contributions. Those plotting above the curve in the 60%–90% flow ranges are indicative of constant discharge sources. Loads that plot above the curve in greater than 90% of all recorded flows reflect hydrologic conditions of drought.

An underlying premise of the LDC approach is the correlation of water quality impairments to flow conditions. The LDC alone does not consider specific fate and transport mechanisms, which can vary depending on watershed or pollutant characteristics. The LDC approach helps identify the issues surrounding the impairment and roughly differentiates among sources according to flow regimes. Table 7 summarizes the relationship between the five hydrologic regimes and potential contributing source areas (EPA, 2007). Impairments observed in low-flow conditions typically indicate the influence of point sources, while those in the higher flow regimes generally reflect potential nonpoint source contributions such as stormwater and streambank erosion. Impairments observed in mid-range flow conditions are generally a result of pollution from onsite septic systems and runoff from riparian areas and impervious surfaces.

Table 7. Relationship between LDC hydrologic regimes and the probability of contribution from applicable sources (EPA, 2007).

Contributing Source Area	Hydrologic Regime				
	High (0-10%)	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)	Low (90-100%)
Point Sources	Low	Low	Low	Medium	High
Onsite Septic Systems Treatment	Low	Low	Low	Medium	Low
Riparian Areas	Low	High	High	High	Low
Stormwater Impervious	Low	High	High	High	Low
Stormwater Upland	High	High	Medium	Low	Low
Bank Erosion	High	High	Low	Low	Low

5.3.3 Microbial Source Tracking

Over the past decade, microbial source tracking (MST) has become a more widely used and accepted approach to better understand sources of fecal contamination in surface waters. MST is a set of methods that collect, isolate, identify, and measure a host-specific fecal indicator from an environmental sample based on the premise that certain fecal microorganisms (i.e., bacteria or viruses) are strongly associated with specific hosts (e.g., humans, dogs, cows, and wildlife). MST uses an analysis of microbial genetic material to determine which human or animal source contributed fecal material to a water sample. The primary impetus behind development of this technology is two-fold: 1) to determine the extent to which fecal sources influence human-health risk from contact with water, and 2) to attribute fecal contamination in waterbodies to the correct sources. The use of this technology can be instrumental in providing supporting documentation on fecal source contamination to watershed studies and allowing the development of more detailed implementation plans associated with TMDLs.

Salt Lake County hired Dr. Hyatt Green of the State University of New York to collect samples and conduct MST analyses throughout the Jordan River watershed from 2018–2020 and in 2021 for Emigration Creek. Sample collection occurred at several locations across 12 of the impaired AUs in July, August, and September of each year. Two impaired AUs - Rose Creek and Midas Creek on the west side of the watershed - were not sampled for MST. Each sample was analyzed for total coliform, *E. coli*, and four MST markers (human, canine, ruminant, and avian). The ruminant marker includes both wildlife and livestock. An AU-specific analysis included in the appendices summarizes the presence or absence of MST markers. Reports that provide a more detailed description of the sampling and analysis methodology, as well as some additional more quantitative interpretation of the data, are available upon request.

Chapter 6. Monitoring Plan

Follow-up monitoring is necessary to document whether implementation efforts result in attainment of the water quality standards. DWQ, in collaboration with stakeholders as part of the cooperative monitoring program, will continue to collect *E. coli* samples when and where appropriate to evaluate the effectiveness of pollution-control efforts. Current water quality trends will be analyzed on a routine basis to determine TMDL attainment.

DWQ and Salt Lake County will routinely monitor *E. coli* at impaired locations in the Jordan River watershed until full-support status is attained for all AUs and they can be delisted for *E. coli* as part of the Integrated Report process. Monitoring efforts are documented in a sampling and analysis plan (SAP) that will be updated on an annual basis.

DWQ will continue its intensive, six-year rotating basin monitoring effort, with the next Jordan River intensive monitoring scheduled for water year (WY) 2024. Monitoring locations will be selected prior to October 1, 2024 and will reflect the needs of the TMDL and evaluate implementation practices.

In addition to these more general monitoring efforts, specific recommendations for follow-up monitoring include:

- *E. coli* monitoring at discharge points both above and below canals.
- *E. coli* monitoring of Vitro Ditch in Mill Creek1-SLCity AU.
- *E. coli* monitoring on the mainstem of the Jordan River, specifically above the Jordan River Narrows and below each of the major tributaries.
- MST monitoring to determine BMP effectiveness.
- BMP effectiveness monitoring, particularly for stormwater, where applicable.
- Flow establishment in AUs without continuous flow gauges.

Chapter 7. Implementation Strategy

An essential component in the restoration of impaired surface waters is the development of a meaningful implementation plan. The TMDL identifies where and when the impairment exists as well as potential sources of loading of the pollutant of concern, while the implementation plan lays out the actual pathway to improving water quality. The critical next step after TMDL development is putting BMPs into action in conjunction with information and education outreach to stakeholders to share information about the water quality impairment, why it matters, and what can be done to improve it.

The focus of this Jordan River watershed implementation plan is to decrease *E. coli* loading from nonpoint sources as well as from the stormwater contribution that will be addressed through the MS4 permitting process.

Decades of watershed improvement work has already occurred throughout the Jordan River basin. That work focused on water quality improvement, stream and riparian habitat, hydrology, and social and recreational services. The original 1978 Salt Lake County Area-wide Water Quality Management Plan served as the first guide toward restoration and maintenance of the Jordan River watershed. The subsequent updates in 2009 and 2015 incorporated updated information and goals. The Salt Lake County Watershed and Restoration Program also developed a Stream Care Guide in 2014 that serves as a handbook for residents to help prevent or minimize erosion problems, avoid flood losses, protect property values, preserve water quality, and contribute to the survival of fish and wildlife.

The Jordan River Watershed Council (JRWC) was established in 1978 to propose implementable solutions to area-wide water quality and pollution problems and oversee the centralization of wastewater treatment facilities in the Salt Lake valley (see Salt Lake County Ordinance Title 17, Chapter 17.06 and the JRWC website).

The Jordan River Commission was created in 2010 to facilitate regional implementation of the Blueprint Jordan River, serve as a technical resource to local communities, and provide a forum for coordination of planning, restoration, and responsible development along the Jordan River corridor. The Commission adopted its first Strategic Plan in June 2015.

Other efforts include Salt Lake City watershed work that has been guided by the 1999 Watershed Management Plan and work by the Seven Canyons Trust, a nonprofit group whose vision is to uncover and restore the creeks in the Salt Lake valley. Other entities, including Emigration Canyon stakeholders, Salt Lake County Stormwater Coalition, Tracy Aviary, Hogle Zoo, Utah Department of Transportation, U.S. Forest Service, U.S. Fish and Wildlife Service, Utah Division of Wildlife Resources, and cities throughout the watershed, have participated in watershed restoration efforts.

7.1 Nonpoint Source Strategy

Implementation of nonpoint source BMPs is voluntary and driven by the interest and willingness of municipalities, permittees, homeowners, and producers. Cost-share incentives are offered in many cases. BMPs related to each potential nonpoint source of *E. coli* loading are discussed in more detail in this section, and a summary is provided in Table 8.

7.1.1 Onsite Systems

Improperly installed or maintained onsite septic systems are one of the potential sources of *E. coli* loading in the Jordan River watershed. Systems installed in inappropriate soils, on excessive slopes, or in areas with shallow groundwater tables are especially prone to failing. It will be critical to identify any onsite systems that are malfunctioning and repair and maintain them as appropriate.

Indicators of a failing onsite system can include wastewater backing up into household drains, pooling water or muddy soil around a septic system, bright green, spongy grass above the drainfield, and a strong odor around the septic tank and drainfield.

Proper care of an onsite system is crucial to prevent failure. The recommended maintenance is straightforward and inexpensive compared to complete replacement of a system. EPA estimates that regular maintenance fees range from $300–$500 every three to five years, with frequency of pumping dependent on how many people live at the residence and the size of the onsite system.

Onsite Wastewater Treatment System BMPs

- Inspect onsite system areas frequently to look for signs of failure.

- Have a professional pump the system every three to five years to optimize primary treatment.

- Conserve household water through high-efficiency toilets and showerheads to minimize hydraulic loading to the system.

- Compost kitchen waste instead of using the garbage disposal to minimize materials going down the drains and impacting the performance of the system.

- Dispose of household products and chemicals properly to minimize materials going down the drains and impacting the performance of the system.

- Maintain the drainfield by keeping the area free of deep-rooted trees and shrubs.

- Never park or drive heavy vehicles over any part of the onsite system.

- Implement a program to help identify failing systems throughout the watershed.

- Provide the public with information on proper maintenance and management of onsite wastewater systems.

- Provide cost-share incentives for onsite system maintenance.

The following resources provide additional information about onsite wastewater treatment systems:

1. Salt Lake County's website on septic systems.

2. EPA's Onsite System website. This site has a wide range of information to assist homeowners, wastewater professionals, and others in properly designing and maintaining onsite systems. It begins with a general overview of the systems and includes guidance, Frequently Asked Questions, and technical resources.

3. EPA Onsite Wastewater Treatment Systems Manual. This manual provides information on onsite wastewater treatment system siting, design, installation, maintenance, and replacement.

4. Utah DWQ's Onsite Wastewater Program. This site has information on certification of onsite system professionals, review of designs and plans for onsite septic systems (including large underground systems), operating permits and information about financial assistance available through the State Revolving Fund (SRF) program for repair or replacement of septic systems when applicants meet the requirements.

5. Utah State University Onsite Wastewater Treatment Training Program website. This training provides classroom and field training specific to onsite wastewater treatment systems.

7.1.2 Wildlife

While much of the wildlife population is well-dispersed throughout the impaired AUs, there are some areas where certain species congregate, and those areas can become hot spots for *E. coli* and other waterborne-pathogen loading to surface waters. Deer, ducks, and geese are the most common nuisance wildlife found in urban settings. Open, grass-covered park spaces make desirable habitat, as do ponds located in parks and golf courses.

Urban Wildlife BMPs

- Reduce potential food sources for wildlife in urban portions of the watershed (open dumpsters, domestic pet food left outdoors, etc.).
- Eliminate mowed areas adjacent to surface waters to discourage nuisance wildlife from congregating in riparian areas.
- Place decoy wildlife to discourage nuisance wildlife from congregating.
- Prohibit wildlife feeding by the public. Remove wildlife feeding station/vending machines that encourage wildlife to congregate.
- Consult with Utah Division of Wildlife Resources staff to identify strategies to reduce wildlife congregating in urban settings. Some nuisance species may be protected by federal law, so make sure to get expert opinion on these strategies.

7.1.3 Pets

The number of pets in an urban setting can be significant, so it's important that pet waste is managed appropriately. Residential yards, recreational paths, "doggy daycares," and zoos are all found in the Jordan River watershed and have the potential to impact water quality if proper waste management techniques aren't practiced.

Pet Waste BMPs

- Develop signage informing the public of the importance of proper pet-waste management.
- Place pet-waste collection supplies and disposal cans at high-use areas near surface waters.
- Establish and protect riparian vegetation to minimize direct access points for pets to surface waters.
- Adopt and enforce pet-waste ordinances and leash laws.
- Ensure that off-leash dog parks are properly maintained so they don't become a source of *E. coli* loading.
- Keep yards and areas where animals are kept free of pet waste so rain doesn't wash it to surface waters and storm drains.
- Develop educational materials on the impact of improper management of pet waste. Distribute in appropriate locations such as veterinary offices and pet stores.

The following resources provide additional information on proper pet waste management:

1. Salt Lake County Watershed Planning and Restoration's "The Real Scoop on Dog Poop" website, which has facts on pet-waste impact to watersheds as well as suggestions for pet owners to minimize the impact of improperly managed pet waste.

2. Salt Lake County Animal Services webpage. This webpage has links to animal ordinances by community and information on watersheds where dogs are prohibited to protect Salt Lake drinking water sources.

7.1.4 Agriculture and Irrigation/Stormwater Conveyance Canals

Grazing and agricultural land uses are minimal throughout the impaired AUs but still have the potential to be a source of *E. coli* loading into surface waters. There are hobby farms dispersed throughout the watershed that support horses, cows, goats, and chickens. Proven agriculture BMPs can be effective in protecting surface waters from the impact of improperly managed agricultural waste.

Another potential source of *E. coli* to the impaired tributaries are the canals that deliver irrigation water throughout the valley. These canals are dual-purpose in that they convey irrigation water and function as a stormwater mitigation tool. No monitoring has been performed in the canals to estimate the contribution of *E. coli* coming from them. However, increases in *E. coli* concentration in several tributaries coincides with the delivery of canal water during the summer irrigation season months.

Agriculture and Irrigation Conveyance BMPs

- Install fencing to prevent livestock from direct access to surface waters.
- Incorporate use of off-channel watering options for livestock.
- Ensure there is proper drainage management from pastures, barns, pens, and corrals to prevent waste from entering nearby waterways.
- Collect and compost stockpiled manure on a regular basis to decrease the likelihood of it draining to surface waters during storm events.
- Establish pollutant-filtering buffer strips of vegetation along waterways near agriculture practices.
- Monitor above and below irrigation canal inputs throughout the Jordan River watershed for *E. coli* to determine which have the potential to contribute to the impairment.

The following resources provide additional information on agriculture waste management:

1. Salt Lake County Watershed Planning and Restoration's "Livestock Keeping" website has information on decreasing livestock waste impact to watersheds and suggestions for managing manure piles and grazing.

2. EPA's publication Protecting Water Quality from Agricultural Runoff. This guide contains background information on the issue as well as related publications and a list of funding sources.

3. Natural Resources Conservation Service website on agriculture and water quality. This website discusses water quality standards and agriculture's role in water quality, and includes a link to conservation practice standards.

7.1.5 Recreation and Unhoused Population

Homeless encampments can be a source of pollutants to surface waters, as can recreators within and adjacent to the riparian area who do not properly dispose of their human waste. It is important to provide and maintain restroom facilities to the extent feasible in high-use areas. It is also important to educate the public on the importance of proper human-waste management in outdoor settings.

Recreation and Unhoused Population BMPs

- Provide and maintain restroom facilities in high-use recreation areas.
- Identify encampments of people experiencing unsheltered homelessness along waterways and provide restroom facilities or supplies as appropriate.
- Enforce ordinances on illegal camping on public grounds, streets, and parks which could lead to improperly managed human waste.

Utah's "Gotta Go" website has information on how to properly manage waste in a variety of outdoor settings. It recommends knowing before you go, being prepared with supplies, and going before you go.

As a quick reference, a summary of potential BMPs per nonpoint source is provided in Table 8.

Table 8. Potential BMPs for each nonpoint source category.

Source Category	Potential BMPs
Onsite Wastewater Systems	Implement a program to help identify failing systems throughout the watershed.
	Provide the public with information on proper maintenance and management of onsite wastewater systems.
	Provide cost-share incentives for onsite system maintenance.
	Inspect onsite system areas frequently to look for signs of failure.
	Have a professional pump the system every three to five years to optimize primary treatment.
	Conserve household water through high efficiency toilets and showerheads to minimize hydraulic loading to the system
	Compost kitchen waste instead of using a garbage disposal to minimize materials going down the drains and impacting the performance of the system.
	Properly dispose of household products and chemicals to minimize materials going down the drains and impacting the performance of the system.
	Maintain the drainfield by keeping the area free of deep-rooted trees and shrubs
	Never park or drive heavy vehicles over any part of the onsite system.

Wildlife	Eliminate mowed areas adjacent to surface waters to discourage nuisance wildlife from congregating in riparian areas.
	Place decoy wildlife to discourage nuisance wildlife from congregating.
	Reduce potential food sources for wildlife in urban portions of the watershed (open dumpsters, domestic pet food left outdoors, etc.).
	Consult with Utah Division of Wildlife Resources staff on strategies to reduce wildlife overpopulation in urban settings.
	Discourage the public from feeding wildlife. Remove wildlife feeding station/vending machines that encourage wildlife to congregate.
Domestic Pets	Place pet waste collection supplies at high-use areas near surface waters.
	Develop signage informing the public of the importance of proper pet-waste management.
	Adopt and enforce pet-waste ordinances.
	Establish and protect riparian vegetation to minimize direct access points to surface waters.
	Develop educational materials on the impact of improper management of pet waste. Distribute in veterinary offices and pet stores.
	Ensure that off-leash dog parks are properly maintained so they don't become a source of *E. coli* loading.
	Keep yards free of pet waste so rain doesn't wash it to surface waters and storm drains.

Agriculture	Monitor irrigation canals throughout the Salt Lake valley for *E. coli* to determine which have the potential to contribute to the impairment.
	Identify areas where livestock have direct access to surface waters and prioritize those for BMP implementation to reduce direct access/direct defecation into surface waters.
	Establish pollutant-filtering buffer strips of vegetation along waterways near agriculture practices.
	Incorporate use of off-channel watering options for livestock.
	Collect and compost stockpiled manure on a regular basis to decrease the likelihood of it draining to surface waters during storm events.
	Ensure there is proper drainage management from pastures, barns, pens, and corrals to prevent waste from entering nearby waterways.
Recreation and Unhoused Population	Provide and maintain restroom facilities in high-use recreation areas.
	Identify encampments of people experiencing unsheltered homelessness along waterways and provide restroom facilities or supplies as appropriate.
	Enforce ordinances on illegal camping on public grounds, streets, and parks which could lead to improperly managed human waste.
Illicit Discharges	Educate the public that it is illegal to dump waste down the storm drain system.
	Inform the public of the DEQ spill hotline that notifies appropriate staff if illegal dumping or other environmental incidents are observed.

7.2 Stormwater Strategy

Data and source analysis using multiple lines of evidence (land cover, LDCs, and MST) indicate that stormwater discharges are a significant contributor to the water quality impairment addressed in this TMDL. As impervious surfaces increase in the urban setting, stormwater infiltration decreases and pollutant-laden stormwater often flows directly into waterbodies. EPA guidance on NPDES-regulated stormwater discharges recommends implementation of a BMP-based approach within the MS4 individual and general permit requirements as a way to demonstrate compliance with a TMDL. The permit requirements must be clear, specific, and measurable (e.g., schedule for BMP implementation, frequency of practice, etc.) and support the minimum control measures identified in the permits (EPA, 2014). The following section is a summary of anticipated MS4 permit requirements resulting from the Jordan River Watershed *E. coli* TMDL.

7.2.1 MS4 Permit Requirements

Permittees covered under MS4 permits are expected to implement the six non-structural minimum control measures, which include:

- Public education and outreach on stormwater impacts.
- Public involvement and participation.
- Illicit discharge detection and elimination.
- Long-term stormwater management in new development and redevelopment (post-construction stormwater management).
- Construction site stormwater runoff control.
- Pollution prevention and good housekeeping for municipal operations.

MS4s will be required to identify sources of *E. coli* within their jurisdiction and target audiences that may be contributing to the sources. Outreach can be addressed through a collaborative program such as a stormwater coalition. An example would be increasing outreach related to pet waste and the impacts improper disposal has on waterbodies.

Permittees will be required to develop and maintain a written inventory and map of areas in their MS4 that are potential sources of *E. coli* (e.g., areas with septic, dense waterfowl areas, dog parks, etc.). Areas will be added to already-identified priority areas in the MS4, and inspection will be required annually at a minimum.

Areas inventoried by the MS4 as a potential source of *E. coli* will be required to be added to the MS4s prioritized street sweeping areas and maintained at the same frequency as other priority areas in their MS4.

MS4 owned and operated facilities that have the potential to discharge *E. coli* (e.g., dog parks, sites with septic, parks with open water, etc.) will be required to be added to the MS4s potential "high-priority" facility list, and those with increased risk of *E. coli* discharges shall be identified as "high priority." Sites that have been identified as potential sources of *E. coli* must have BMPs (structural and/or nonstructural) that reduce the potential of the discharge of *E. coli*.

MS4s will be required to evaluate the potential *E. coli*-generating activities in their MS4, such as mowing, trimming and planting, inspection and cleaning of stormwater conveyance structures, and sanitary sewer maintenance to determine whether existing standard operating procedures (SOPs) should target reduction of *E. coli* discharges, or if additional SOPs should be developed to address the water quality impairment in the MS4 area. MS4s will be required to add potential *E. coli* reduction as a criterion for ranking when evaluating their retrofit plans, and will also be required to analyze *E. coli* (MPN/100 mL) at their established wet-weather monitoring sites.

MS4s will be required to promote the use of low-impact development (LID) controls that have a medium or high pollutant-removal effectiveness for *E. coli* as identified in the Guide to Low-impact Development within Utah. This document was developed in 2019 as a reference and guide for incorporating LID stormwater approaches into new development and redevelopment projects. The guide helps planners and designers select appropriate practices to incorporate in their site design and helps MS4 program managers evaluate LID practices and determine what is most appropriate for their stormwater programs. The recommendations in the guide comply with the goals of the federal Clean Water Act (CWA) "to reduce the discharge of pollutants to the maximum extent practicable."

MS4s will be required to report annually on their TMDL compliance by submitting a TMDL compliance report form with their annual report. The reporting will include identification of problem areas for which source control BMPs were developed, the cost, and the anticipated pollutant reduction.

7.2.2 Structural BMPs for Consideration

Table 9 lists structural stormwater source-control BMPs that have the potential to reduce *E. coli* loading to surface waters. While structural BMP implementation will not be a permit requirement in response to this TMDL, permittees can explore these and other stormwater source-control BMPs options if they choose to go above and beyond their MS4 permit requirements.

Table 9. Structural BMPs for stormwater source control.

BMP	Description	Location within Guide to Low-impact Development in Utah
Rain garden	Rain gardens are shallow bioretention areas with engineered or native soils that allow for infiltration and removal of pollutants.	Appendix C-3
Bioretention cell	Bioretention cells are shallow bioretention areas with engineered soil. They typically differ from rain gardens by having a delineation such as a curb, wall, or other distinct boundary.	Appendix C-10
Bioswale	Bioswales are vegetated open channels designed to convey and treat stormwater runoff. They are appropriate when it is desirable to convey flows away from structures or as an alternate conveyance method to pipes, concrete channels, or curbed gutters.	Appendix C-16

Vegetated strip	Vegetated strips are designed to receive and treat sheet flow from adjacent surfaces. This is accomplished by slowing runoff velocity to allow pollutants and sediments to settle and filtering out pollutants in the vegetation before entering the storm sewer system. Vegetated strips are best utilized for stormwater treatment from roads, parking lots, and other impervious surfaces.	Appendix C-23
Tree box filter	Tree box filters are bioretention systems that consist of an underground concrete vault that contains a soil matrix that provides bioretention and has a grated top where vegetation grows.	Appendix C-28
Green roof	A green roof is a vegetated system that is designed to retain and treat rooftop runoff. The primary function of a green roof is bioretention, volume retention, and filtration. Green roofs capture stormwater within the pore space of the soil and vegetation, and the moisture is then released through evapotranspiration.	Appendix C-31
Pervious surfaces	Pervious surfaces such as permeable pavement, concrete pavers, pervious concrete, modular open pavers, and other types of pervious surfaces provide structural support for light vehicle or pedestrian traffic while also providing open space for stormwater infiltration.	Appendix C-36

Infiltration basin	Infiltration basins are shallow depressions that use existing soils to retain and provide treatment for stormwater runoff. Infiltration basins function by capturing and infiltrating runoff over a specified drawdown time.	Appendix C-41
Infiltration trench	Infiltration trenches are linear excavations that are backfilled with a combination of gravel, open graded stone, and sand layers that provide storage within the pore space of the specified layers.	Appendix C-47
Dry well	Dry wells are underground storage areas that retain water and infiltrate runoff into the existing soils surrounding the well.	Appendix C-53
Underground infiltration galleries	Underground storage devices are proprietary alternatives to above-ground storage when space at the project site is limited. Pretreatment of water entering the underground system may be required.	Appendix C-58
Harvest and reuse	Harvest and reuse refer to any type of runoff collection system that captures rainfall, stores it temporarily, and reuses it for irrigation, landscaping, or other non-potable uses.	Appendix C-62

7.3 Implementation Plan Funding Sources

Project implementation will require collaboration on project identification, planning, technical assistance, and funding. There are a variety of funding sources available to support the goals of this TMDL, including in-kind contributions, donations, grants, and loans. Local, state, and federal programs are in place to provide technical and financial support.

The primary funding mechanism through DWQ for nonpoint source project implementation is CWA Section 319 nonpoint source funding and state nonpoint source grants. EPA Section 319 funds are allocated to states and tribes annually to support voluntary water quality improvement projects.

A list of potential federal funding sources for onsite septic systems can be found on the EPA website for onsite septic systems.

Several potential funding sources to address agricultural waste management can be found in the EPA publication "Protecting Water Quality from Agricultural Runoff."

A comprehensive list of state and federal funding opportunities to address stormwater runoff was compiled by EPA's Water Infrastructure and Resiliency Finance Center.

7.4 EPA's Nine-element Watershed Planning

EPA lays out an organized, six-step path for successful watershed management planning that includes nine minimum elements. Any projects included in the TMDL implementation plan that will utilize Section 319 nonpoint source funds are required to follow the nine-element watershed planning process. The process is similar to TMDL development, with steps included to build partnerships, provide a detailed characterization of the water quality concerns, identify the goals and solutions, and ensure the public is included in the process. The six steps of the watershed planning process are listed below; within those are the required minimum nine elements.

Step 1. Build partnerships.

Step 2. Characterize your watershed.

Element 1: Identify causes and sources of pollution.

Step 3. Finalize goals and identify solutions.

Element 2: Estimate load reductions expected.

Element 3: Develop management measures and targeted critical areas.

Step 4. Design an implementation plan.

Element 4: Estimate technical and financial assistance needed.

Element 5: Develop an information and education component.

Element 6**:** Develop a project timeline.

Element 7: Describe interim, measurable milestones.

Element 8: Identify indicators to measure progress.

Element 9: Develop a monitoring component.

Step 5. Implement the watershed plan.

Step 6. Measure progress and make adjustments.

Completed and in-progress nine-element watershed plans for the Jordan River watershed include the 2015 Salt Lake County Watershed Plan and the Emigration Canyon Watershed Plan, which is slated to be finalized in 2023.

The EPA website has additional information about resources for watershed planning as well as a Quick Guide to Developing Watershed Plans to Restore and Protect Waters.

7.5 Information and Education Strategy

The information and education strategy for the Jordan River watershed is primarily addressed through the public engagement and information/education requirements in the Salt Lake area MS4 permits. The Salt Lake County Stormwater Coalition has developed messaging about the importance of stormwater management. It maintains a website with information related to stormwater, and the Coalition hosts water fairs that teach students and residents about watershed function and the importance of good water quality. Salt

Lake County's Watershed Planning and Restoration Program hosts an annual watershed symposium that includes discussions on water quality and watershed issues.

Implementation plan recommendations for the information and education component include continuation of the previously mentioned efforts as well as the following action items:

1. Continue to work with the Jordan River Watershed Council, Jordan River Commission, Salt Lake County Stormwater Coalition, Seven Canyons Trust, Salt Lake County Conservation District and other active watershed groups to help inform local landowners, state, federal, and local agencies, and environmental groups on pertinent issues within the watershed.

2. Continue to work with watershed groups to hold education events with local stakeholders to inform them of the water quality problems that exist, potential solutions, and entities that can provide technical and financial assistance.

3. Develop an education campaign addressing the need for onsite septic system inspection and maintenance. Develop an incentive program to help landowners pay for the inspection and maintenance of their septic systems if needed.

4. Continue to promote education on the proper disposal of pet waste in recreation areas in the watershed.

5. Continue to promote the education campaign addressing the benefits of proper stormwater management, LID practices, green infrastructure (GI), and SWPPPs in managing the impacts of construction on water quality.

6. Work with local conservation district staff to implement the agriculture-related goals of the TMDL.

Chapter 8. Public Participation

Stakeholder participation for the Jordan River Watershed *E.coli* TMDL was achieved through meetings and site visits with governmental agency representatives and local landowners.

Jordan River watershed stakeholders include:

- Utah Division of Water Quality
- Utah Department of Agriculture and Food
- Utah Department of Transportation
- Salt Lake County Health Department
- Salt Lake County Watershed Planning and Restoration
- Salt Lake Conservation District
- Salt Lake County Stormwater Council
- Local municipalities (MS4 Permittees)
- Jordan River Commission
- Jordan River Commission Technical Advisory Council
- Central Valley Wastewater Reclamation Facility
- South Valley Wastewater Reclamation Facility
- Natural Resource Conservation District
- U.S. Forest Service
- Private landowners
- Wheeler Farm
- U. S. Environmental Protection Agency

Table 10. Public participation timeline

YEAR	ACTIVITY
2011 - ongoing	*E. coli* and field sampling conducted by Salt Lake County and DWQ
2018	**Year 1 of 3:** MST monitoring (via NPS grant)
2019	**Year 2 of 3:** MST monitoring **February 5** - Kick-off TMDL meeting at the Jordan River Watershed Council
2020	**Year 3 of 3:** MST monitoring Scoping project: TMDL tracking and credit tool MS4 and POTW interviews (TMDLs and tracking tool)
2021	Emigration Canyon MST sampling **February 23** - NRCS Local Workgroup: TMDL update **March 21** - Salt Lake County Stormwater Coalition: TMDL update **April 21** - Salt Lake County Stormwater Coalition: TMDL Tracking Tool **May 26** - Water Quality Board: TMDL Introduction **June 17** - Jordan River Commission Technical Advisory Committee: TMDL update **July 27** - Big Cottonwood Creek Tour with Salt Lake City Public Utilities (SLCPU) **October 5** - Best Management Practices Training presentation: Emigration **November 17** - Salt Lake County Watershed Symposium presentation: TMDLs

2022	
	February 22 - NRCS Local Workgroup Meeting: TMDL Introduction
	April 4 - Targeted Solicitation: Salt Lake Conservation District
	April 13 - Utah Stormwater Advisory Committee presentation: TMDL, MS4, IR
	April 20 - Salt Lake County Stormwater Coalition: TMDL update
	April 26 - Wheeler Farm site visit
	April 28 - Targeted Solicitation: Utah Department of Agriculture and Food
	May 17 - Targeted Solicitation: Salt Lake County Watershed and Restoration
	May 26 - Targeted Solicitation: Salt Lake City Public Utilities
	May 31 - Targeted Solicitation: Jordan River Watershed MS4s
	June 8 - Draft TMDL Report: Stakeholder review period begins
	June 16 - Targeted Solicitation: Jordan River Commission Technical Advisory Committee
	July 8 - Draft TMDL Report: Stakeholder review period ends
	August 4 - Jordan River Commission Governing Board: TMDL Overview
	August 17 - Little Cottonwood Creek Restoration tour with Seven Canyons Trust
	August 24 - Water Quality Board: Request to Initiate Rule-making
	September 15 - October 15: Official Public Comment Period
	September 20 - Utah Stormwater Expo - TMDL Overview
	September 21 - University of Utah - TMDL Overview
	October 7 - Sandy City - TMDL & MS4 discussion
	December 14 - Water Quality Board: Request adoption into Rule
	December 15 - Submit to EPA for final approval

Chapter 9: TMDL Public Comment & DWQ Response

Organization	Report	Page #	Comment	Response
Salt Lake City Public Utilities	Main Report	All	Editorial	DWQ made editorial changes per recommendations throughout the main report.
Salt Lake City Public Utilities	Main Report	Page 17, Table 4	Is this for the Brighton Loop? The new Town of Brighton would have jurisdiction for this area.	Brighton Loop is in Big Cottonwood-2 (BCC-2) Assessment Unit, which extends from the canyon mouth upstream to the headwaters. While this upper AU is listed on the 2022 303 (d) List for elevated levels of *E. coli*, it is not addressed in this TMDL report. The lower Big Cottonwood Assessment Unit-1 (BCC-1) is addressed in this TMDL (see Appendix A) and extends from the confluence of the Jordan River upstream to the drinking water plant at the canyon mouth. DWQ will address the BCC-2 *E.coli* impairment when additional data, including Microbial Source Tracking data, are available. Stakeholder input, including the town of Brighton, will be crucial in the BCC-2 TMDL analysis. No change was made in response to this comment.
Salt Lake City Public Utilities	Main Report	31	What about the Jordan Basin facility in Bluffdale?	The Jordan Basin Wastewater Treatment Facility discharges into Jordan River-6 Assessment Unit (JR-6), which is currently not impaired for *E. coli*. This AU is upstream of the *E. coli* impaired assessment units (JR-1 through JR-5) addressed in this TMDL. The Jordan Basin Wastewater Treatment Facility was not included as a point source discharge in the TMDL. No change was made in response to this comment.
Salt Lake City Public Utilities	Main Report	33	Is this supposed to be Salt Lake Valley or Jordan Valley Municipalities UTS00000?	DWQ made the correction on page 33 in response to this comment.

Organization	Report	Page #	Comment	Response
Salt Lake City Public Utilities	Main Report	37 Figure 7	What year is this map?	The permit data illustrated in Figure 7 were downloaded on March 1, 2022 as stated in the preceding paragraph. DWQ included this date to the heading of Figure 7 on page 37.
Salt Lake City Public Utilities	Main Report	39	What are the 5 sites?	The 5 satellite systems for South Valley Water Reclamation Facility are: 1) South Valley Sewer District, 2) West Jordan City, 3) Sandy Suburban Improvement District, 4) Midvalley Improvement District, and 5) Midvale City. The 7 satellite systems for Central Valley Water Reclamation Facility are: 1) Mt. Olympus, 2) Granger-Hunter, 3) Cottonwood, 4) Kearns, 5) Taylorsville-Bennion, 6) Murray, and 7) South Salt Lake. DWQ included these systems on page 39 in response to this comment.
Salt Lake City Public Utilities	Main Report	44	Is this correct? I thought the trail was longer and continuous lake to lake.	The Jordan River trail is a 45-mile trail from Utah Lake to Great Salt Lake as stated on the Jordan River Commission website. No change was made in response to this comment.
Salt Lake City Public Utilities	Main Report	52	There has been a recent update to the Blueprint [Jordan River].	The update to the Jordan River Blueprint was not finalized at the time of publication of this TMDL. No change was made in response to this comment.
Salt Lake City Public Utilities	Main Report	70	This plan is an IWM plan and not a 9-element watershed plan. We also have our 1999 Watershed Plan and update, but those are per the SDWA and thus do not fall under the CWA 9-elements.	Thank you for pointing this out. DWQ made the correction on page 70 in response to this comment.
Salt Lake City Public Utilities	Main Report	70	Year?	The Emigration Canyon Watershed Plan will be completed in 2023. DWQ made the correction on page 70 in response to this comment.
Salt Lake City Public Utilities	Main Report	70	Is this the Salt Lake County Watershed Council or the new JRWC that will be housed under the JRC per the watershed council legislation?	The State Watershed Councils are in the process of being formed and will include one for the Jordan River. The Jordan River Watershed Council that was overseen by Salt Lake County has not been active in recent years, but it has not been officially dissolved either. No change was made in response to this comment.

Organization	Report	Page #	Comment	Response
Salt Lake City Public Utilities	Main Report	71	How about working with the UACD?	Under the Outreach and Education section, DWQ identifies the Salt Lake Conservation District, a local branch of UACD, as a partner in future work. DWQ made the correction on page 71 in response to this comment.
Bluffdale City	Main Report	61	I like the idea of placing decoy wildlife, however I could see these getting stolen or vandalized very quickly.	These suggested BMPs should be deployed in strategic locations to prevent vandalism or theft. No change was made in response to this comment.
Bluffdale City	Main Report	64	2nd paragraph - What is the logic behind how E. Coli contaminants make it into the streets? And can you really sweep up E. Coli? It's hard to envision more street sweeping as a highly effective BMP to control E. Coli. Besides, wouldn't this be considered more of a remedial measure rather than preventative/source control?	Bacteria (*E. coli*) can attach to the sediment, so street sweeting acts as a preventative measure in two (2) ways: 1. removing sediment from the streets and storm drain system that have bound with *E. coli*, thus removing the amount of *E. coli* that reaches the stream; and 2. removing the amount of fine sediment that reaches the stream that *E. coli* can attach to. No change was made in response to this comment.
Bluffdale City	Main Report	64	3rd paragraph - What would a "high-priority" annual visual discharge observation look like for a site with E. Coli concerns? Since E. Coli contamination is not visible, any visual cues would only point to investigation of other usual contaminants of concern (oils, sediment, chemical etc). The semi-annual inspection procedure in the current permit is also not written in a way that is helpful for examination of a site listed high-priority only because of E. Coli. It focuses more on the other contaminants.	The concept is the same as other "high priority" facilities identified as part of the Pollution Prevention and Good Housekeeping Minimum Control Measure. Permittees must assess Permittee-owned or operated facilities, operations, and stormwater controls for common pollutants (including *E. coli*) that may originate from these facilities and how to prevent them from entering the storm drain system. *E. coli* can attach to sediment and pathogens (*E. coli*) live longer when levels of organic carbon and fine sediment particles in stream sediment is higher. So, conducting annual visual observation for turbidity, organic matter, etc. would make a difference by ensuring that there is not significant sediment or organic matter discharging offsite. MS4s will have an opportunity to comment on any proposed permit condition when the permit is modified in early 2023. No change was made in response to this comment.

Organization	Report	Page #	Comment	Response
Bluffdale City	Main Report	64	4th paragraph down - Targeting mowing/trimming, planting, and inspection/cleaning of storm drains as potential E. Coli "generating" activities seems like a stretch. I can't think of what specifics could be added to these SOPs to address E. Coli. Would we add instructions in our SOP to go around and pick up all poop off the lawn before you start mowing/trimming? And for conveyances/storm drains, any decant from the cleaning already requires proper disposal by its current SOP (and the permit) anyway.	The idea is for MS4s to take a look at SOPs and determine if there is anything that can be added as a stand-alone SOP or as an update to an existing SOP in regard to reducing E. *coli.* In regard to mowing/trimming, grass clippings and other organic matter (leaves) are the bi-product and ensuring that the organic matter does not get into the storm drain or directly into waterbodies is a way to reduce *E. coli* in streams. Pathogens (*E. coli*) live longer when levels of organic carbon and fine sediment particles in stream sediment is higher. Additionally, although there are existing requirements in the MS4 permit for specific SOPs, MS4s must regularly evaluate their SOPs to ensure SOPs are adequate. The requirement is meant to draw attention to those SOPs that could benefit from review. MS4s will be provided an opportunity to comment on specific permit requirements when the MS4 permits are modified in early 2023. No change was made in response to this comment.
Bluffdale City	Appendix H. Rose Creek AU TMDL	194	Regarding the last paragraph about permittees being required to show they are in compliance with E. coli reduction requirements - I am concerned about the possibility that even full implementation of identified BMPs may not bring the required 83% reduction in E. Coli required for this watershed, considering the unknown proportions of contamination that natural wildlife (in areas beyond our control such as in canals and wetlands, both of which are many in our City) may be contributing. What will be the consequences of not meeting this metric despite our efforts?	The 83% reduction stated on page 181 serves only as a magnitude reference point for the Rose Creek AU. It is not a TMDL requirement or MS4 permit limit. The TMDL requirement is that all waterbodies meet the *E. coli* Water Quality Standards. By implementing the best management practices identified in the TMDL and adhering to the amended MS4 permit, a reduction in *E. coli* will occur. No change was made in response to this comment.

Organization	Report	Page #	Comment	Response
Bluffdale City	Appendix H. Rose Creek AU TMDL	197	4th paragraph down - "No further implementation" for natural wildlife brings some sense of relief, but it is concerning to wonder how much of the E. Coli loading that we are charged to reduce may be coming from this 76% of land that is natural and beyond our control, seeing that much of it lies uphill and would runoff to our MS4?	The wildlife contribution is unknown for Rose Creek AU. As part of the TMDL implementation plan, DWQ will work with land managers to reduce animal sources on a voluntary basis using both state and federal nonpoint source grants. Increased monitoring including targeted site selection and Microbial Source Tracking will help address the relative contribution per source. Urban implementation efforts should focus on stormwater sources within the designated MS4 boundary. Addressing both nonpoint and point sources of *E. coli* contamination will reduce concentrations in Rose Creek. No change was made in response to this comment.
Bluffdale City	Appendix H. Rose Creek AU TMDL	188	Since microbial source tracking was not performed for this watershed, it is difficult to know what sources to target. Will the burden of source tracking now be on the MS4's within this watershed?	Microbial Source Tracking (MST) will not be required as part of MS4 Permit requirements. If Bluffdale City would like to collect MST samples, Nonpoint Source Grant funding is available. Please contact Sandy Wingert for more information. No change was made in response to this comment.
Salt Lake County	Main Report	26	According to data collected by Salt Lake County in the MST final report (Green, 2020), the most significant contributor to E. coli concentrations in Salt Lake County is Avian through waterfowl. This information should be added to non-point sources in 4.7.2.	Wildlife sources are described in the Nonpoint Source Section 5.2.4 on page 46. No changes were made in response to this comment.
Salt Lake County	Main Report	39	Salt Lake County has many more reported Sanitary Sewer overflows than this report indicates.	DWQ made the correction on page 39 in response to this comment.
Salt Lake County	Main Report	66	Will high priority sites based on E. coli generation potential require the same inspection frequency and site specific SWPPP documentation as other existing high priority sites?	The "high priority" sites based on *E. coli* generation will be required to meet the same requirements as other "high priority" facilities per the Pollution Prevention and Good Housekeeping for Municipal Operations Minimum Control Measure. MS4s will have an opportunity to comment on permit specifics when the permit is modified in early 2023. No

Organization	Report	Page #	Comment	Response
				changes were made in response to this comment.
Salt Lake County	Main Report	1	Salt Lake County believes a wider stakeholder group including private canal/irrigation companies should be engaged to implement this TMDL as much of the water in the impaired watersheds enters those watersheds through canal inflows (cross basin diversions and transport) rather than inflows from the watersheds themselves. BMP installation in impaired watersheds will do very little to change the nature of a problem that originates outside of its boundaries.	Targeted stakeholder groups, including canal and irrigation companies, will be involved once project work has been identified. They are crucial to implementation of BMPs and reducing E. coli concentrations in impaired streams. No changes were made in response to this comment.

Organization	Report	Page #	Comment	Response
University of Utah	Main Report	59	I very much appreciate that BMPs in this section are written to encourage the provision of restrooms to unsheltered populations and people recreating. Perhaps it should be noted that restroom facilities should be open year-round in high use areas and some areas lack such services. I am concerned, as well, that inclusion of language promoting greater enforcement of illegal camping will only bolster the sweeps of unsheltered camps, which have significant detrimental effects on unsheltered populations and only solidify the state of being unsheltered and ultimately just leads people to move elsewhere (often still along waterways). Rather, I suggest the inclusion of providing greater services to alleviate homelessness in general. Recent surveys conducted by the University of Utah provide evidence that unsheltered populations generally, but not always, take care of their surroundings. Without strong evidence that e coli is coming directly from unsheltered populations, the language in this report could add to the unfounded concern of 'poop and needle' proliferation near waterways from unsheltered populations.	As part of the TMDL implementation plan, State Nonpoint Source funds could be secured to address the unhoused community and their water quality impacts. This project work would be directed by stakeholders such as the Jordan River Commission and Salt Lake County Health Department. No changes were made in response to this comment.

Organization	Report	Page #	Comment	Response
University of Utah	Appendix I. Jordan River-5 AU TMDL	199	My comment really applies to all units of the Jordan River and the inability to distinguish different humans sources of e coli (i.e., e coli vs. recreation / unsheltered populations) using microbial source tracking markers. The Jordan River has chronic inputs of effluent, likely with high levels of e coli that swamp inputs from users of the Jordan River Parkway. I recommend UDWQ sample effluent from multiple WRFs and obtain effluent discharge data to model loads of e coli from effluent and compare that to loads observed in the river.	Microbial Source Tracking analysis was used to determine plausible sources of E. coli contamination in the Jordan River watershed. It does not distinguish between human sources, however local knowledge of the impaired reaches provides insight into more specific sources. Wastewater treatment facilities monitor their effluent for *E. coli,* which is required by their UPDES discharge permit. Their permit limit is less than *E. coli* water quality standards. Since this TMDL uses a concentration based approach and not a load based one, comparing loads is not appropriate. No changes were made in response to this comment.
University of Utah	Main Report	99999999	My third comment is a suggestion that future studies try to distinguish sources of e coli within stormwater, given loads tend to be quite high after flushing events. Since avian sources are ubiquitous, I wonder if fecal matter from birds nesting on buildings is flushed from roofs via storm sewers. I also recommend a collaboration with the Department of Health to identify unmapped, defunct septic systems in Salt Lake City (especially by Red Butte Creek) to identify if leakage to groundwater and subsequent recharge to surface waters may be a source of e coli.	The amended MS4 permits will not require additional monitoring above and beyond the current permit. Project implementation efforts in impaired streams would target localized sources including waterfowl and failing septic tanks. Salt Lake County Health Department is currently working on digitizing onsite septic systems which could provide further insight into necessary BMPs to address the TMDL endpoints. No changes were made in response to this comment.
Environmental Protection Agency	Main Report	9, Figure 1	Missing "i"	DWQ made the correction on page 9 in response to this comment.
Environmental Protection Agency	Main Report	14	Consider changing the word standard to criteria in the paragraph after Table 2.	DWQ made the correction on page 14 in response to this comment.

Organization	Report	Page #	Comment	Response
Environmental Protection Agency	Main Report	19, Figure 3	In the legend, the title above Emigration Canyon is a little confusing. Makes it seem like all symbology underneath are approved E. coli TMDLs. Consider making the title of the purple symbology "Approved E. coli TMDLs" instead of "Emigration Canyon".	DWQ made the correction on page 19 in response to this comment.
Environmental Protection Agency	Main Report	Page 23 – First paragraph in section 4.6	add units (MPN) after 206,……"the more stringent criterion of 206 MPN/100 mL"	DWQ made the correction on page 23 in response to this comment.
Environmental Protection Agency	Main Report	36, Figure 6	Map legend is difficult to read at 100% and when zoomed in. This occurs in other map legends throughout the document.	DWQ made the correction on page 36 in response to this comment.

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