WATERSHED MANAGEMENT PLAN

FOR THE SPRING CREEK WATERSHED

Topical Report RSI-2416

prepared for

Pennington County
315 Saint Joseph Street, Suite 118
Rapid City, South Dakota 57701

April 2015

RESPEC
CONSULTING & SERVICES

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by

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The Spring Creek Watershed Management and Implementation Project is sponsored by the Pennington County Board of Commissioners with support from the following organizations: city of Hill City; South Dakota School of Mines and Technology (SDSM&T); West Dakota Water Development District; city of Rapid City; U.S. Forest Service's Black Hills National Forest; South Dakota Game, Fish and Parks; Black Hills Resource Conservation and Development Association; Pennington Conservation District; Black Hills Flyfishers; and the Natural Resources Conservation Service.

Specific individuals involved in gathering, analyzing, and interpreting data for this plan include Ms. Brittney Molitor, Ms. Lysann Zeller, Ms. Kelsey Rausch, Ms. Mandi Schmierer, and Mr. Aaron Olson with Pennington County; Mr. Art Anderson and Mr. Brett McMacken with the city of Hill City; Mr. Chris Nichols with Custer County; Mr. Scott Hipple and Mr. Lee Baron with the SD DENR; Mr. Pete Rausch, Mr. Tom Schmitz, Mr. Tyler French, and Dr. Scott Kenner with the SDSM&T; and Ms. Teresa Whitney, Mr. Eric Krantz, Mr. Cory Foreman, Ms. Cindie McCutcheon, and Mr. Jared Oswald with RESPEC.

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1.0 INTRODUCTION

Approximately 1.5 to 2 million people visit the Black Hills annually to enjoy its attractions, recreation, and history. Many of these attractions, including Mount Rushmore National Memorial, the Black Hills National Forest (BHNF), Custer State Park, the Norbeck Wildlife Preserve, Crazy Horse Memorial, the Sturgis® Motorcycle Rally, and Deadwood, are within a 15-minute to 1-hour drive of the Spring Creek Watershed. Water resources in the Black Hills are vital because they provide health, economic, ecologic, agriculture, and recreation benefits. Some of these water resources are located within the Spring Creek Watershed. The Spring Creek Watershed is the drainage area, including Spring Creek and its tributaries, above Sheridan Lake Dam, and it encompasses 92,840 acres in Pennington and Custer Counties. The watershed is located approximately 13 miles southwest of Rapid City, South Dakota. Hill City is the only municipality within the watershed. Spring Creek is a perennial, mountain stream and a tributary to the Cheyenne River. Sheridan Lake, Sylvan Lake, Major Lake, and Mitchell Lake are within the watershed and provide a variety of recreational activities.

The state of South Dakota has assigned streams with the beneficial uses of fish and wildlife propagation, recreation, stock watering, and commerce and industry unless otherwise stated [South Dakota Legislature, 2012a]. Lakes have been assigned the beneficial uses of immersion recreation, limited-contact recreation, fish and wildlife propagation, recreation, and stock watering unless otherwise stated [South Dakota Legislature, 2012a]. In addition to the irrigation, fish and wildlife propagation, recreation beneficial uses, Spring Creek was assigned the following beneficial uses: coldwater permanent fish life propagation (above Sheridan Lake), coldwater marginal fish life propagation (below Sheridan Lake), warm-water permanent fish life propagation (below South Dakota Highway 79), immersion recreation, and limited-contact recreation. Additional assigned beneficial uses for Sheridan Lake and Sylvan Lake include coldwater permanent fish life propagation, immersion recreation, and limited-contact recreation.

Water quality standards in support of beneficial uses have also been adopted by the state of South Dakota and include criteria that apply to streams and lakes based on the assigned uses [South Dakota Legislature, 2012a]. South Dakota's water quality criteria for immersion recreation waters apply during the recreation season, which is defined from May 1 to September 30 [South Dakota Legislature, 2012a]. The South Dakota Department of Environment and Natural Resources (SD DENR) monitors surface waters through a water quality monitoring program, Total Maximum Daily Load (TMDL) assessments, surface water discharge permits, and nonpoint-source projects. The SD DENR has prepared South Dakota's impaired waterbody lists and integrated reports, which identify waterbodies that are in need of TMDLs. These waterbody lists and integrated reports have included Spring Creek, Sheridan Lake, and Sylvan Lake. The SD DENR performed assessments on Sylvan Lake, Sheridan Lake, and Spring Creek from 2001 to 2004 to determine sources of fecal coliform bacteria, sediment, and nutrients. The assessments were used to develop TMDLs, which were approved by the U.S.

Environmental Protection Agency (EPA) on Sylvan Lake, Sheridan Lake, and Spring Creek in 2005, 2006, and 2008, respectively.

A report prepared by the SD DENR [2008a], a pollutant assessment, was based on a review of available information and communication with local landowners and representatives from Hill City. The report suggested that the primary nonpoint sources of fecal coliform within the watershed included urban and agricultural runoff, as well as wildlife and human sources [SD DENR, 2008a]. Watershed modeling efforts estimated that more than half (63.5 percent) of the nonpoint-source fecal coliform bacteria load comes from livestock and agricultural sources, and the remaining load originates from urban runoff (13.7 percent); human sources (14.8 percent), including failing septic and leaking sewer systems; and wildlife (7.9 percent) [SD DENR, 2008a]. Critical conditions occur during the summer when increased livestock and tourist activities cause a peak in bacteria sources, which is combined with localized, intense thunderstorms to produce significant fecal coliform bacteria loading [SD DENR, 2008a]. Potential sources included manure from livestock, failing on-site wastewater treatment systems (OWTS), wildlife, leaking sewers, and domestic animals [SD DENR, 2008a].

In 2009, the SD DENR expressed their interest in protecting Spring Creek and met with representatives from the city of Hill City, the West Dakota Water Development District, the Black Hills Resource Conservation and Development Association, and the Pennington Conservation District to review the TMDL and potential funding opportunities. Later in 2009, the Pennington County Board of Commissioners approved submitting the *Spring Creek Watershed Management and Project Implementation Plan–Segment 1* proposal to the SD DENR. In 2010, the SD DENR's Board of Water and Natural Resources approved the South Dakota Nonpoint Source Task Force's recommendation to fund Pennington County's *Spring Creek–Segment 1* proposal, which included riparian and septic rehabilitation projects; public outreach and project management; ambient and storm event water quality monitoring; and management plan development for stormwater, on-site wastewater, and watershed implementation.

1.1 PROJECT AREA

The project area is the Spring Creek Watershed, which covers approximately 92,840 acres (145 square miles) and is defined as the drainage upstream of Sheridan Lake Dam, as illustrated in Figure 1-1. The "watershed" and "project area" terms are used interchangeably throughout this plan. The watershed is approximately 18 miles long and 11 miles wide. The project area is located in the Middle Cheyenne–Spring subbasin (8-digit Hydrologic Unit Code [HUC] 10120109) and the western portion of the Upper Spring Creek Watershed (10-digit HUC 1012010910) and contains the Newton Fork, Newton Fork–Spring Creek, Headwaters Spring Creek, and Sheridan Lake–Spring Creek 12-digit (6th level HUC) hydrologic units or designated subwatersheds. These subwatersheds were obtained from the National Watershed Boundary Dataset [Natural Resources Conservation Service, 2012a].

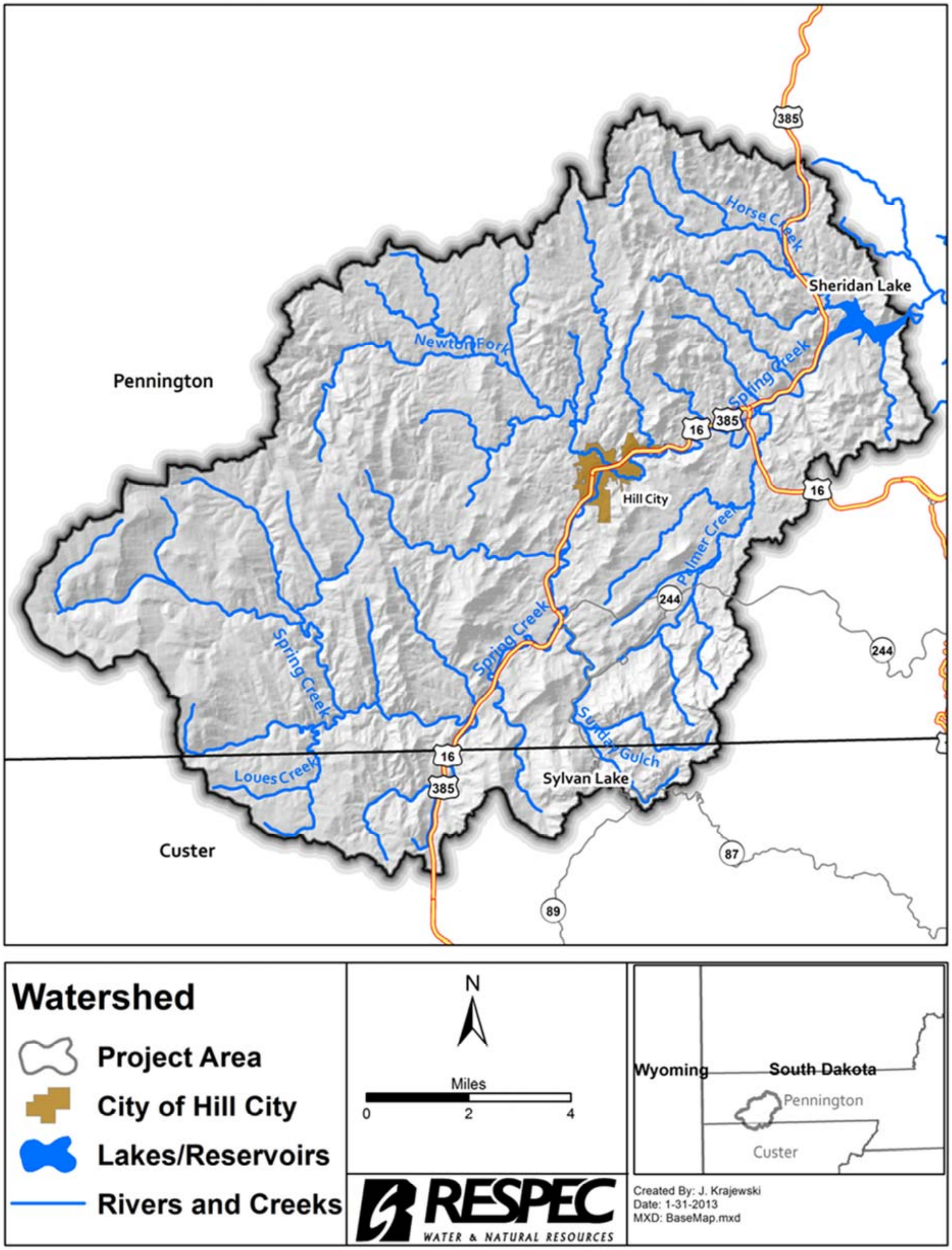

Figure 1-1. Spring Creek Watershed Project Location Map.

1.2 ADVISORY GROUP

In June 2010, the Pennington County Board of Commissioners formed a 14-member advisory group to provide recommendations to the board about the project. The Spring Creek Watershed Advisory Group has consisted of three private property owners and representatives from the local, state, and federal agencies and organizations. The advisory group has met several times and made recommendations to the Pennington County Board of Commissioners regarding water quality monitoring, cost-share application rankings, and cost-share dockets.

1.3 WATERSHED MANAGEMENT AND IMPLEMENTATION

This Watershed Management Plan summarizes past accomplishments and provides information that can assist residents, landowners, and decision makers in attaining water quality standards on waterbodies within the Spring Creek Watershed. Water quality, wildlife, on-site wastewater, stormwater, recreation, and grazing conditions and activities, in addition to suggested implementation practices, proposed alternatives, and recommended priorities, are described in this plan. This plan is one of three planning tasks for the *Spring Creek Watershed Management and Project Implementation Plan–Segment 1* [Oswald, 2009]. The other two tasks included a *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013] and an *On-Site Wastewater Management Plan for the Spring Creek Watershed* [Krajewski, 2013].

1.3.1 Mission Statement

The mission of the Spring Creek Watershed Management and Implementation Project is to encourage voluntary progressive and efficient implementation of best management practices (BMPs) to restore beneficial uses on waterbodies within the Spring Creek Watershed.

1.3.2 Goals

The project goal is to bring Spring Creek into compliance for fecal coliform bacteria and *E. coli* by implementing the recommended BMPs by 2021. The goal of this project segment, as set forth in the Spring Creek and Sheridan Lake TMDL studies, is to accomplish the following:

- Implement several BMP pilot projects that will be used to demonstrate and promote the effectiveness of BMP implementation on water quality
- Develop a 10-year Spring Creek Watershed Project Plan, Stormwater Management Plan, and Septic System (OWTS) Management Plan that will help prioritize BMP implementation and public outreach efforts.
- Conduct significant public education and outreach to stakeholders within the Spring Creek Watershed

- Perform water quality monitoring to aid in developing a baseline condition that will ensure that BMPs are effective and proper BMPs are being implemented.

1.3.3 Project Accomplishments

Since June 2010 (during Segments 1 and 2),Pennington County has entered into project agreements with participating property owners who have installed OWTS, riparian/streambank, grazing management, livestock water, and stormwater projects, as summarized in the sections below.

1.3.3.1 Segment 1 (2010–2012)

Pennington County approved six cost-share agreements in 2010 that totaled $42,508 of 319 funding for riparian and manure management BMPs. In November 2011, Pennington County approved an additional five cost-share agreements that totaled $45,800 of 319 funding for riparian and manure management BMPs. In Segment 1, five riparian and manure management BMP projects were completed (three streambank protection/riparian vegetation, one livestock water, and one grazing/riparian), which totaled $22,441 of 319 funding. These projects have implemented 20 acres of access control (use exclusion), 1 acre of riparian forest buffer, 2,735 feet of fencing, 1 acre of irrigation system, 320 feet of livestock water pipeline, 1 watering facility, 50 feet of streambank protection, 24 acres of pest management, and 450 feet of channel vegetation. Pennington County approved 13 cost-share agreements in Segment 1 that totaled $75,000 of 319 funding for OWTS projects. In Segment 1, seven septic improvement projects were completed (four single-family residential and three seasonal cabin/dwelling systems), which totaled $20,965 of 319 funding.

1.3.3.2 Segment 2 (2012–Current)

Pennington County approved two cost-share agreements in 2013, which totaled $30,569 of 319 funding for riparian BMPs. To date, one riparian project has been completed by using $6,350 of 319 funding. This project implemented 105 feet of streambank protection and improvement. Pennington County approved one cost-share agreement in 2013, which totaled $3,500 of 319 funding for OWTS projects. To date, one project has been completed by using $2,561 of 319 funding for a single-family residential system.

1.4 WATERSHED DESCRIPTION

Spring Creek begins as a small, perennial, mountain stream in western Pennington County in the Black Hills of South Dakota. Mining, logging, ranching, recreation, and tourism have all influenced Hill City, Spring Creek, its watershed, and the surrounding Black Hills. Mining has a long history in the area with gold discovery on French Creek, which is located approximately 13 miles south of Hill City. Hill City was established in 1876 and is the only municipality within the project area. Early in the twentieth century, the Black Hills began to emerge as a tourist destination [Pennington County, 2003]. Currently, Pennington County has a significant number of land uses that cater to tourism, including bed-and-breakfast establishments, temporary campgrounds, commercial campgrounds, hotels, and restaurants [Pennington County, 2003].

1.4.1 History

Spring Creek bears a name of disputed origin, with one version stating that the name is a translation of the Sioux name for this creek, which means “water springs creek,” and was given because of the large springs that form its headwaters. The other version states that Spring Creek was named because of the water flows above and below the stream bed [Sneve, 1973]. Sheridan Lake is named for the town of Sheridan, which the lake inundated when the dam and reservoir was built by the Civilian Conservation Corps [U.S. Geological Survey, 2012]. Sheridan Lake was once named Lake of the Pines which was a result of the contest conducted by the Rapid City Chapter of the Izaak Walton League [Sneve, 1973; Dennis, 1998]. Mitchell Lake was named for a pioneer resident, who lost his life near the site of the dam [Sneve, 1973]. Sylvan Lake was named in 1892 by Mrs. C. C. Crary, whose husband was one of the original locators of the site because the beauty and seclusion of this little mountain lake made it an ideal sylvan retreat [Sneve, 1973].

In describing the central portion of Pennington County in the Black Hills, Reverend Peter Rosen [Rosen, 1895] stated:

> *Some of the wildest scenery of the Hills is found in this county, especially on the slopes of the Harney range, and in the canyons of Rapid, Castle, Battle and Spring Creek.”*

In 1897, Henry S. Graves [Graves, 1899] of the U.S. Geological Survey, wrote:

> *Spring Creek forms one of the largest and most important regions of the eastern Hills. It has a continuous stream of water from it headwaters to the point where it finally sinks in the limestone formation below the timber line. There are two important forks, which come together near the present site of Hill City, meeting at a wide angle. The northern branches of the South Fork head within the open parks of the limestone region and flow through narrow canyon into more open country of schist formation. The southern branches rise among the granite and schist mountains on the western side of the Harney Peak Range.*
>
> *The streams flow through broad open parks with rich, productive soil, and below that point where the two forks come together the main creek enters a formation of hard slate, through which it has cut a narrow canyon. Where the side streams enter the creek, as at Sheridan, there is a considerable amount of rich agricultural land; elsewhere the canyon is narrow, with rugged slopes and cliffs on each side. The total timber area drained by Spring Creek system is 166.4 square miles. The entire region was formerly densely, and in most parts heavily, wooded, and there are still left some extensive bodies of the finest timber in the Dakota portion of the Black Hills.”*

Spring Creek has had an historical influence on Hill City, Pennington County, and Custer County. Mining, logging, ranching, recreation, and tourism have all influenced Hill City, Spring Creek and its watershed, and the surrounding Black Hills. Mining has a long history in the area with the discovery of gold on French Creek, located approximately 13 miles south of Hill City. During the Collins-Russell Expedition of 1874–75, which was led by General George Custer to obtain information about the Black Hills, gold was discovered in French Creek on July 30, 1874 [Ensz, 1990; Mitchell, 2010]. The Newton-Jenney Expedition of 1875, which was led by Professor Walter Jenney and Colonel Richard Dodge, discovered gold in the gravels of Spring Creek, Castle Creek, and Rapid Creek in 1875 [Mitchell, 2010]. An estimated 10,000 people were drawn to the Black Hills from late 1875 to early 1876 [Schell, 2004; Ensz, 1990].

Many of the towns and cities in Pennington County were established because of mining activities in the Black Hills [Pennington County, 2003]. Established in 1876, Hill City is the oldest existing town in Pennington County and is centrally located within the Black Hills and the Spring Creek Watershed. Hill City grew as a stage stop along the Cheyenne to Deadwood stage route and, in the 1880s, tin was found and mined near Hill City. In 1889, the Chicago Burlington & Quincy (CB&Q or the "Burlington") expanded its railroad line into southwestern South Dakota heading for Wyoming and Montana but then constructed a line from Edgemont to Hill City in 1890 [Hufstetler and Bedeau, 2007]. The Burlington then constructed a line to Deadwood from Hill City in 1891 and, in 1900, their railroad line reached Keystone from Hill City. The Black Hills Central Railroad owns the Burlington Railroad between Hill City and Keystone and operates the "1880 Train" during the tourist season.

President Grover Cleveland established the Black Hills Forest Reserve in 1897, which was surveyed by Henry S. Graves for the U.S. Geological Survey (USGS) [Graves, 1899; Pennington County, 2003]. Later in 1905, the forest reserve was transferred to the U.S. Department of Agriculture's Forest Service, and in 1907, was renamed as the BHNF [Pennington County, 2003]. Early in the twentieth century, the Black Hills began to emerge as a tourist destination [Pennington County, 2003]. In 1927, Sculptor Gutzon Borglum began carving Mount Rushmore but died in 1941 before the work was finished and the monument was declared complete [U.S. National Park Service, 2012]. In addition, other nearby attractions, such as Custer State Park, Jewel and Wind Caves, BHNF, Custer State Park, Crazy Horse Memorial, Sturgis® Motorcycle Rally, and Deadwood, have all brought increasing numbers of tourists to the area.

1.4.2 Climate

The watershed has a cool climate, including late-spring and early-fall freezing with an average growing season of 125 days [High Plains Regional Climate Center, 2012]. The average annual precipitation at Hill City is 20.4 inches, with over 70 percent occurring during the months of April through August and over 50 percent occurring during the months of May through July [SD DENR, 2008a; High Plains Regional Climate Center, 2012]. The average maximum temperatures range between 75°F and 81°F during the summer months, and the average minimum temperatures typically range from 5°F to 13°F within the watershed [SD DENR, 2008a; High Plains Regional Climate Center, 2012].

1.4.3 Hydrology

Spring Creek begins in Section 5, Township 2 South, Range 3 East, Black Hills Meridian, Pennington County, South Dakota; flows east for approximately 11 miles; and then flows northeast for approximately 7 miles to Hill City. Spring Creek flows northeast for approximately 3 miles through the city of Hill City and another 1.6 miles to Mitchell Lake. From Mitchell Lake, Spring Creek continues to flow northeast for approximately 5 miles where it enters Sheridan Lake, for a total creek length of approximately 28 miles. Approximately 167 miles of streams, with 67 miles of perennial and 100 miles of intermittent streams, are located in the project area, as illustrated in Figure 1-2.

Driscoll and Norton [2009] described stream flows in the project area as very responsive to precipitation and other variables, except a small part in the headwaters of the watershed, which is characterized as “limestone headwater” hydrogeology where direct runoff is uncommon and stream flows are dominated by relatively stable spring flows that originate from groundwater discharge. Table 1-1 lists the 25th, 50th, and 75th percentile annual flows from October 1, 1990, to September 30, 2004, at the USGS Station 06406920, located above Sheridan Lake [Driscoll and Norton, 2009]. Figure 1-3 shows the boxplots for monthly and annual actual and extrapolated stream flows at the USGS Station 06406920 [Driscoll and Norton, 2009]. The average daily discharges at Site SPC500, also located at the USGS Station 06406920 above Sheridan Lake, from June through October in 2010, June through September 2011, and April through October 2012 (located on Spring Creek above Calumet Road above Sheridan Lake) are illustrated in Figure 1-4. Site SPC500 is also located at the USGS Station 06406920. The average daily discharges ranged from 9 cubic feet per second (cfs) to 83 cfs in 2010, 9 to 61 cfs in 2011, and 0.4 to 38 cfs in 2012.

Four notable lakes are located within the watershed, including Sheridan Lake, Sylvan Lake, Major Lake, and Mitchell Lake. Sheridan Lake is a 383-acre reservoir managed by the U.S. Forest Service (USFS) that provides flood control and recreation. Sylvan Lake covers approximately 18 acres, is the oldest lake in the Black Hills, and is part of Custer State Park. Major Lake is a 5-acre reservoir constructed on Newton Fork within Hill City. Mitchell Lake is a 7-acre reservoir created by an earthen dam constructed on Spring Creek in 1936 and is managed by the USFS. Four subwatersheds are present, including Sheridan Lake–Spring Creek, Newton Fork–Spring Creek, Headwaters Spring Creek, and Newton Fork; they comprise approximately 27, 26, 25, and 22 percent of the project area, respectively. These subwatersheds were obtained from the National Watershed Boundary Dataset and are listed in Table 1-2 and illustrated in Figure 1-5 [Natural Resources Conservation Service, 2012a].

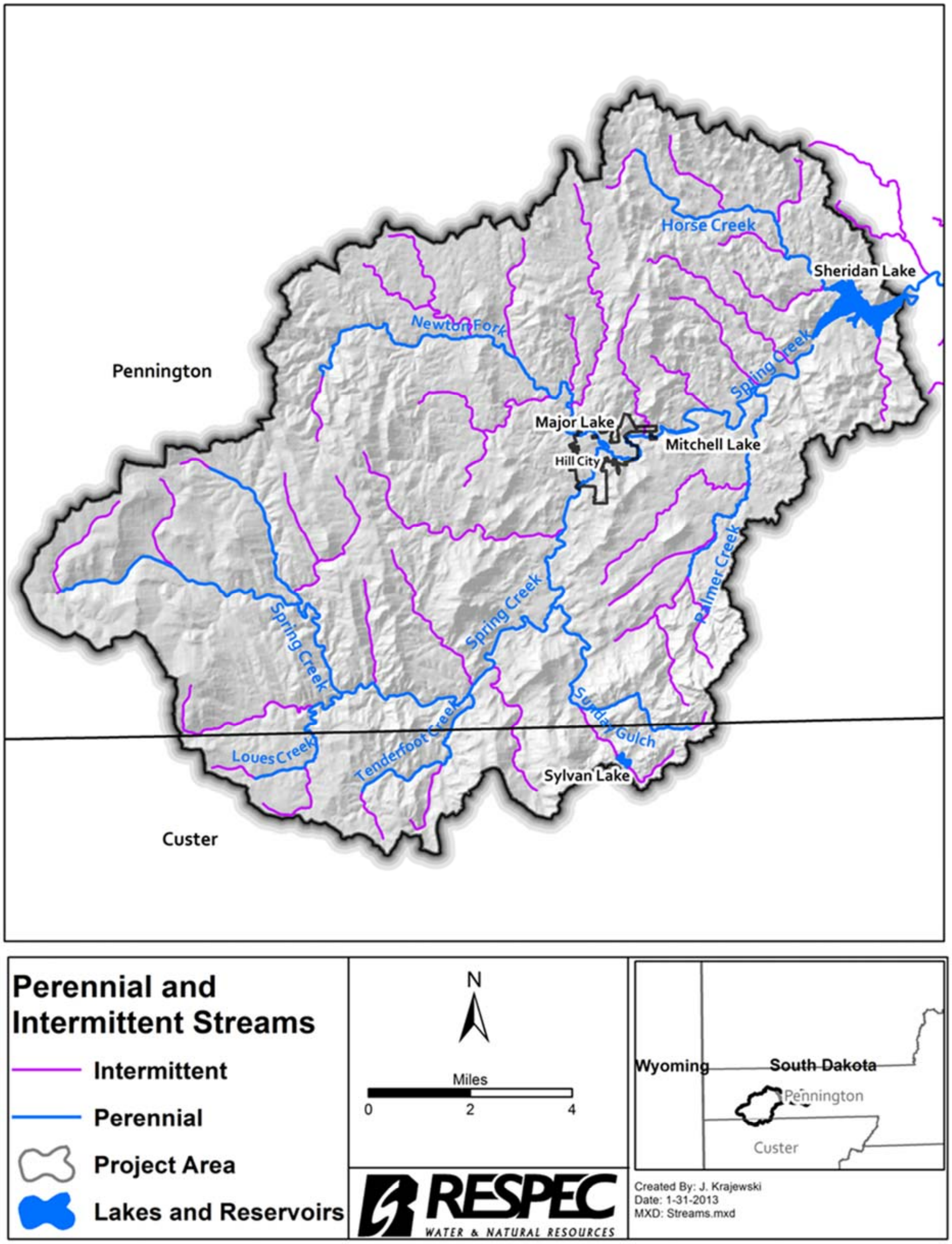

Figure 1-2. Spring Creek and Tributaries Within the Spring Creek Watershed.

Table 1-1. Stream Flows for Spring Creek Above Sheridan Lake (USGS Station 06406920) for Water Years 1991 to 2004 From Driscoll and Norton [2009]

Statistic	Stream Flow (cfs)												
	Month												Annual
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Mean	10.90	11.30	8.19	5.74	6.20	11.60	20.96	55.23	72.04	28.46	17.33	10.77	21.61
Maximum	35.80	51.20	34.80	21.90	19.20	21.80	64.20	144.50	184.70	63.30	50.10	26.20	50.72
75^{th} Percentile	15.75	12.00	9.49	6.01	8.47	15.93	23.13	86.23	121.28	50.23	22.80	16.50	30.25
50^{th} Percentile	6.86	6.51	4.50	3.42	3.63	9.07	16.75	34.40	58.10	26.95	12.65	6.79	17.75
25^{th} Percentile	4.42	3.86	2.62	1.99	2.36	7.24	11.23	21.03	15.10	6.62	4.37	3.55	9.40
Minimum	2.59	2.37	1.62	1.01	1.21	4.66	5.38	4.12	2.21	2.92	2.19	1.32	2.80
Standard Deviation	9.32	12.94	9.05	6.06	5.32	6.14	15.85	44.51	64.54	22.60	15.42	8.96	15.48

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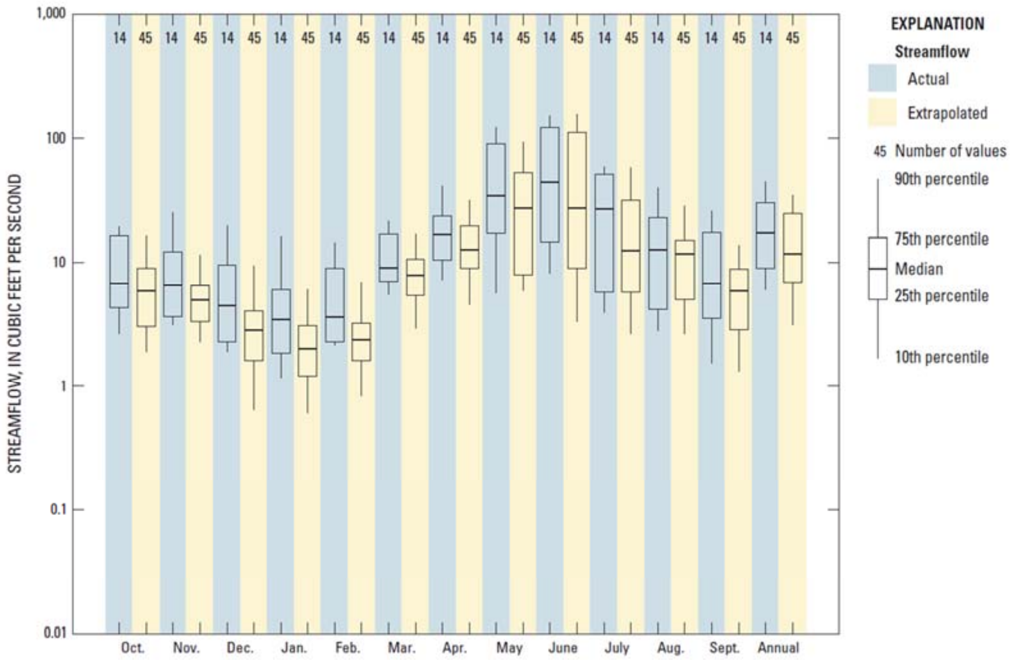

Figure 1-3. Boxplots for Monthly and Annual Streamflow for Spring Creek Above Sheridan Lake (USGS Station 06406920) for the Actual Period of Record (Water Years 1991–2004) and Extrapolated Period (Water Years 1962–2006) [Driscoll and Norton, 2009].

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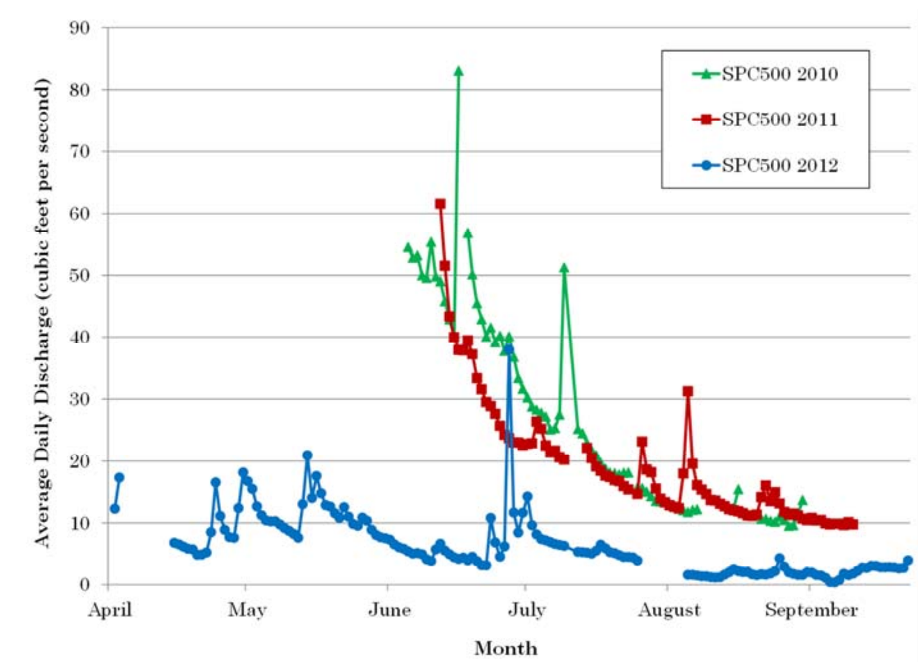

Figure 1-4. Average Daily Discharge in 2010, 2011, and 2012 on Spring Creek at Monitoring Site SPC500, Located Above Calumet Road Above Sheridan Lake.

Table 1-2. Subwatersheds in the Spring Creek Watershed

Subwatershed	Area (acres)	Area (miles^2)	Area (%)
Newton Fork–Spring Creek	24,411	38.1	26.3
Sheridan Lake–Spring Creek	24,976	39.0	26.9
Headwaters Spring Creek	23,095	36.1	24.9
Newton Fork	20,358	31.8	21.9
Project Area	**92,840**	**145.0**	**100.0**

Water use in the project area is from both surface and groundwater sources. The majority of water rights in the watershed are for commercial, irrigation, industrial, and municipal uses. Domestic water use includes two community and transient noncommunity public water systems. Rural and noncommunity public water usage ranges from less than 70,000 to more than 140,000 gallons per day. Groundwater is used from approximately 415 water wells for domestic, municipal, industrial, irrigation, stock, and commercial use [SD DENR, 2012a]. Domestic groundwater use is the most common, and over 95 percent of all permitted water wells are categorized as domestic wells, as illustrated in Table 1-3. Domestic wells range in depth from 15 to 695 feet, and other types of water wells, including business, industrial, and municipal wells, range in depth from 60 to 442 feet and have average depths of 238, 253, and 130 feet, respectively.

1.4.4 Geology

The watershed is located within the central core of the Black Hills uplift. Spring Creek has its headwaters originating from a spring along the eastern extent of the Madison Limestone Plateau. The watershed contains a variety of geological features and rocks with Precambrian metamorphics exposed throughout the watershed, gravels and alluvium along creeks, and outcrops of the Deadwood Formation and Madison Limestone at the western edge. Table 1-4 provides a description of the bedrock geological units illustrated in Figure 1-6. Metamorphic slates and schists and granite rock underlie a large portion of the watershed and form the Central Crystalline Area of the Black Hills [Ensz, 1990].

The geologic structure in the watershed is primarily the result of Precambrian folding, faulting, and igneous intrusion. Almost 75 percent of the watershed is underlain by metabasalts, metamorphosed tuffaceous shales, and metagraywackes. At the western edge of the watershed, along the Limestone Plateau, a domal shaped uplift has exposed a small outcrop of the Deadwood Formation. Driscoll and Norton [2009] found that the majority of the watershed upstream from the USGS Gaging Station 06407500, which is below Sheridan Lake, was in the crystalline core hydrogeologic setting.

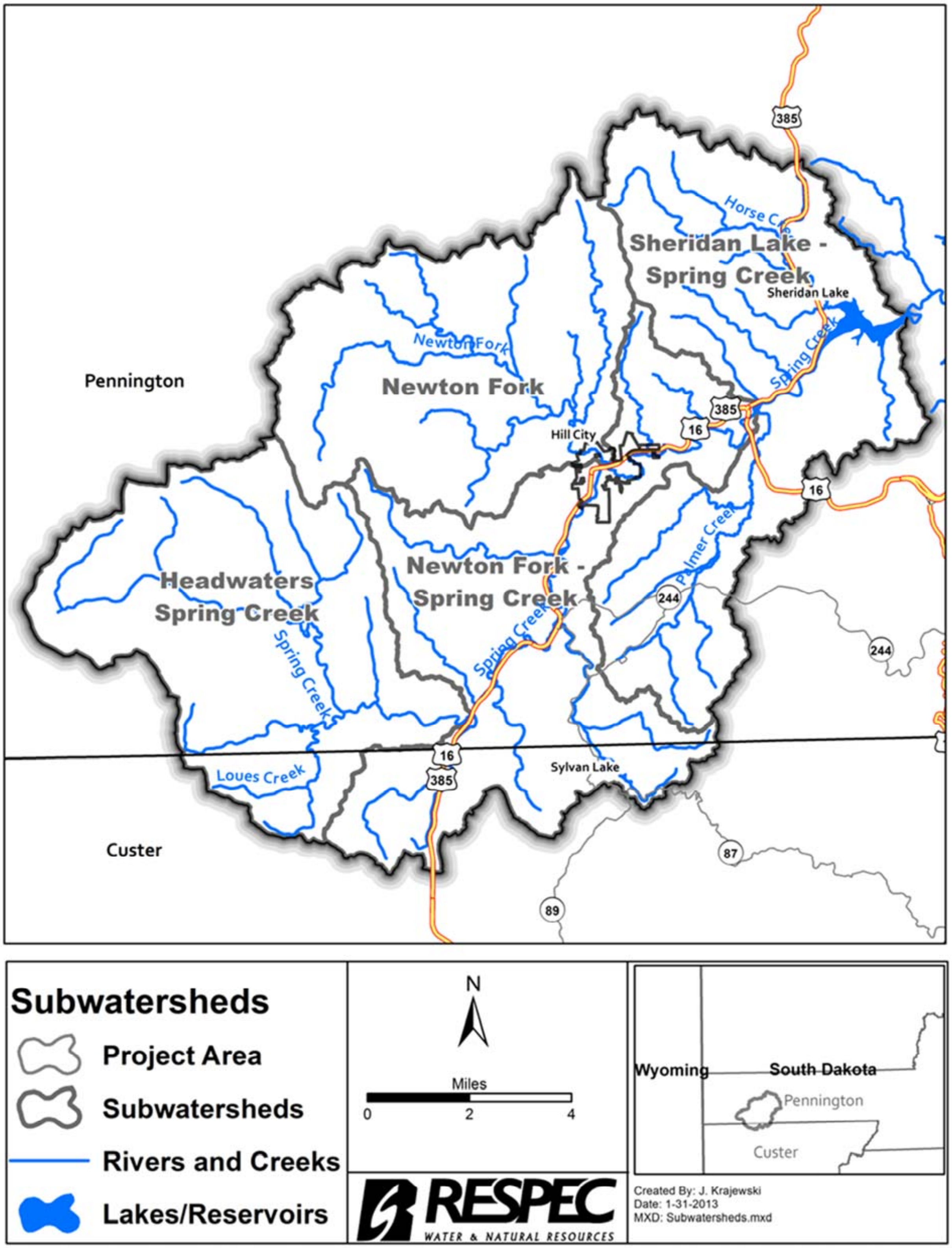

Figure 1-5. Subwatersheds in the Spring Creek Watershed.

Table 1-3. Permitted Water Wells in the Spring Creek Watershed

Well Type	Number of Wells	Percent of Total	Average Well Depth (ft)	Range of Well Depth (ft)
Business	7	1.7	238	87–442
Commercial	1	0.2	Not Applicable (N/A)	130
Domestic	396	95.4	187	15–695
Industrial	2	0.5	253	166–340
Irrigation	1	0.2	N/A	80
Municipal	3	0.7	130	60–205
Rehabilitated	4	1.0	263	141–425
Stock	1	0.2	N/A	39
Total	**415**	**100.0**	**187**	**15–695**

Table 1-4. Bedrock Geological Units and Areas Within the Spring Creek Watershed

Name	Description	Area (ac)	Area (%)
H_2O	Water	439	0.5
Mdpe	Madison Limestone Group	2,990	3.2
Ocwd	Whitewood Limestone, Winnipeg, and Deadwood Formations	1,021	1.1
Qal	Alluvium	1,300	1.4
Qc	Colluvium	183	0.2
Qt	Terrace deposits	181	0.2
Wos	Older metasedimentary rocks	833	0.9
Xb1	Metabasalt	1,115	1.2
Xb2	Metabasalt	19,688	21.2
Xc	Metaconglomerate	1,485	1.6
Xcg	Metamorphosed conglomerate	3,530	3.8
Xd	Metamorphosed dolomite	1,950	2.1
Xgw	Metagraywacke	13,370	14.4
Xgw1	Metagraywacke Unit 1	5,945	6.4
Xgw2	Metagraywacke Unit 2	1,670	1.8
Xgw3	Metagraywacke Unit 3	8,635	9.3
Xgwl	Metagraywacke	2,045	2.2
Xh	Harney Peak Granite	3,435	3.7
Xif	Banded Iron-Formation	745	0.8
Xmg	Metagabbro	370	0.4
Xms	Metamorphosed tuffaceous shale	14,855	16.0
Xsh	Metamorphosed shale	7,055	7.6
Project Area		**92,840**	**100.0**

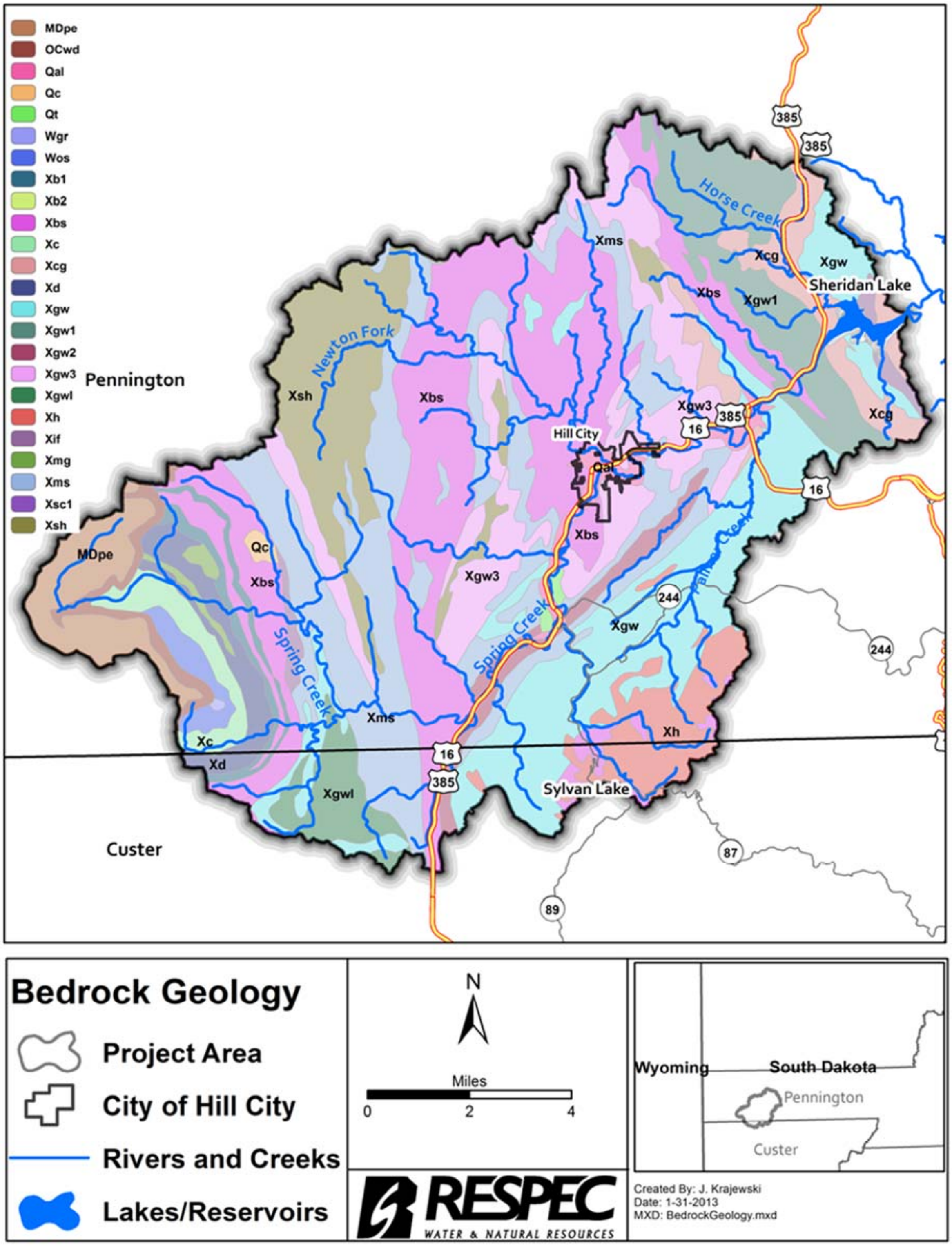

Figure 1-6. Bedrock Geological Units and Areas Within the Spring Creek Watershed.

1.4.5 Soils

The Natural Resources Conservation Services' (NRCS)] web soil survey was used to compile soils information within the watershed [NRCS, 2012b]. The watershed's major soil series include the Pactola and Buska, which cover approximately 78 percent of the project area. Rock outcrops and unweathered bedrock cover approximately 18 to 26 percent of the watershed. Approximately 75 percent of the project area's soil surface textures are a type of channery, cobbly, gravelly, or silt loam. Soil textures are predominantly channery loam and loams on 0 to 40 percent slopes, as listed in Table 1-5. Channery is a soil comprised of long, flat fragments of shale, slate, limestone, schist, or sandstone [NRCS, 2012b].

Table 1-5. Soil Surface Textures in the Spring Creek Watershed

Soil Surface Texture	Area (ac)	Area (%)
Channery loam	34,919	37.6
Channery silt loam	609	0.7
Cobbly loam	1,040	1.1
Gravelly loam	92	0.1
Loam	29,742	32.0
Silt loam	4,579	4.9
Bedrock	21,434	23.1
Other	425	0.5
Project Area	**92,840**	**100.0**

The majority of these soils are deep and well drained with moderate permeability and a depth of 40 to 60 inches to bedrock [NRCS, 2012b]. The Pactola-Virkula-Rock outcrop complex on 10 to 40 percent slopes is the largest soil map unit in the project area, which covers approximately 29,860 acres (32 percent) of the watershed. Other major soil units include the Rock Outcrop-Pactola complex on 40 to 80 percent slopes and the Buska-Rock outcrop complex on 10 to 40 percent slopes. Soil map units within the project area are provided in Table 1-6 and illustrated in Figure 1-7.

1.4.6 Septic Absorption Field Soil Ratings

The NRCS' web soil survey [NRCS, 2012b] and the *Soil Survey of Custer and Pennington Counties, Black Hills Parts, South Dakota* [Ensz, 1990]] contain septic absorption field ratings for the soil map units within the watershed, as illustrated in Table 1-7 and Figure 1-8. An absorption field is part of the OWTS where effluent wastewater from the septic tank

Table 1-6. Soil Map Units in the Spring Creek Watershed

Map Symbol	Soil Map Unit Description	Area (acres)	Area (%)
Q0226E	Pactola-Virkula-Rock outcrop complex, 10 to 40 percent slopes	29,860	32.2
Q0232G	Pactola-Pactola, shallow-Rock outcrop complex, 40 to 80 percent slopes	15,158	16.3
Q0202E	Buska-Rock outcrop complex, 10 to 40 percent slopes	11,881	12.8
Q0005G	Mocmont-Rock outcrop complex, 40 to 80 percent slopes	4,112	4.4
Q0001E	Buska-Mocmont-Rock outcrop complex, 10 to 40 percent slopes	3,890	4.2
Q0315E	Pactola-Virkula-Rock outcrop complex, dry, 10 to 40 percent slopes	3,487	3.8
Q0418E	Stovho-Trebor complex, 10 to 40 percent slopes	3,171	3.4
Q0206B	Cordeston-Marshbrook loams, 0 to 6 percent slopes, flooded	3,014	3.2
Q0231G	Buska-Rock outcrop complex, 40 to 80 percent slopes	2,748	3.0
Q0239D	Virkula-Pactola complex, 2 to 15 percent slopes	2,440	2.6
Q0205C	Cordeston loam, high mica, 2 to 10 percent slopes, flooded	2,197	2.4
Q0203D	Buska-Virkula, high mica loams, 2 to 15 percent slopes	2,181	2.3
Q0319G	Pactola-Pactola, shallow-Rock outcrop complex, 40 to 80 percent slopes	2,099	2.3
Q0211E	Hilger, moist-Virkula complex, 2 to 30 percent slopes	1,005	1.1
Q0209D	Heely-Cordeston complex, 2 to 15 percent slopes	745	0.8
Q0200C	Bullflat, moist-Cordeston silt loams, high mica, 2 to 9 percent slopes	692	0.7
Q0208E	Heely channery loam, 10 to 40 percent slopes	665	0.7
Q0302E	Buska, dry-Rock outcrop complex, 10 to 40 percent slopes	643	0.7
Q0420G	Trebor-Rock outcrop complex, 40 to 80 percent slopes	610	0.7
QW	Water	409	0.4
Q0304D	Buska-Virkula, high mica loams, dry, 2 to 15 percent slopes	319	0.3
Q0322D	Virkula-Pactola complex, dry, 2 to 15 percent slopes	316	0.3
Q0416C	Stovho-Riflepit-Trebor complex, 2 to 12 percent slopes	244	0.3
Q0415D	Stovho silt loam, 2 to 15 percent slopes	188	0.2
Q0300C	Bullflat-Cordeston, dry silt loams, high mica, 2 to 9 percent slopes	186	0.2
Q0003C	Mocmont gravelly loam, 2 to 12 percent slopes	92	0.1
Q0309E	Heely channery loam, dry, 9 to 30 percent slopes	85	0.1
Q0413C	Redbird-Gillum silt loams, 2 to 9 percent slopes	75	0.1
Q0587E	Vanocker-Hickok complex, 10 to 40 percent slopes	71	0.1
Q0307B	Cordeston, dry-Marshbrook loams, 0 to 6 percent slopes, flooded	62	0.1
Q0705D	Udarents, reclaimed gravel pits	57	0.1
Q0312E	Roubaix-Virkula, complex, dry, 2 to 30 percent slopes	34	< 0.1
Q0306C	Cordeston loams, dry, high mica, 2 to 10 percent slopes, flooded	23	< 0.1
Q0405D	Jenksdraw-Gillum-Rockerville, cool complex, 2 to 25 percent slopes	16	< 0.1
Q0702F	Pits, quarry	14	< 0.1
Q0514C	Citadel-Vanocker complex, 2 to 12 percent slopes	14	< 0.1
Q0317G	Buska, dry-Rock outcrop complex, 40 to 80 percent slopes	12	< 0.1
Q0310D	Heely-Cordeston complex, dry, 6 to 15 percent slopes	12	< 0.1
QM-W	Miscellaneous water	10	< 0.1
Q0701F	Orthents, loamy, earthen dams, 0 to 75 percent slopes	1	< 0.1
Project Area		**92,840**	**100.0**

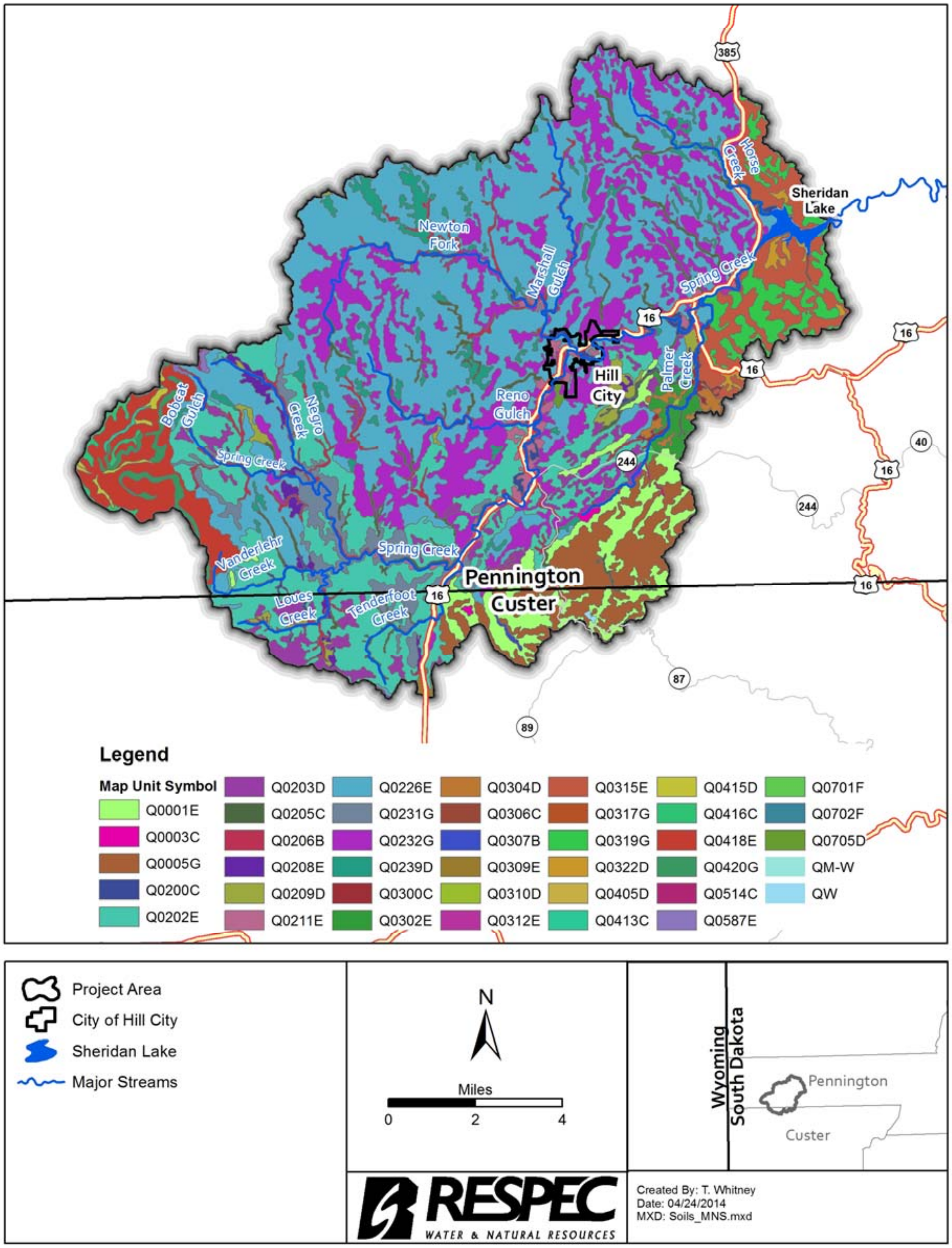

Figure 1-7. Soil Types and Areas Within the Spring Creek Watershed.

is distributed into the soil via piping that is typically installed in subsurface trenches. The ratings are based on soil properties such as saturated hydraulic conductivity, depth to water, depth to bedrock, and flooding frequency [NRCS, 2012b] and are defined as the following:

- **Not limited**–the soil has features that are very favorable for effluent treatment with good performance and very low maintenance.
- **Somewhat limited**–the soil has features that are moderately favorable for effluent treatment with limitations that can be overcome or minimized by special planning, design, or installation and may have fair performance and moderate maintenance.
- **Very limited**–the soil has one or more features that are unfavorable for effluent treatment with limitations that generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures and may have poor performance and high maintenance.

Table 1-7. Septic Absorption Field Ratings for Soils in the Spring Creek Watershed

Septic Absorption Field Soil Rating Description	Area (ac)	Area (%)
Very Limited	83,556	90.0
Somewhat Limited	8,820	9.5
Not Rated	464	0.5
Project Area	**92,840**	**100.0**

Ninety-nine percent of the project area's soils have somewhat limited to very limited ratings for soil absorption and treating wastewater effluent. These ratings are general and indicate that the soils have one or more soil features that are favorable or unfavorable for wastewater treatment. In areas with unfavorable or very limited conditions, the limitations can be mitigated by a site-specific evaluation, planning, designing , or installing OWTS alternatives. Although these site-specific alternatives can improve OWTS performance, they are expensive, and the operation and maintenance requirements increase for the property owner.

1.4.7 Vegetation

The Black Hills is an isolated, unglaciated, and distinctive group of rugged mountains rising above the surrounding plains and is often described as an "island on the plains," with species from diverse environments, including the Rocky Mountains, northern coniferous forests, eastern hardwoods, and the surrounding Great Plains [U.S. Forest Service, 2005]. In the Black Hills, vegetative communities include forestland, shrubland, grassland, and riparian/wetland types.

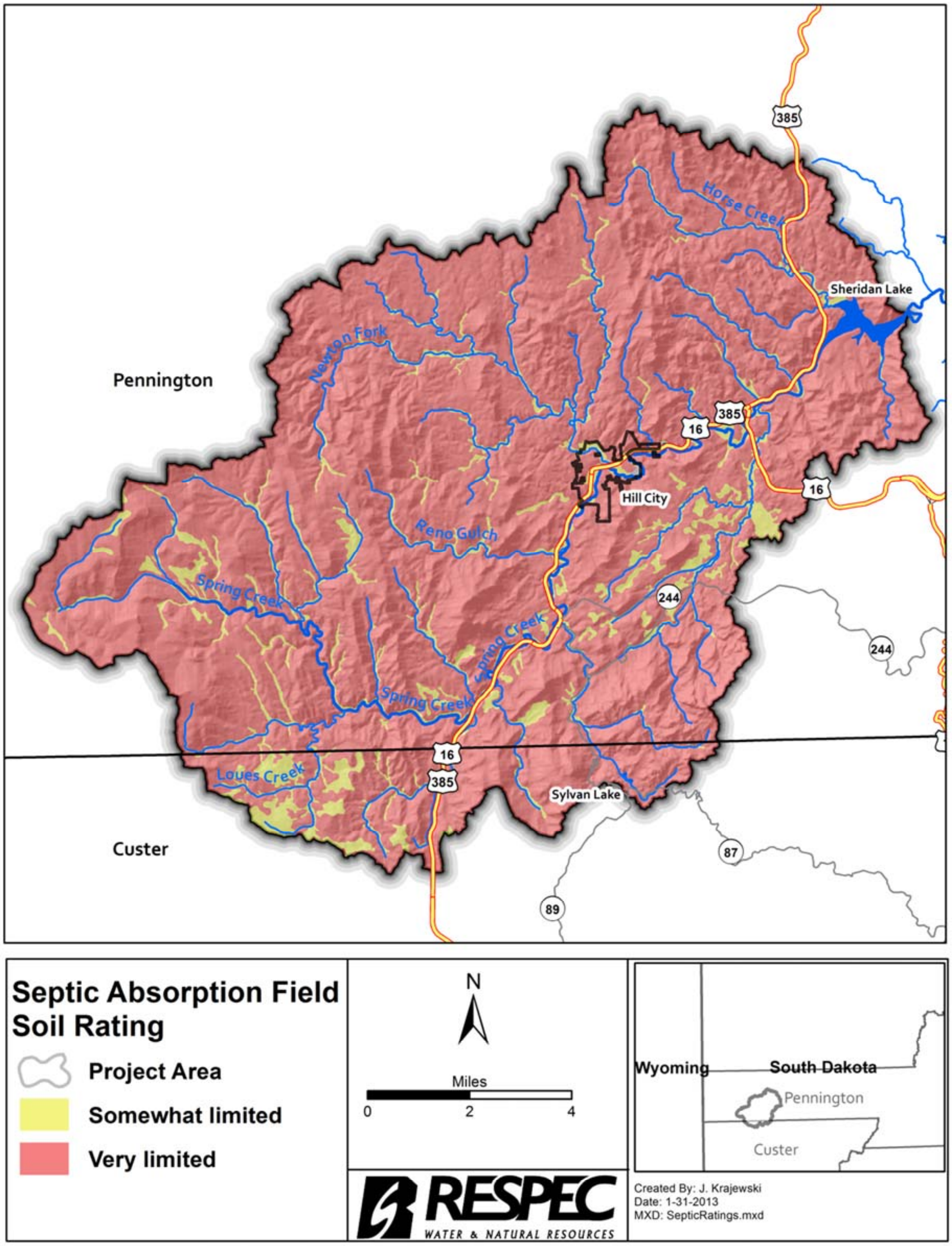

Figure 1-8. Septic Absorption Field Ratings for Soils Within the Spring Creek Watershed.

Ponderosa pine dominates the Black Hills with existing forested areas of White spruce, Aspen, and other hardwoods [Hall et al., 2002]. The vegetative cover types were inventoried on the BHNF land and are listed in Table 1-8 and illustrated in Figure 1-9 [USFS, 2009]. The cover types are for plant species or a nonvegetated condition that was presently dominant and use canopy or foliage cover as the measure of dominance [USFS, 2009]. Ponderosa pine is the dominant vegetative type, which covers approximately 70,043 acres (75 percent) on BHNF lands within the project area. Other dominant cover types include Aspen (Birch), which covers approximately 3,821 acres (4.1 percent) and grasslands, which cover approximately 2,652 acres (2.9 percent).

Table 1-8. Vegetative and Nonvegetative Cover Types on the Black Hills National Forest Land Within the Spring Creek Watershed

Vegetative/Nonvegetative Cover Type	Area (acres)	Area ($miles^2$)	Area (%)
Ponderosa pine	70,043	109.4	75.4
Aspen (Birch)	3,821	6.0	4.1
Grasslands	2,652	4.1	2.9
White spruce	557	0.9	0.6
Reservoirs/impoundments	378	0.3	0.4
Unclassified	164	0.3	0.2
Bluegrass	49	0.1	0.1
Rush/Sedge	34	0.1	< 0.1
Snowberry	12	< 0.1	< 0.1
Mines, quarries, or pits	6	< 0.1	< 0.1
Urban	2	< 0.1	< 0.1
Other (private, county, state, roads	15,122	23.6	16.3
Project Area	**92,840**	**145.0**	**100.0**

1.4.8 Land Ownership and Land Use

Ninety percent of the watershed is located in Pennington County, with the remaining 10 percent in Custer County. Eighty-five percent of the watershed is public lands with 13 percent under private ownership, as illustrated in Table 1-9 and Figure 1-10. Most of this public land is managed by the USFS. Existing land-use zoning designations and parcel data were obtained from Custer and Pennington Counties and are displayed in Table 1-10 and Figure 1-11. Over 91 percent of the watershed is classified as general and limited agricultural lands. Limited agricultural lands are typically zoned for a minimum of 10 to 40 acres in size. Low-density residential parcels cover approximately 4,084 acres (4 percent) and are typically zoned with a minimum size of 3 acres. Private land covers approximately 11,914 acres, as illustrated in Figure 1-12.

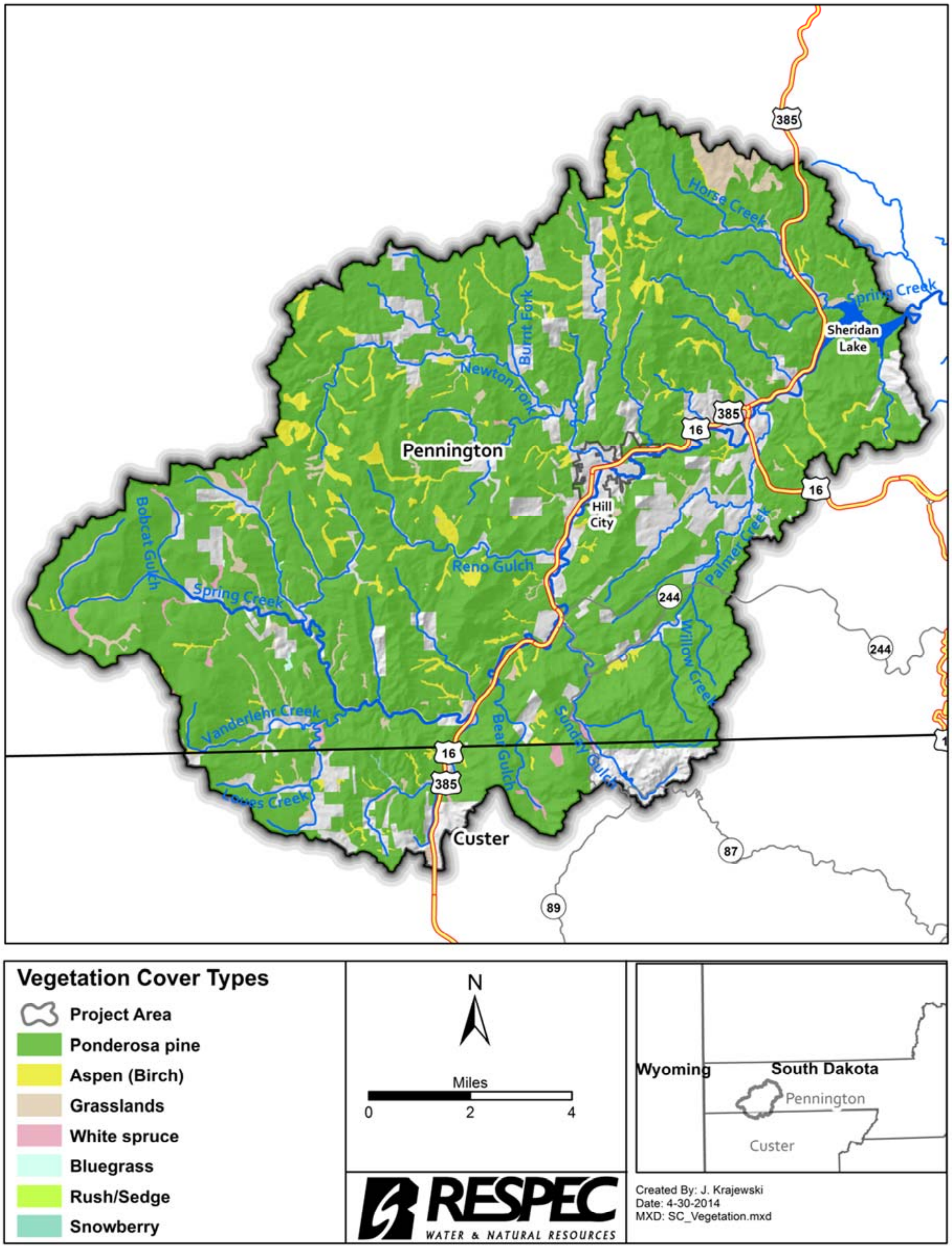

Figure 1-9. Vegetative Cover Types Inventoried Within the Spring Creek Watershed.

Table 1-9. Public and Private Land Ownership in the Spring Creek Watershed

Ownership Type	Area (ac)	Area (%)
Private Land	11,914	12.8
City, County, and School Land	94	0.1
State Land	1,143	1.2
Federal Land	77,718	83.7
Roads	1,532	1.7
Water	439	0.5
Project Area	**92,840**	**100.0**

1.4.9 Addressed Structures

An estimated 1,430 addressed structures are located in the watershed. Address and tax parcel geodata provided by Custer and Pennington Counties were used to analyze and categorize current addressed structures within the watershed [Nichols, 2010; Pennington County, 2011]. Addressed structure data were compared with OWTS data to determine the ages and types of structures. Addressed structures were defined as any structure or building used, intended, or designed to be occupied by humans including, but not limited to, houses, cabins, mobile homes, hotels, motels, apartments, businesses, and industrial facilities. Approximately 532 addressed structures are located within Hill City and another 898 are located outside of Hill City, as illustrated in Figure 1-13. Of these 898 addressed structures outside of Hill City, approximately 860 are in Pennington County and 38 are in Custer County. Ninety-seven percent, or 871 of the 898 structures, are located on private land, and the remaining 3 percent are on public land.

The 898 addressed structures are located on 762 tax parcels covering 6,575 acres. These parcels range in size from 0.1 acre to 495 acres with a median size of 2.6 acres. Fifty-four percent of the parcels are 0.1 to 3 acres in size, and almost 70 percent are less than 5 acres in size. Table 1-11 lists the size categories of these parcels. Seventy-five parcels have addressed structures that are intersected by Spring Creek within the project area, and Table 1-12 lists the size categories of these parcels.

The average residential property value was approximately $215,000, and the median of the residential property value was $170,000. For approximately 380 residential properties on parcels from 0.1 to 3 acres in size, the mean of the total property value was an estimated $176,000, and the median of the total property value was $151,000. Additionally, commercial property valuation data were available for 63 of the 898 structures and parcels. The mean of the total property value was $509,000, and the median of the total property value was $282,000.

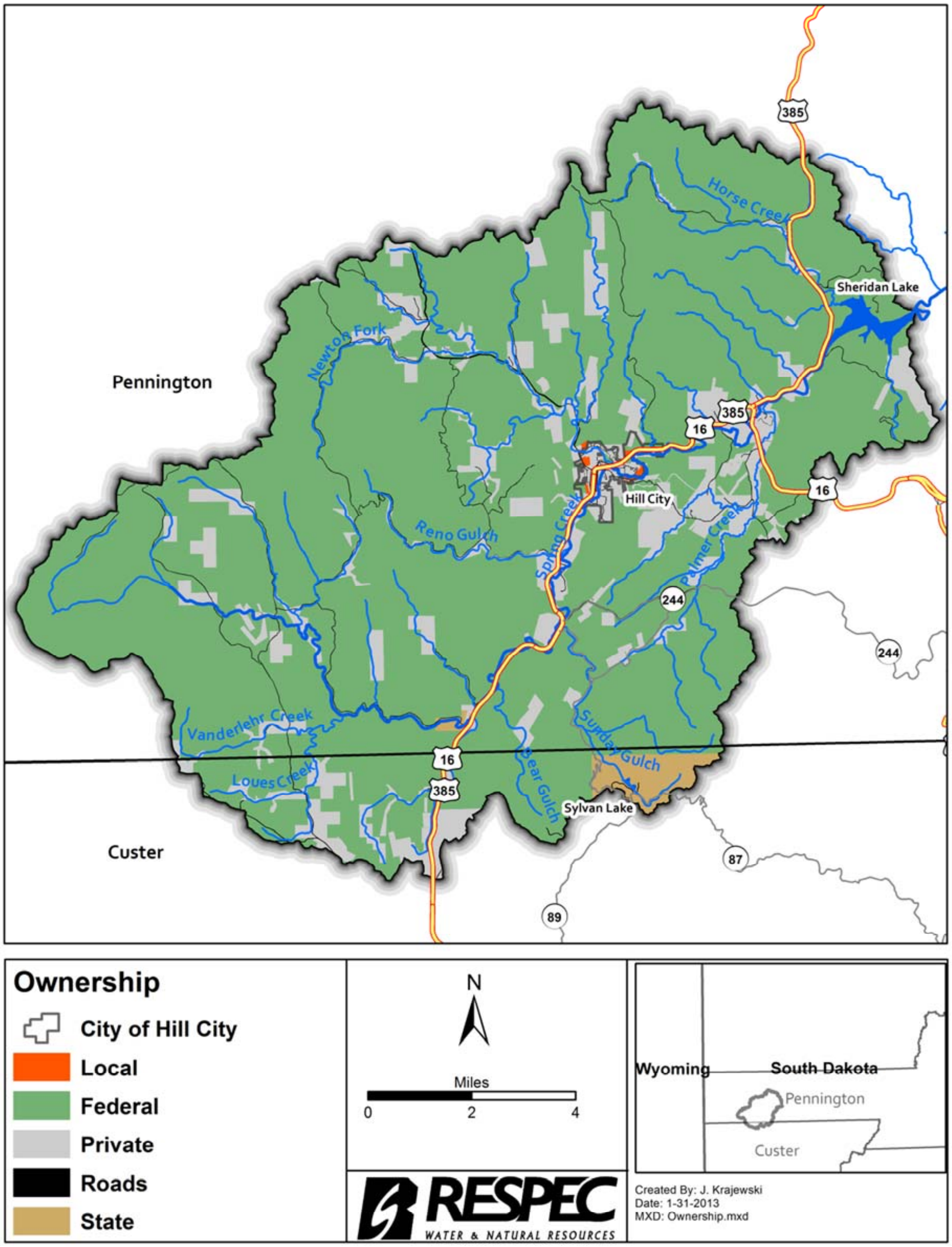

Figure 1-10. Land Ownership in the Spring Creek Watershed.

Table 1-10. Land Use in the Spring Creek Watershed

Land Use, Zoning Description	Zone Code	Area (ac)	Area (%)
General Agriculture	GAD	83,528	89.9
General Commercial	GCZD	180	0.2
Heavy Industrial	HIZD	51	0.1
Highway Service/Roads	HS	1,822	2.0
Limited Agriculture	LAD	1,144	1.2
Low-Density Residential	LDR	4,084	4.4
Planned Unit Development	PUD	950	1.0
Suburban Residential	SRD	642	0.7
Water		439	0.5
Project Area		**92,840**	**100.0**

The U.S. Census Bureau's Population Finder, Factfinder, and other search tools (provided on their website: *www.census.gov*) were used to acquire the following data. An estimated 472 housing units are located in Hill City, which indicates that approximately 89 percent of the 532 addressed structures are residential [U.S. Census Bureau, 2012a]. In Custer County, tax parcel geodata indicates that 79 percent of the parcels with addressed structures are classified as residential, and the remaining 21 percent are categorized as agricultural. However, in Pennington County, tax parcel geodata indicates that 63 percent of the parcels with addressed structures are agricultural, another 33 percent of parcels with addressed structures are categorized as residential, and the remaining 4 percent are classified as commercial or industrial. These parcels with addressed structures are illustrated in Figure 1-14.

Building permit data were available for approximately 662 of the 860 structures (77 percent) located in Pennington County outside of Hill City [Pennington County, 2012a]. The data included the year that the structure was last permitted or built. These structures were built or permitted from 1928 to 2011. Approximately 66 percent were built or permitted since 1970, and approximately 22 percent were built from 1990 to 1999, and another 18 percent were built from 2000 to 2009, as illustrated in Table 1-13 and Figure 1-15. The greatest amount of structures permitted or built occurred in 1994, 1996, 2003, and 2004. These 4 years account for over 15 percent of the structures in the project area. Information could not be obtained on 193 addressed structures.

1.4.10 Population and Growth

Census population, addressed structures, visitor use, traffic count, and motel/hotel and campground occupancy data were collected and analyzed. The only municipality in the project area is Hill City, with a population of 948 in 2010 [U.S. Census Bureau, 2012b]. The city of Hill City covers approximately 800 acres (approximately 0.8 percent of the project area).

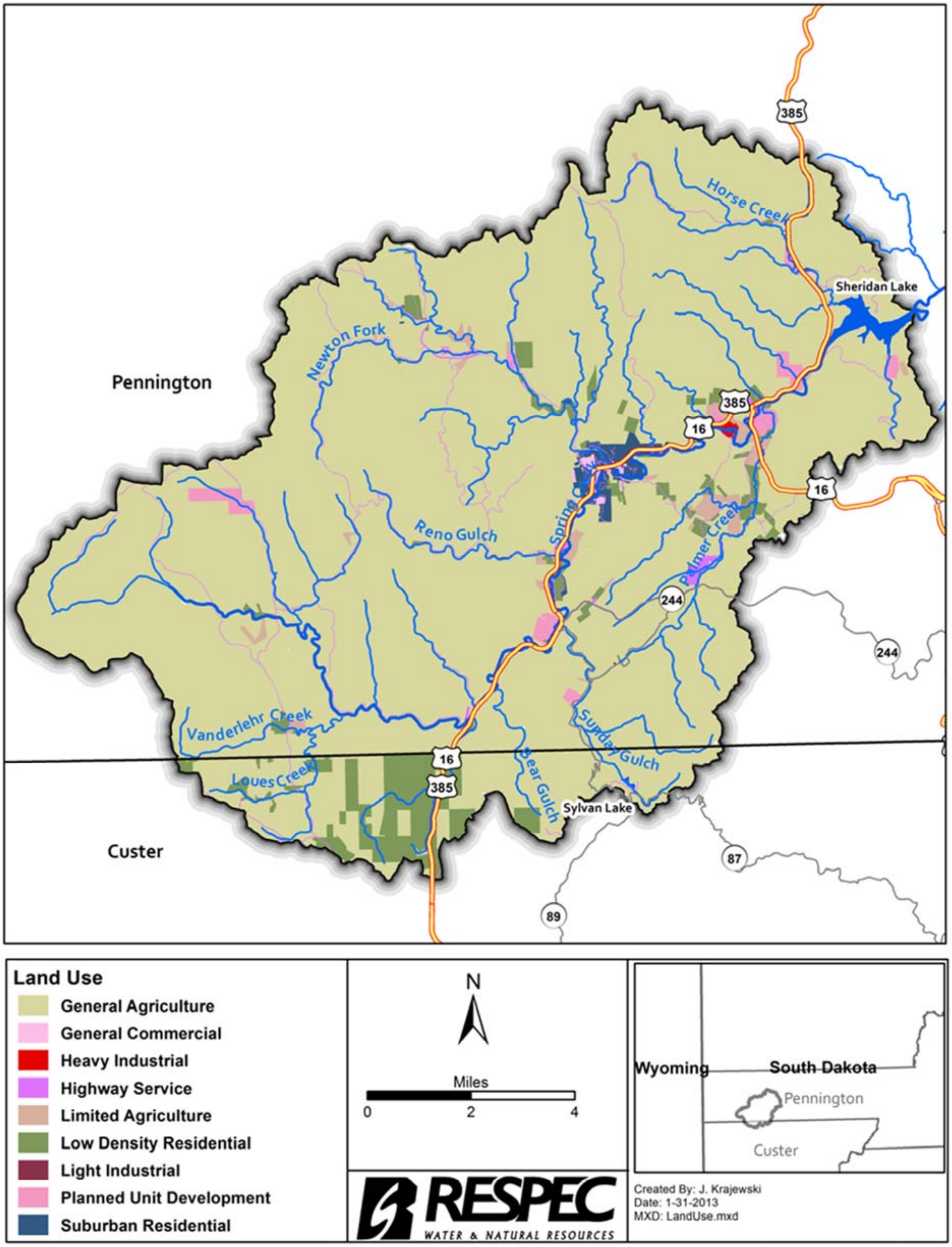

Figure 1-11. Land Use in the Spring Creek Watershed.

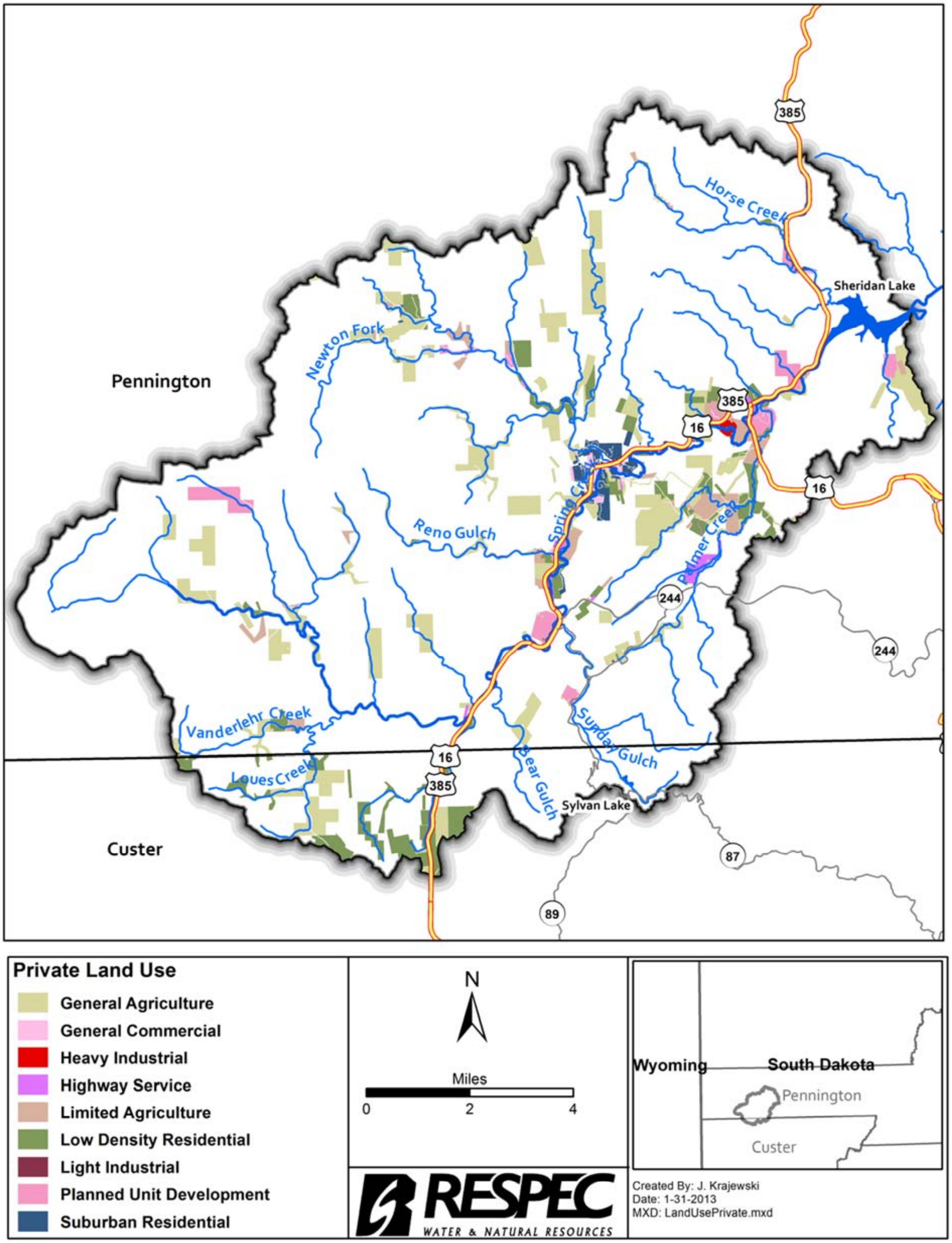

Figure 1-12. Private Land Use in the Spring Creek Watershed.

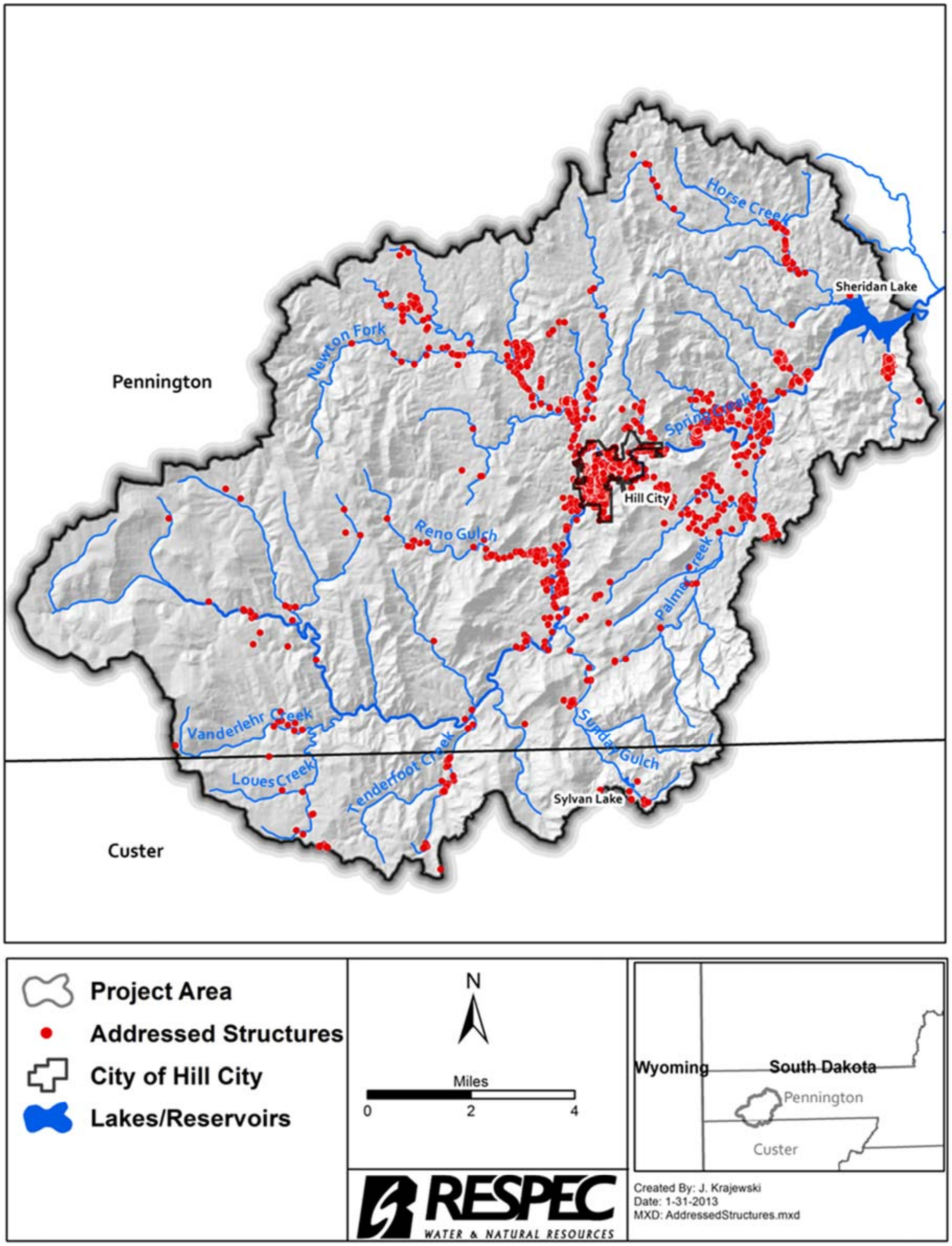

Figure 1-13. Addressed Structures in the Spring Creek Watershed.

Table 1-11. Size Categories of Tax Parcels With Addressed Structures

Parcel Size (ac)	Parcel Size (number)	Parcel Size (%)
0–1	179	23.5
1–3	238	31.2
3–5	115	15.1
5–10	107	14.0
10–40	101	13.3
40–500	22	2.9
Project Area	**762**	**100.0**

Table 1-12. Size Categories of Tax Parcels With Addressed Structures on Spring Creek

Parcel Size (ac)	Parcel Size (number)	Parcel Size (%)
0–1	27	36.0
1–3	19	25.3
3–5	8	10.7
5–10	7	9.3
10–40	10	13.3
40–500	4	5.3
Project Area	**75**	**99.9**

An estimated 394 households, with an average household size of 2.41 persons, are located in Hill City [U.S. Census Bureau, 2012a]. Pennington County covers over 90 percent of the project area. The population of Pennington County was 100,948, with an average household size of 2.38 in 2010 [U.S. Census Bureau, 2012a]. Most of the population in Pennington County is in Rapid City, which has a population of 68,000 in 2010, and Rapid City is approximately 20 miles east of the watershed [U.S. Census Bureau, 2012a]. Custer County covers approximately 10 percent of the watershed, and the city of Custer is 4 miles south of the project area. In 2010, Custer County's population was 8,216 with an average household size of 2.38, and the city of Custer's population was 2,067 [U.S. Census Bureau, 2012a].

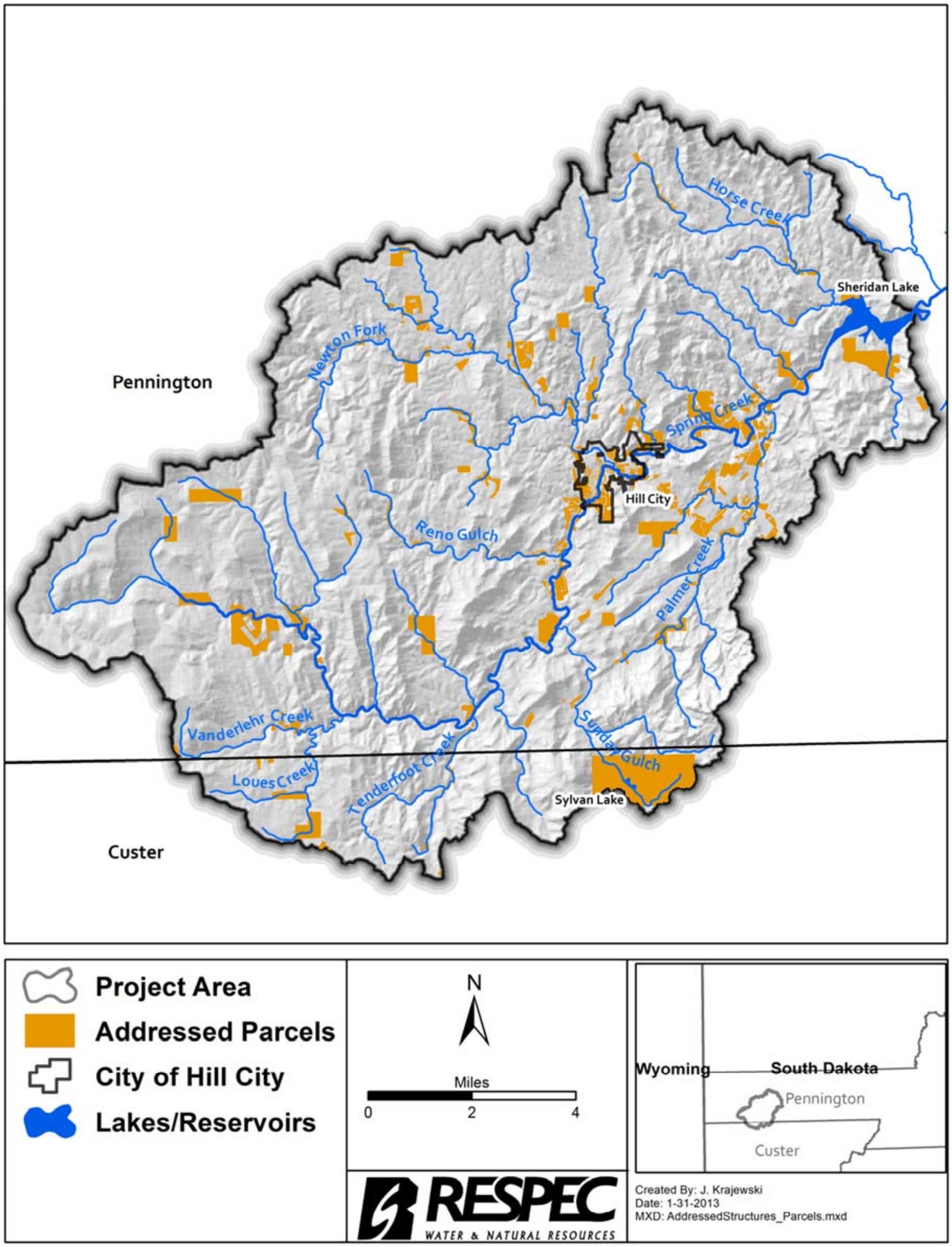

Figure 1-14. Tax Parcels With Addressed Structures in the Spring Creek Watershed.

Table 1-13. Structures Built or Permitted in Pennington County Within the Watershed

Addressed Structure Built or Permitted (decade)	Addressed Structure Built or Permitted (number)	Addressed Structure Built or Permitted (%)
1889–1929	23	3.5
1930–1939	20	3.0
1940–1949	34	5.1
1950–1959	80	12.1
1960–1969	57	8.6
1970–1979	110	16.6
1980–1989	70	10.6
1990–1999	145	21.9
2000–2009	117	17.7
2010–2012	6	0.9
Total	**662**	**100.0**

An estimated 1,845 to 2,364 people reside in 1,058 addressed residential structures within the watershed, depending on the season. The project area has 1,430 addressed structures, and approximately 74 percent (1,058 of the 1,430) of the addressed structures are residences or households. To estimate the population in the watershed, the 1,058 residential structures were multiplied by the average household sizes in Hill City, Custer County, and Pennington County. Because some of these residential structures may be vacant, seasonal cabins, or vacation or recreational homes, the population estimate includes both the recreation season (May through September) and the nonrecreation season (October through April). In estimating seasonal populations, occupancy rates of the residential structures were assumed to be 90 percent during the recreation season and 60 percent during the nonrecreation season. The estimated human populations within the project area are listed in Table 1-14.

Pennington County's population increased approximately 14 percent between 2000 and 2010, and Hill City's population increased 21 percent during that same period. From 1990 to 2010, populations in Hill City, Custer County, and Pennington County increased 46 percent, 33 percent, and 24 percent, respectively, as illustrated in Table 1-15 [U.S. Census Bureau, 1990 and 2012b; Forstall, 1995; Pennington County, 2003].

The watershed, which is located in western Pennington County and northwestern Custer County, is predominantly rural in character with an economy based on recreation, tourism, timber production, and agriculture. Agriculture, retail, recreation, food services, real estate, finance, management, administrative, and education are major industries and employ approximately 74 percent of people. Construction and manufacturing jobs account for 15 percent

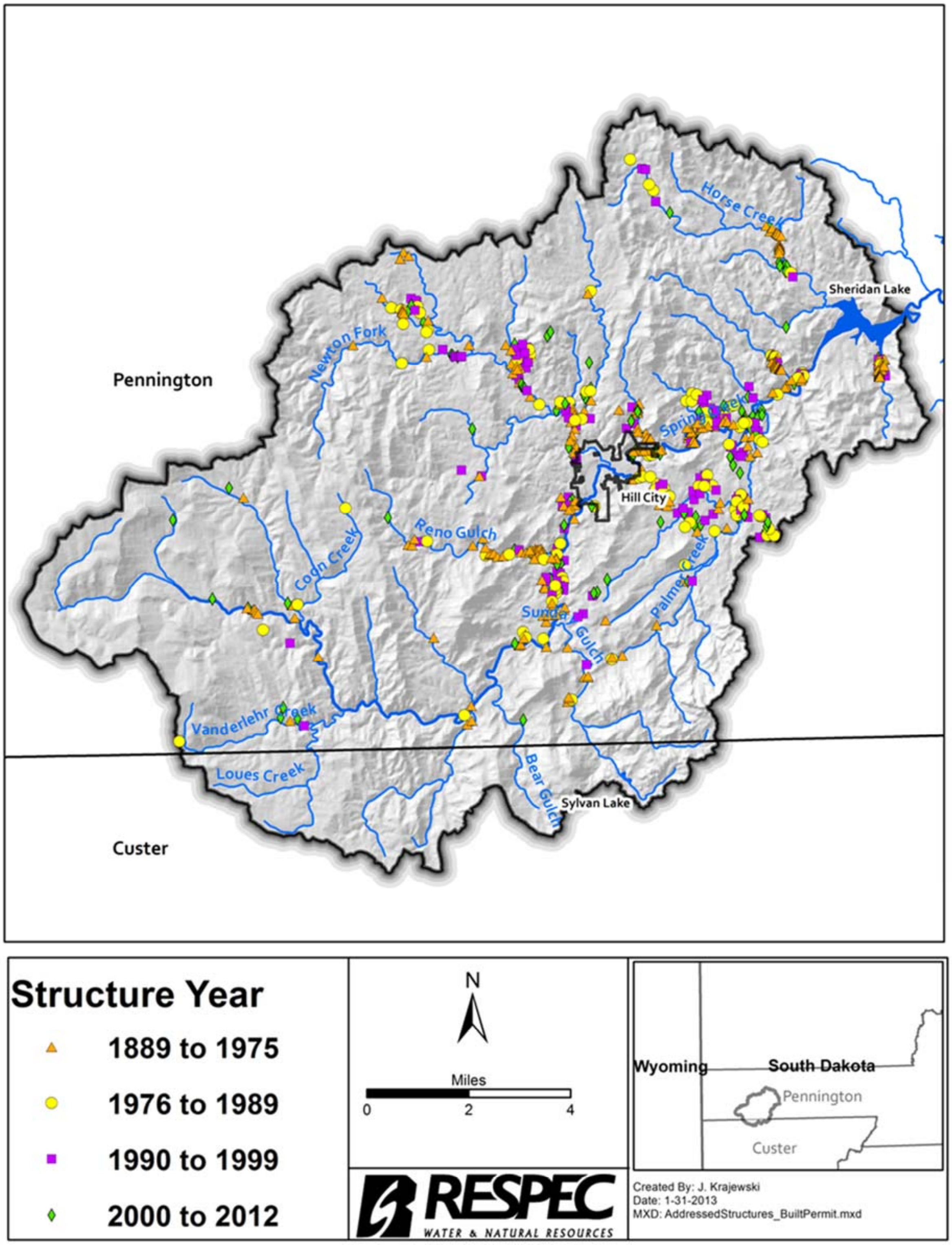

Figure 1-15. Addressed Structures Permit or Built Year in the Watershed.

of employment [U.S. Census Bureau, 2012a]. From 2007 to 2011, the estimated average per capita income in Hill City was $22,627, and the median household income was $41,691. The estimated average per capita income in Pennington County was $26,451, and the median household income was $48,378. The estimated average per capita income in Custer County was $25,525, and the median household income was $48,125 [U.S. Census Bureau, 2012a].

Table 1-14. Estimated Human Population in the Spring Creek Watershed

Area of Watershed	Addressed Structures		Persons per Addressed Structure (number)	Estimated Human Population		
	Total (number)	Residential (number)		Total Structures (number)	Residential Recreation Season (number)	Residential Nonrecreation Season (number)
Hill City	532	394[a]	2.41	1,282	949[b]	901[c]
Custer County	38	28[a]	2.06	78	52[b]	35[c]
Pennington County	860	636[a]	2.38	2,046	1,363[b]	909[c]
Project Area	**1,430**	**1,058[a]**	**2.38[d]**	**3,406**	**2,364[b]**	**1,845[c]**

(a) Assumes 74 percent of all addressed structures are residential.
(b) Assumes 90 percent occupancy of residential structures during the recreation season.
(c) Assumes 60 percent occupancy of residential structures during the nonrecreation season.
(d) Weighted average number of persons per addressed structure.

1.4.11 Tourism and Recreation

In addition to the estimated population of 1,845 to 2,364 in the watershed, approximately 1 to 2 million people visit area attractions annually. Mount Rushmore National Memorial is located approximately 3 miles southeast of the project area and 14 miles from Hill City via State Highway 244 or U.S. Highway 16. The northwest corner of Custer State Park is in the watershed and is 9 miles south of Hill City via State Highway 87 or U.S. Highway 16. Over 85 percent of the watershed is within the BHNF. Taking scenic drives, visiting national and state parks, and visiting local attractions were the most popular activities for visitors to the Black Hills [South Dakota Department of Tourism, 2012a].

In 2011, South Dakota Department of Transportation (SDDOT) traffic recorders, located on U.S. Highway 385/16 east of Hill City, counted an average of 7,041 vehicles per day during the recreation season, as listed in Table 1-16 [South Dakota Department of Transportation, 2012]. Also in 2011, an estimated 2,081,718 people visited Mount Rushmore National Memorial and 1,747,175 people visited Custer State Park, as illustrated in Table 1-17 [U.S. National Park Service, 2012; Worth, 2012]. During the recreation season in 2011, approximately 1.8 million and 1.3 million people visited Mount Rushmore National Memorial and Custer State Park, respectively. Figure 1-16 depicts the number of visitors in 2011 to Mount Rushmore National Memorial and Custer State Park as well as daily average vehicle counts on U.S. Highway 385/16 east of Hill City.

Table 1-15. Population Change in Hill City, Custer, Rapid City, Custer County, and Pennington County From 1970 to 2010

City or County	Census Year					Population Change (+ or –)		
	1970	1980	1990	2000	2010	1970–1990 (%)	1990–2010 (%)	1970–2010 (%)
Hill City	389	535	650	780	948	+67.1	+45.8	+143.7
Custer	1,597	1,830	1,741	1,860	2,067	+9.0	+18.7	+29.4
Rapid City	43,836	46,492	54,523	59,607	67,956	+24.4	+24.6	+55.0
Custer County	4,698	6,000	6,179	7,275	8,216	+31.5	+33.0	+74.9
Pennington County	59,349	70,361	81,343	88,565	100,948	+37.1	+24.1	+70.1

Table 1-16. South Dakota Department of Transportation Automated Traffic Recorder (Station #161) Vehicle Counts on U.S. Highway 385/16

Month in 2011[a]	East-Bound Lane	West-Bound Lane	East- and West-Bound Lanes	Days Monitored
	Daily Average Vehicle Count	Daily Average Vehicle Count	Daily Average Vehicle Count	
January	1,644	1,619	3,263	30
February	1,757	1,736	3,493	20
March	1,771	1,724	3,495	30
April	1,980	1,917	3,897	30
May	**2,565**	**2,501**	**5,066**	**31**
June	**3,723**	**3,644**	**7,367**	**30**
July	**4,379**	**4,243**	**8,622**	**31**
August	**4,008**	**3,967**	**7,975**	**30**
September	**3,132**	**3,044**	**6,176**	**30**
October	2,299	2,236	4,535	30
November	1,855	1,806	3,661	29
December	1,953	1,928	3,881	15
Annual Total	31,066	30,365	61,431	336
Annual Average	2,589	2,530	5,119	28
Recreation Season Total (May 1 to Sept 30)	**17,807**	**17,399**	**35,206**	**152**
Recreation Season Average (May 1 to Sept 30)	**3,561**	**3,480**	**7,041**	**30**
Nonrecreation Season Total (October 1 to April 30)	13,259	12,966	26,225	184
Nonrecreation Season Average (October 1 to April 30)	1,894	1,852	3,746	26

(a) Recreation season in bold.

Table 1-17. 2011 Visitors to Mount Rushmore and Custer State Park

Month in 2011	Mount Rushmore National Memorial	Custer State Park
January	16,069	30,595
February	18,011	28,152
March	37,430	50,159
April	51,022	63,801
May	151,638	134,505
June	365,017	289,779
July	566,526	371,256
August	441,359	357,622
September	281,653	245,122
October	99,606	103,174
November	29,662	41,951
December	23,725	31,059
Total	**2,081,718**	**1,747,175**

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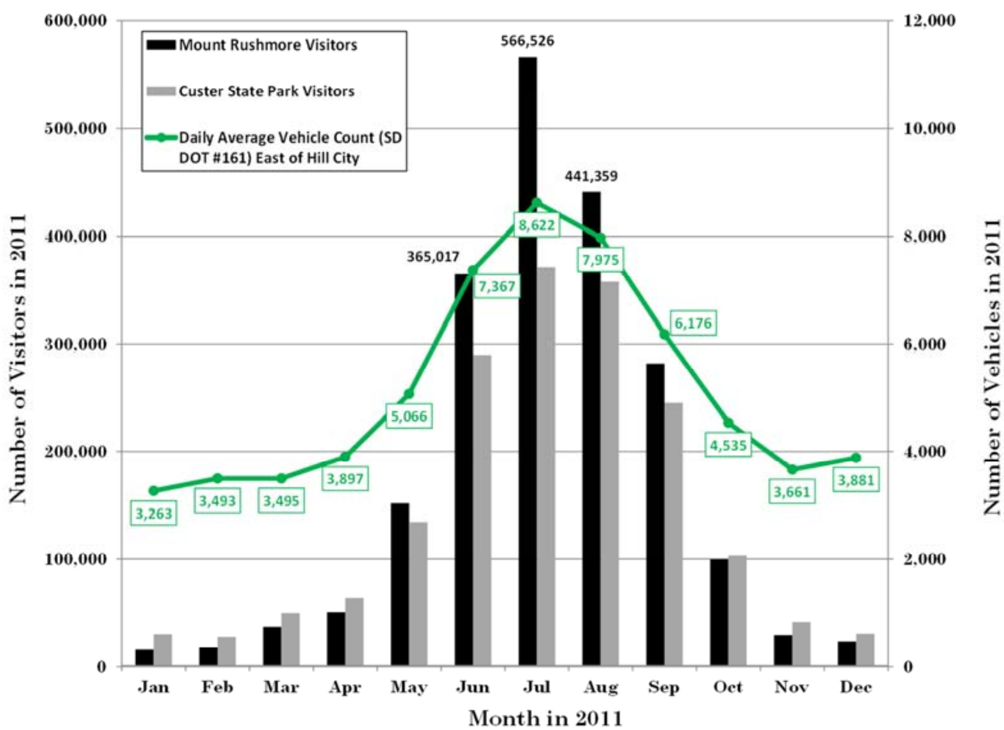

Figure 1-16. 2011 Visitors to Mount Rushmore National Memorial and Custer State Park and Daily Average Vehicle Counts East of Hill City.

The USFS estimated that the BHNF had 953,000 visitors in 2009 [USFS, 2012a]. The USFS contacted 2,690 visitors and completed interviews with 1,525 individuals, and the results were reported in the USFS' Visitor Use Report for the Black Hills [USFS, 2012a]. Survey participants indicated that their top three activities during their visit were viewing natural features, viewing wildlife, and driving for pleasure, and they averaged 4 to 5 hours doing these activities.

The survey results from the USFS' National Visitor Use Monitoring Program also indicated that 55 percent of all respondents were from South Dakota and traveled less than 50 miles from their home to the interview location [USFS, 2012a]. Another 15 percent of respondents were from Minnesota, Wyoming, Iowa, Nebraska, and North Dakota. Over 48 percent of all visitors were from six South Dakota counties, including Butte, Custer, Fall River, Lawrence, Meade, and Pennington. The average group size of the respondents was 2.5 people, and they spent an average of 4.6 nights per visit within 50 miles of the BHNF [USFS, 2012a]. Visitors were also asked about the type of lodging used during their visit to the BHNF, and more than half (54 percent) responded that they rented a private home or stayed with friends or family, as illustrated in Table 1-18 [USFS, 2012a].

Table 1-18. Type of Lodging Used by Visitors to the Black Hills National Forest

Type of Lodging	Type of Lodging (%)
Forest Service Campground on this National Forest	14.4
Undeveloped Camping in this National Forest	1.9
Forest Service Cabin	4.8
Other Public Campground	9.2
Private Campground	13.4
Rented Private Home	44.6
Home of Friends/Family	9.6
Owned Home	6.1
Other Lodging	0.5

1.4.12 Motel, Hotel, and Campground Use

Approximately 35 to 40 motels, hotels, and developed campgrounds are located within the watershed that provide over 1,600 lodging accommodations for visitors and travelers. Approximately eight private, four USFS, and one South Dakota Department of Game, Fish and Parks (SD GF&P) developed campgrounds are located in the area. These campgrounds have over 1,000 recreational vehicle sites and over 200 motel rooms and cabins. Approximately seven motels and hotels are located within Hill City that provide approximately 260 rooms and 6 cabins for visitors. Additionally, approximately 30 rooms, 50 cabins, and 20 houses are available at several resorts, ranches, bed-and-breakfast facilities, and vacation homes. Also located in the watershed is a camp that hosts over 1,200 youth during the summer. An estimated 75 percent of these motels, hotels, and campgrounds have installed OWTS, and the remaining 25 percent are serviced by Hill City's wastewater facility.

Motel and hotel occupancy and demand data for 2011 are listed in Table 1-19 for the Black Hills, Badlands, and Lakes Region and for Rapid City [Worth, 2012]. The demand for accommodations and percent occupancy peaked in July 2011 in both areas with occupancy rates of 88 percent and 87 percent for the Black Hills, Badlands, and Lakes Region and for Rapid City, respectively. Demand during the recreation season (May through September) in 2011 ranged from over 498,000 in Rapid City to over 1.2 million in the Black Hills, Badlands, and Lakes Region. Motel and hotel occupancy and demand data from 1995 to 2004 are illustrated in Table 1-20 for the Black Hills, Badlands, and Lakes Region [South Dakota Department of Tourism, 2012b]. From 1995 to 2004, the motel 10-year monthly average occupancy rates ranged from 48 percent to 85 percent. Campground occupancy and demand data from 1995 to 2004 are illustrated in Table 1-21. Campground average occupancy ranged from 45 percent to 61 percent. Additionally, the highest monthly average occupancy was in 1998 for motels and in 2003 for campgrounds in the Black Hills, Badlands, and Lakes Region.

Table 1-19. Motel and Hotel Occupancy and Demand for 2011 in Rapid City and in the Black Hills, Badlands, and Lakes Region

Month in 2011	Rapid City Occupancy (%)	Rapid City Demand	Black Hills, Badlands, and Lakes Region Occupancy (%)	Black Hills, Badlands, and Lakes Region Demand
January	33.1	43,515	30.7	87,964
February	41.0	48,720	39.8	102,768
March	41.0	54,004	37.6	106,999
April	38.4	48,956	37.6	113,706
May	52.3	69,387	40.6	168,669
June	78.3	100,462	79.7	257,718
July	87.0	118,030	88.5	295,013
August	80.8	109,659	79.5	265,612
September	77.1	101,161	71.5	232,806
October	53.2	70,412	51.4	166,675
November	36.5	46,359	37.1	102,682
December	37.9	49,813	41.4	86,026
Annual	**54.71**	**860,478**	**52.95**	**1,986,638**

Table 1-20. Motel/Hotel Occupancy in the Black Hills, Badlands, and Lakes Region

Month	Motel/Hotel Occupancy Rates During May Through October From 1995 to 2004 (%)										
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Monthly Average
May	52.9	46.2	44.8	45.0	45.6	49.8	51.8	54.9	51.6	45.0	48.8
June	80.3	78.6	73.7	81.1	80.9	75.6	71.2	75.9	73.1	70.5	76.1
July	86.9	85.6	83.9	87.0	89.1	83.5	80.3	84.3	87.2	79.4	84.7
August	79.9	82.6	84.4	85.1	82.7	79.3	77.5	81.0	82.6	77.3	81.2
September	66.4	65.3	70.2	73.3	68.3	62.9	54.5	66.7	64.9	61.6	65.4
October	48.6	55.1	59.8	57.6	50.9	47.9	46.0	46.8	50.3	45.7	50.9
Average	**69.2**	**68.9**	**69.5**	**71.5**	**69.6**	**66.5**	**63.5**	**68.3**	**68.3**	**63.2**	**67.9**

Table 1-21. Campground Occupancy in the Black Hills, Badlands, and Lakes Region

Month	Campground Occupancy Rates During June Through August From 1995 to 2004 (%)										
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Monthly Average
June	42.0	38.4	40.7	43.9	46.1	50.1	49.4	59.6	53.7	30.3	45.4
July	39.4	39.0	62.6	65.8	70.9	67.1	65.5	67.9	73.1	58.2	61.0
August	55.7	55.3	59.7	62.9	62.3	64.8	49.2	56.9	60.3	61.5	58.9
Average	**45.7**	**44.2**	**54.3**	**57.5**	**59.8**	**60.7**	**54.7**	**61.5**	**62.4**	**50.0**	**55.1**

1.4.13 Forest and Timber

Timber production and forest fuels management are also important land-use activities within the watershed. Ponderosa pine is the predominant vegetation species, and it covers an estimated 70,795 acres or approximately 76 percent of the watershed. With the discovery of gold in the Black Hills, large areas of forest were harvested to provide timber for mining and housing [USFS, 2007]. In 1897, the Black Hills Forest Reserve was established, and in 1898, the first federal timber sale was sold to the Homestake Mining Company [USFS, 2007]. Later in 1905, the forest reserve was transferred to the U.S. Department of Agriculture's Forest Service and was renamed as the BHNF [Pennington County, 2003].

Past forest management has aggressively suppressed wildfire with minimal prescribed burning, vegetation management for sustained growth and yield of timber, and providing and maintaining wildlife habitat [USFS, 2007]. This practice has resulted in a dense, continuous forest with few open areas and more of the Black Hills being affected by large, intense forest fires [USFS, 2007]. Historically, fire and insects shaped the composition of the Ponderosa pine forests of the western United States, including the Black Hills [USFS, 2007]. Insect infestations, specifically the mountain pine beetle (*Dendroctonus ponderosae*) (MPB), also thinned dense forest stands, which resulted in a more open forest, abundant hardwoods, and open meadows [USFS, 2007]. The MPB has affected over 41 million acres in the United States and approximately 405,000 acres in the Black Hills [USFS, 2012b]. An estimated 29,000 to 33,000 acres in the Spring Creek Watershed were infested by MPB from 2007 through 2011 [Guffey, 2011].

Also within the watershed, an MPB-infested area referred to as the “Red Zone” occurs from Keystone to west of Hill City [USFS, 2007]. Because of the high risk, high hazard, and high value of the wildland-urban interface (WUI) within the “Red Zone,” the area has been a management priority for fire and fuel hazard reduction to minimize the potential for large-scale wildfires [USFS, 2007]. In 2007, the USFS Mystic Ranger District’s Mitchell Project was authorized to treat approximately 15,500 acres by using mechanical and prescribed fire methods to create fuel break corridors adjacent to private property boundaries and along main roads and utility corridors to reduce the potential for large-scale, severe wildfire occurrence in the WUI setting [USFS, 2007]. In 2008, the USFS Mystic Ranger District’s Upper Spring Creek Project was authorized to mechanically treat approximately 27,000 acres and prescribe burn approximately 14,200 acres of the BHNF to reduce the threat to ecosystem components, including forest resources from the existing insect and MPB disease epidemic and to reduce the potential for large-scale, severe wildfire [USFS, 2008].

In recent years, a cooperative effort between private, local, state, and federal organizations has responded to the MPB infestation that began in 1996 and has dramatically affected the Ponderosa pine forest of the Black Hills and continues to expand [South Dakota Department of Agriculture, 2012]. In 2011, Pennington County instituted their Mountain Pine Beetle Suppression Project to landowners and homeowners in fire-sensitive ecosystems and increase protection of people and property by identifying MPB-infested trees and assisting private landowners with management costs [Pennington County, 2012b]. In 2012, the Forest Supervisor of the BHNF authorized the Mountain Pine Beetle Response Project, which is an adaptive approach at the landscape scale to quickly respond to the threat to forest resources from the existing mountain pine beetle infestation and to reduce hazardous fuels to reduce potential large-scale wildfire on nearly 250,000 acres in the BHNF [USFS, 2012c].

1.4.14 Pets and Domestic Animals

An estimated 72.1 million dogs, 81.7 million cats, 11.2 million birds, and 7.3 million horses were owned as pets in the United States based on a survey of 47,000 households in 2006 by the American Veterinary Medical Association (AVMA) [AVMA, 2013]. Approximately 37.2 percent of the households owned dogs and 32.4 percent of the households owned cats as pets in 2006 [U.S. Census Bureau, 2012c]. In 2006, the average number of dogs and cats owned per household was 1.7, and 2.2, respectively in the United States [U.S. Census Bureau, 2012c]. In 2011, the AVMA conducted their survey of pet owners again and found that South Dakota ranked third in the United States with approximately 65.6 percent of households owning a pet [AVMA, 2013]. South Dakota also ranked fourth nationally with approximately 39.1 percent of households owning a cat while the state ranked twelfth with approximately 42.8 percent of households owning a dog [AVMA, 2013].

As part of the *Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Spring Creek, Pennington County,* 19 bacteria ribotyping samples on Spring Creek were collected and analyzed from May through August of 2004, which indicated that 12.5 relative percent contribution of the isolates were from domestic animals [SD DENR, 2008a]. Pet populations within the project were not surveyed or inventoried as part of this planning effort, but an estimate of pet populations was approximated by using these generalized percentages of pet ownership within South Dakota and the United States. Approximately 1,430 addressed structures are located within the project area, with approximately 74 percent or 1,058 being residences or households.

To estimate the pet population in the watershed, the 1,058 households were multiplied by the percent of households owning a dog and cat in South Dakota (42.8 percent and 39.1 percent, respectively). The households with dogs and cats were then multiplied by the average number of dogs and cats owned per household (1.7 dogs and 2.2 cats, respectively) in the United States. Using these generalized assumptions, approximately 453 households have approximately 770 dogs and approximately 414 households have approximately 910 cats. In addition to the households with pets within the project area, additional populations of pets exist with tourists, visitors, and travelers that would be in the watershed for a shorter period of time, however, no data or information was available with which to make any assumptions or estimate those pet numbers.

1.4.15 **Grazing and Livestock**

Ranching and livestock grazing are important land-use activities in the Black Hills. Livestock grazing has been occurring in the Black Hills since the initial explorations of the 1874 Black Hills Expedition, which included a large number of cattle, horses, and mules to sustain the expedition and was in addition to the native grazers such as bison, elk, deer, and bighorn sheep [USFS, 2010]. Cavalry officers, herders, scouts, and miners all were united in praise of the grazing including, “California Joe,” who said of the valley of Spring Creek: “There’s gold from the grass roots down, but there’s more gold from the grass roots up.” No matter how rich the gold-placers in the Black Hills may prove to be, the great business in this regions in the future will be stock raising and dairy farming [Rosen, 1895].

With the gold rush, increasing numbers of cattle and sheep were needed to satisfy the need for food and dairy products. Concurrently, the amount of grazing by range and dairy animals quickly increased in and around the Black Hills [USFS, 2010]. In 1903, 300,000 cattle, 100,000 sheep, and 7,000 horses were estimated to be present in the Black Hills region compared to the 23,000 head of cattle currently grazed on all of the BHNF lands [USFS, 2010]. Today, approximately 128,000 animal unit months of livestock grazing consume up to 127 million pounds of forage each year on the BHNF, and grazing by domestic sheep is not permitted [USFS, 1997].

Livestock grazing occurs on approximately 79,000 acres (approximately 85 percent) of the 92,840 acres within the Spring Creek Watershed. These 79,000 acres consist of over 73,600 acres on national forest lands and approximately 5,400 acres of private lands zoned as general and limited agriculture lands. Many of the private agricultural lands are used in conjunction with the grazing allotments located on the BHNF lands, which are illustrated in Figure 1-17.

1.4.15.1 Black Hills National Forest Grazing Allotments

Several ranchers graze their cattle by permit on the BHNF in the watershed during the summer and fall, typically from early June to mid-October. Approximately 14 national forest grazing allotments cover approximately 73,600 acres, with approximately 1,600 cow/calf pairs within the watershed, as illustrated in Figure 1-17. Table 1-22 summarizes these allotments [McConkey, 2014; Vedder, 2013; USFS, 2010].

In 2010, the USFS Mystic Range Project analyzed alternatives, outlined necessary improvements, and reauthorized livestock grazing on eight allotments that cover 85,000 acres of the BHNF. The purpose of the USFS Mystic Range Project is to accomplish the following:

- Improve livestock management to be consistent with the goals, objectives, standards, and guidelines of the Forest Plan, as amended
- Improve species composition of upland vegetation
- Improve streambank stability
- Improve riparian vegetation diversity and abundance
- Reduce the risk of livestock-vehicle collisions.

Approximately 86 livestock/wildlife water developments are supplied by springs, ponds, wells, solar pumps, and reservoirs that deliver water to approximately 118 livestock/wildlife watering facilities, including tanks, troughs, storage tanks, and ponds as illustrated in Figure 1-18 [Vedder, 2013; USFS, 2010]. Representatives of the Pennington Conservation District, BHNF Mystic Ranger District, Pennington County, and the NRCS met to discuss the grazing management, livestock numbers, and grazing improvements on USFS allotments. Opportunities for livestock/wildlife water development and coordinated grazing of private lands and public grazing allotments exist within the project area. The areas within the watershed where potential livestock/wildlife water development should be investigated include portions of the Gordon Points, Hill City, Medicine Mountain, Palmer Gulch, Spring Creek, and Tigerville grazing allotments.

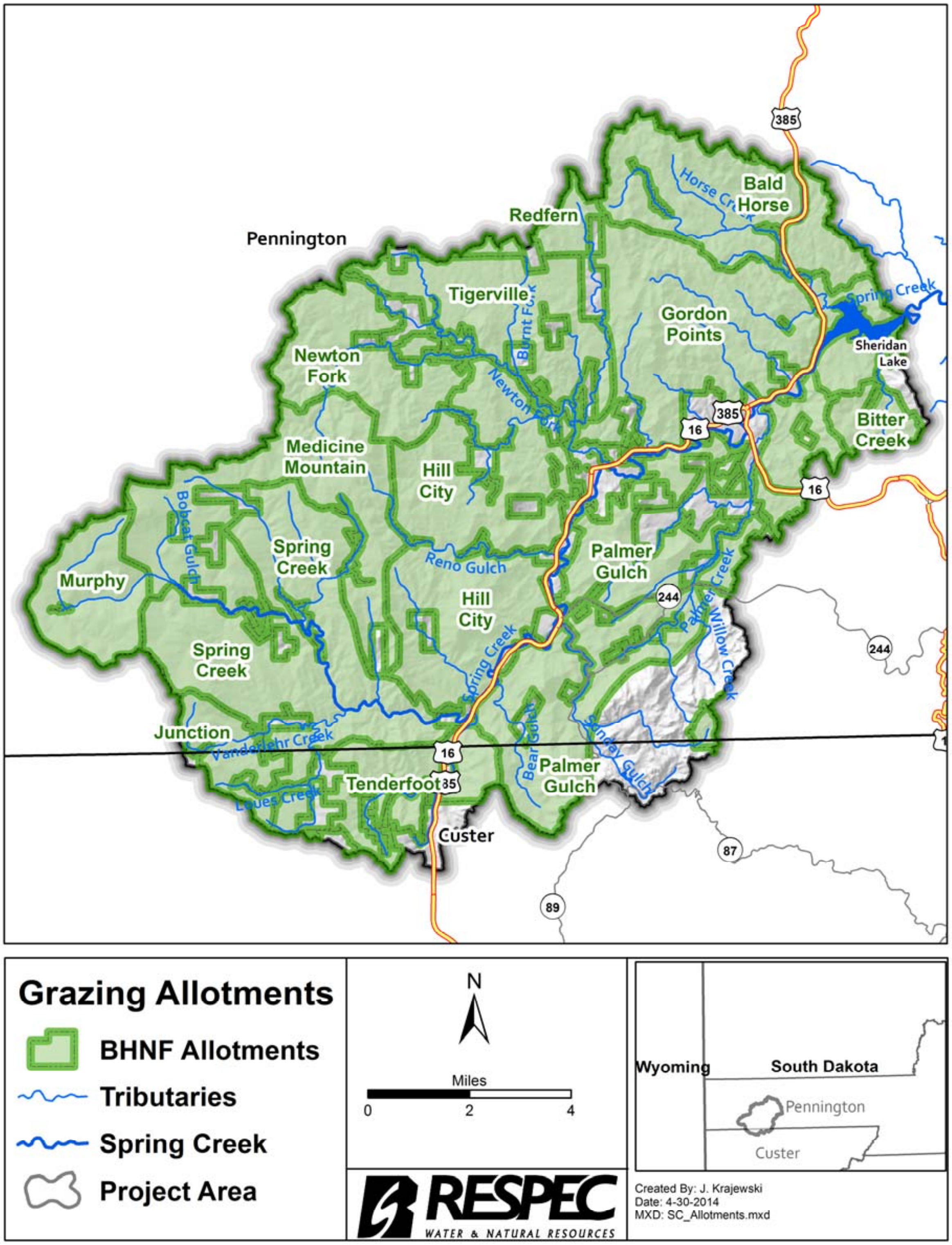

Figure 1-17. Grazing Allotments on the Black Hills National Forest Within the Spring Creek Watershed.

Table 1-22. U.S. Forest Service Authorized Livestock Use Allotments Within the Spring Creek Watershed

Allotment Name	Total Acres	Number of Pastures, Type of Grazing System	Number of Livestock and Permits	Season of Use	Animal Unit Months (AUMs)	Acres in Project Area	Percent in Project Area	Access to Spring Creek
Hill City[a]	10,652	6 pastures, deferred	80 cow/calf, 1 permittee	June 1–October 15	476	10,652	100.0	Tributary
Gordon Points	8,256	6 pastures, deferred	150 cow/calf, 1 permittee	June 1–September 30	794	8,256	100.0	None to low
Spring Creek[a]	9,807	9 pastures, deferred	185 cow/calf, 1 permittee	June 1–October 15	1100	9,807	100.0	Moderate
Medicine Mountain	9,146	5 pastures, deferred	226 cow/calf, 1 permittee	June 16–October 15	1206	7,448	81.4	Low to moderate
Oblivion	14,190	5 pastures, deferred	74 cow/calf; 1 permittee	June 1–October 10	491	11,540	81.8	None to low
Palmer Gulch[a]		6 pastures, deferred	67 cow/calf; 1 permittee	June 1–October 21	416			
Redfern	11,573	5 pastures, deferred	177 cow/calf, 1 permittee	June 11–October 25	1,052	976	8.4	NA
Tigerville	5,825	6 pastures, deferred	112 cow/calf, 1 permittee	June 1–October 25	715	5,082	87.2	None to low
Newton Fork	5,502	3 pastures, deferred	74 cow/calf; 1 permittee	June 1–October 31	421	4,416	80.3	None to low
Murphy	6,137	5 pastures, deferred	114 cow/calf, 1 permittee	June 16–October 15	604	3,093	50.4	Headwater
Junction	3,612	4 pastures, deferred	147 yearlings, 1 permittee	June 1–October 15	NA	1,763	48.8	NA
Tenderfoot[a]	10,549	5 pastures, deferred	223 cow/calf, 2 permittees	June 1–September 30	NA	3,457	32.8	NA
		1 pasture	10 cow/calf, 1 permittee	July 1–October 1				
Bald Horse	27,828	9 pastures, deferred	299 cow/calf; 1 permittee	June 1–October 26	1,921	6,056	21.7	NA
Bitter Creek	10,484	5 pastures, deferred	50 cow/calf; 1 permittee	June 1–October 31	332	1,058	10.1	NA

(a) Indicates which allotments may have pre- or postseason livestock use on private lands.

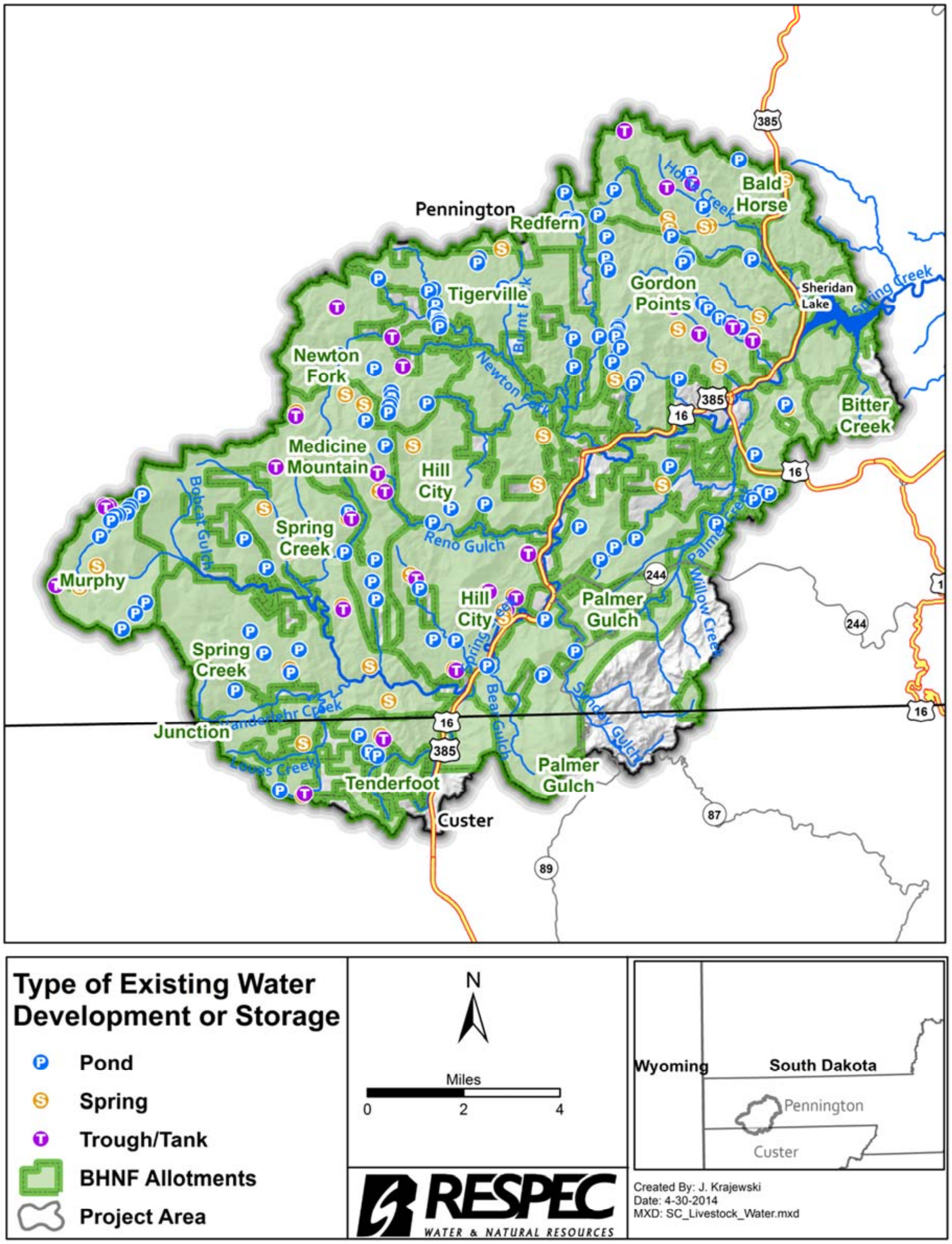

Figure 1-18. Existing Livestock and Wildlife Water Developments on the Black Hills National Forest Within the Spring Creek Watershed.

1.4.15.2 Private Land Grazing

No livestock that are grazed on the USFS allotments stay year-round on the BHNF. Some of the livestock that are grazed on the allotments are also grazed on the adjacent private lands within the watershed. The livestock are grazed on private lands before and after the season of use in the allotments as described in Table 1-22. Livestock on private land were not inventoried as part of the planning effort; however, in visiting with project participants and landowners, the majority of grazing animals on private lands in the watershed are associated with small pastures, season-long supplemental feeding areas, equine arenas, trail riding activities, and livestock-handling or -loading areas. Also, no confined animal feeding operations exist within the watershed.

1.4.16 Wildlife and Fisheries

In the *Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Spring Creek, Pennington County, South Dakota*, estimates from watershed modeling indicated that approximately 7.9 percent of the fecal coliform bacteria load comes from wildlife [SD DENR, 2008a]. During the TMDL assessment, bacteria ribotyping samples were collected and analyzed to help define the source of fecal coliform within the watershed. In 2004, bacteria ribotyping samples collected at four sites on Spring Creek and one site on Palmer Gulch indicated that wildlife contributed 7.7 percent of the fecal coliform bacteria sources [SD DENR, 2008a]. Additionally, because there was limited identification of wildlife in the bacterial ribotyping analysis, the TMDL document suggested that associating a significant portion of the unknown fecal coliform bacteria contribution to wildlife may be reasonable [SD DENR, 2008a].

1.4.16.1 Wildlife

Wildlife resources within the project area include primary game species, such as white-tailed deer, bighorn sheep, mule deer, elk, turkey, mountain lion, and mountain goat. Other wildlife species in the area include coyote, red fox, bobcat, raccoon, porcupine, skunk, beaver, red squirrel, northern flying squirrel, mink, badger, cottontail rabbit, bald eagle, red-tailed hawk, turkey, osprey, canada geese, ruffed grouse, and sharp-tailed grouse [Huxoll, 2003; NRCS, 2012c]. County wildlife estimates within the state of South Dakota were developed by SD GF&P personnel from 1991 through 2002 for big game, furbearer, small game, and waterfowl abundance. County wildlife assessment summaries for Custer and Pennington Counties are illustrated in Table 1-23. These county estimates were approximated annually and may have significant influence from observers and methods in addition to spatial and temporal variability and should not be interpreted as absolute wildlife abundance [Huxoll, 2003].

1.4.16.2 Fisheries

Fisheries resources within the project area primarily include brook, brown, rainbow trout, and other fish species that inhabit the creeks, lakes, and reservoirs. Historically fish-species diversity was limited in the Black Hills, with native species including longnose dace,

Table 1-23. County Wildlife Assessments Summary From 1991 Through 2002 for Custer and Pennington Counties (Adapted From Huxoll [2003])

Species	Custer County 1991 Through 2002			Pennington County 1991 Through 2002		
	2002 Average Per Square Miles	5-Year Average	Overall Average	2002 Average Per Square Miles	5-Year Average	Overall Average
White-tailed Deer	1.97	3,400	3,617	4.22	6,747	8,753
Mule Deer	1.84	2,400	2,218	1.16	3,315	5,898
Elk	1.46	2,053	1,522	0.59	1,415	977
Antelope	0.54	770	724	0.29	996	1,574
Mountain Goat	0.05	81	79	0.03	81	90
Bighorn Sheep	0.00	17	12	0.08	206	207
Turkey	10.73	11,675	7,788	1.97	3,970	3,105
Mink	0.38	600	600	0	638	563
Beaver	0.25	328	289	0.36	1,000	808
Muskrat	0.32	480	391	1.61	4,560	2,482
Skunk	2.03	3,080	2,359	1.11	3,698	3,263
Badger	0.13	120	109	0.72	2,020	1,973
Coyote	0.45	600	827	1.04	3,807	3,594
Fox	0.03	50	59	0.11	480	632
Raccoon	0.95	1,560	1,523	1.02	3,576	3,653
Bobcat	0.13	260	264	0.14	378	361
Jackrabbit	0.06	2,020	2,982	1.07	3,200	3,745
Pine Marten	0.03	42	34	0.03	65	50
Mountain Lion	0.02	19	13	0.01	20	13
Cottontail Rabbit	2.86	4,800	4,291	3.24	8,862	10,074
Squirrel	3.18	5,600	4,045	2.88	5,497	23,226
Ruffed Grouse	0.13	220	182	0.09	250	255
Partridge	0.06	400	245	0.43	1,300	1,236
Sharptail Grouse	0.95	2,330	1,762	2.07	6,616	5,980
Nesting Canada Geese	0	0	0	0.57	1,540	1,306

mountain sucker, white sucker, creek chub, fathead minnow, lake chub, longnose sucker, and finescale dace [USFS, 2005]. Table 1-24 lists fish species found in the Black Hills and their general habitat [USFS, 2005]. Spring Creek is possibly the most accessible stream in the Black Hills because most the of the creek is located along the U.S. Highway 385/16 corridor [Erickson and Koth, 2002]. Spring Creek upstream of Sheridan Lake through Hill City is managed for brown trout while tributaries and Spring Creek upstream of Hill City are primarily brook trout waters, but they do contain a few large brown trout [Erickson and Koth, 2002].

In 2009, fish populations were surveyed by the SD GF&P on reaches of Spring Creek, Horse Creek, Newton Fork Creek, Palmer Gulch, Sunday Gulch, Tenderfoot Creek, Vanderlehr Creek, and Willow Creek [Bucholz and Willhite, 2009]. During the survey, three sites on Spring Creek above Sheridan Lake were sampled during July and August in addition to seven tributary stream sites [Bucholz and Willhite, 2009]. Brook trout, creek chub, longnose dace, and white sucker were the most abundant fish species found in Spring Creek and its tributaries during the 2009 survey, as illustrated in Table 1-25. Low flows and a prolonged drought likely affected stream habitat and fish populations in the Black Hills [Bucholz and Willhite, 2009]. In 2013, sections of Spring Creek and Palmer Gulch Creek, as well as Newton Fork Dam, Sheridan, Lake Alexander (Medicine Mountain Boy Scout Pond), Sylvan, Sunday Gulch Pond, Mitchell Lake, and Major Lake, were stocked with rainbow trout [SD GF&P, 2013].

1.4.16.3 Sensitive Species

The USFS defines sensitive species as those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population, density, or habitat that would reduce a species' existing distribution [USFS, 2010]. In 2010, the wildlife, botanical, and fisheries resources within the Mystic Range Project were summarized in the project's Biological Evaluation to disclose, in detail, the potential effects of all alternatives to federally listed and USFS sensitive species [USFS, 2010].

The USFS Mystic Range Project encompasses the Spring Creek Watershed and the sensitive species list from the Mystic Range Project is referenced and included in this plan in Table 1-26. This information is included because whenever a potential project or alternative in this Watershed Management Plan is located on federal lands, then the potential project could be subject to the National Environmental Policy Act (NEPA) and other federal regulations such as the Endangered Species Act; the National Historic Preservation Act; the Environmental Justice Executive Order; and other federal, state, tribal, and local laws and regulations. Consequently, coordinating with state and federal agencies with regulatory oversight and permitting approval would be required and strongly encouraged on those potential projects involving federal lands.

Table 1-24. Fish Species General Habitat, Abundance, and Management in the Black Hills (Adapted From U.S. Forest Service [2005])

Species	Black Hills Management	General Habitat	Abundance/ Population Trend
Black Crappie	Introduced, Game Fish	Large lakes, clear water, beds of aquatic vegetation	Fairly common in Pactola and Sheridan Lakes
Black Bullhead	Introduced, Game Fish	Lakes, clear to very turbid water in small ponds	If it occurs, possibly only in Stockade and Sheridan Lakes
Brook Trout	Introduced, Game Fish (Stocked)	Cold, clear streams and lakes	Many creeks have self-sustaining populations; less common than brown trout
Brown Trout	Introduced, Game Fish (Stocked)	Cold, clear streams and lakes	No longer present in Sheridan Lake; widely stocked in Black Hills streams
Creek Chub	Native, Nongame	Mainly found in small, clear streams	Has declined in several creeks since the 1980s; stable population on French Creek through the 1990s
Fathead Minnow	In SD, may not be native, Nongame	Slow-flowing streams with weeds, shallow lakes, and ponds	Present in Deerfield Reservoir in late 1990s; populations have decreased in several streams the last 20–40 years
Finescale Dace	Native Nongame	Pools of boggy headwaters, creeks and small rivers, lakes and ponds, and common in beaver ponds	No occurrences on the South Dakota portion of the Forest
Lake Chub	Native, Nongame	Standing or flowing waterbodies; common in gravel-bottomed streams and rocky lake margins	Historically more widespread and abundant, only persists in Deerfield Reservoir
Largemouth Bass	Introduced, Game Fish	Larger lakes	Common in Pactola and Sheridan Lakes; rare in Rapid and Spring Creeks
Longnose Dace	Native, Nongame	Small and large cool to coldwater streams	Widespread and common in the Black Hills
Longnose Sucker	Native, State Threatened	Fairly small, clear, cold streams	Present on a few creeks in the 1990s; no records in Pactola Reservoir in the late 1990s
Mountain Sucker	Native, Nongame	Rivers and streams, occurring often in cool, clear mountain streams with moderate water velocities	Occurs in most major drainages, localized distribution and abundance likely reduced from historic levels
Northern Pike	Introduced, Game Fish	Lakes, ponds, and slow-flowing rivers with abundant aquatic vegetation; clear water	Occurs in almost all lakes in the Black Hills; also found in Spring Creek
Rainbow Trout	Introduced, Game Fish (Stocked)	Variety of creeks and lakes; cool, clear lakes; cool, swift streams; rocky substrates, vegetated banks	Stocked in reservoirs and creeks; a few self-sustaining populations in Spearfish Creek
Rock Bass	Introduced, Game Fish	Found almost exclusively in larger lakes	Very common in Pactola and Sheridan Lakes
White Sucker	Native, Nongame	Lake and stream habitats; small, cool creeks	Widespread in large and small lakes and streams
Yellow Perch	Introduced, Game Fish	Shallow waters of lakes and large ponds; clear, weedy creeks	Widespread in large and small lakes, localized in streams

Table 1-25. Fish Species Abundance and Density (per 100 mi^2) Captured in 2009 Within Sample Sites in the Spring Creek Watershed (Adapted From Huxoll [2009])

Streams and Sample Sites Within the Project Area											
Stream	**Spring Creek**	**Spring Creek**	**Spring Creek**	**Horse Creek**	**Horse Creek**	**Palmer Gulch**	**Willow Creek**	**Newton Fork**	**Sunday Gulch**	**Tenderfoot Creek**	**Vanderlehr Creek**
Sample Site	SPR06	SPR04	SPR07	HOC01	HOC02	PAG01	WCP01	NFC01	SUN01	TFC01	VON02
Species Abundance and (Density per 100 m^2)											
Brook trout	7 (8.7)	32 (16.2)					9 (6.8)	11 (3.7)	No fish	No fish	3 (4.0)
Brown trout		3 (1.5)									
Rainbow trout		1 (0.1)						1 (3.4)			
Longnose dace		22 (11.2)	101 (20.4)	4 (2.8)	22 (9.2)	1 (0.6)		18 (6.0)			
White sucker			14 (2.8)			14 (8.2)	4 (3.0)				
Creek chub			69 (13.9)								
Rock bass			1 (0.1)								

Table 1-26. U.S. Forest Service Region 2 Sensitive Wildlife, Fish, and Plant Species Listed for the Black Hills National Forest (Adapted From U.S. Forest Service [2010]) (Page 1 of 2)

Common Name	Scientific Name	Species or Habitat Present
	Mammals	
Black-tailed prairie dog	Cynomys ludovicianus	Yes (habitat)
American marten	Martes americana	Yes (both)
Fringed myotis	Myotis thysanodes	Yes (both)
Rocky Mountain bighorn sheep	Ovis canadensis canadensis	Yes (both)
Townsend's big-eared bat	Plecotus townsendii	Yes (both)
	Birds	
Burrowing owl	Athene cunicularia	Yes (habitat)
Northern goshawk	Accipiter gentilis	Yes (both)
Grasshopper sparrow	Ammodramus savannarum	Yes (both)
Ferruginous hawk	Buteo regalis	Yes (habitat)
Northern harrier	Circus cyaneus	Yes (both)
Yellow-billed cuckoo	Coccyzus americanus	Yes (habitat)
Olive-sided flycatcher	Contopus cooperi	Yes (both)
American peregrine falcon	Falco peregrinus anatum	Yes (habitat)
Bald eagle	Haliaeetus leucocephalus	Yes (both)
Loggerhead shrike	Lanius ludovicianus	Yes (habitat)
Lewis's woodpecker	Melanerpes lewis	Yes (both)
Long-billed curlew	Numenius americanus	Yes (habitat)
Flammulated owl	Otus flammeolus	Yes (habitat)
Black-backed woodpecker	Picoides arcticus	Yes (both)
American three-toed woodpecker	Picoides dorsalis	Yes (both)
	Reptiles and Amphibians	
Northern leopard frog	Lithobates pipiens	Yes (both)
Black Hills red-bellied snake	Storeria occipitomaculata pahasapae	Yes (both)
	Fish	
Mountain sucker	Catostomus platyrhynchus	Yes (both)
Lake chub	Couesius plumbeus	Yes (both)
	Invertebrates	
Ottoe skipper	Hesperia ottoe	Yes (habitat)
Regal fritillary	Speyeria idalia	Yes (both)
Cooper's Rocky Mountain snail	Oreohelix strigosa cooperi	Yes (both)

Table 1-26. U.S. Forest Service Region 2 Sensitive Wildlife, Fish, and Plant Species Listed for the Black Hills National Forest (Adapted From U.S. Forest Service [2010]) (Page 2 of 2)

Common Name	Scientific Name	Species or Habitat Present
Plants		
Prairie moonwort	Botrychium campestre	NA
Narrowleaf grapefern	Botrychium lineare	NA
Foxtail sedge	Carex alopecoidea	NA
Yellow lady's slipper	Cypripedium parviflorum	NA
Trailing clubmoss	Lycopodium complanatum	NA
Large round-leaf orchid	Platanthera orbiculata	NA
Sage willow	Salix candida	NA
Autumn willow	Salix serissima	NA
Highbush cranberry	Viburnum opulus var. americanum	NA
Great-spurred violet	Viola selkirkii	NA

1.4.16.4 Proposed, Threatened, and Endangered Species

The following species have the potential to occur in Custer and Pennington Counties [U.S. Fish and Wildlife Service, 2014]:

- **Endangered:** Black-footed ferret (*Mustela nigripes*), Whooping crane (*Grus americana*), Least tern (*Sterna antillarum*)
- **Proposed Endangered:** Northern Long-Eared bat (*Myotis septentrionalis*)
- **Proposed Threatened:** Red knot (*Calidris canutus rufa*)
- **Candidate:** Sprague's pipit (*Anthus spragueii*).

1.5 WATER QUALITY

1.5.1 Beneficial Uses and Water Quality Standards

The state of South Dakota has assigned all streams with the beneficial uses of fish and wildlife propagation, recreation, stock watering, and commerce and industry [South Dakota Legislature, 2012a]. Lakes have been assigned the beneficial uses of immersion recreation, limited-contact recreation, fish and wildlife propagation, recreation, and stock watering [South Dakota Legislature, 2012a; SD DENR, 2012b]. In addition, Spring Creek was assigned coldwater permanent fish life propagation (above Sheridan Lake), immersion recreation, and limited-contact recreation in the project area.

Additional beneficial uses for Sheridan Lake and Sylvan Lake include coldwater permanent fish life propagation, immersion recreation, and limited-contact recreation [South Dakota Legislature, 2012a]. Table 1-27 contains the assigned beneficial uses for Spring Creek and its

Table 1-27. Beneficial Uses for Spring Creek and Certain Tributaries, Sheridan Lake, and Sylvan Lake

Waterbody	From	To	County	Beneficial Uses
Spring Creek	S.D. Highway 79	Sheridan Lake	Pennington	Coldwater marginal fish life propagation, immersion recreation, limited-contact recreation
Spring Creek	Sheridan Lake	S5, T2S, R3E	Pennington	Coldwater permanent fish life propagation, immersion recreation waters, limited-contact recreation
Bear Gulch Creek	Spring Creek	S26, T2S, R4E	Custer	Coldwater marginal fish life propagation, limited-contact recreation
Bobcat Gulch Creek	Spring Creek	S34, T1S, R3E	Pennington	Coldwater marginal fish life propagation waters, limited-contact recreation
Cabin Springs Creek	Sunday Gulch Creek	Headwaters	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Horse Creek	Spring Creek	S30, T1N, R5E	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Loues Creek	Vanderlehr Creek	S30, T2S, R4E	Custer	Coldwater marginal fish life propagation, limited-contact recreation
Marshall Gulch Creek	Newton Fork Creek	S6, T1S, R5E	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Medicine Mountain Creek	Spring Creek	S10, T2S, R3E	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Newton Fork Creek	Spring Creek	S18, T1S, R4E	Pennington	Coldwater permanent fish life propagation, limited-contact recreation
Medicine Mountain Creek	Spring Creek	S26, T1S, R3E	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Palmer Gulch Creek	Spring Creek	S8, T2S, R5E	Pennington	Coldwater permanent fish life propagation, limited-contact recreation
Reno Gulch Creek	Spring Creek	S28, T1S, R4E	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Sunday Gulch Creek	Spring Creek	S18, T2S, R5E	Pennington	Coldwater permanent fish life propagation, limited-contact recreation
Tenderfoot Creek	Spring Creek	S29, T2S, R4E	Custer	Coldwater permanent fish life propagation, limited-contact recreation
Vanderlehr Creek	Spring Creek	S24, T2S, R3E	Pennington	Coldwater marginal fish life propagation, limited-contact recreation
Sheridan Lake	Cheyenne River	S.D. Highway 79	Pennington	Warm-water permanent fish life propagation waters, limited-contact recreation waters
Sylvan Lake	S.D. Highway 79	Sheridan Lake	Pennington	Coldwater marginal fish life propagation waters, immersion recreation waters, limited-contact recreation waters

tributaries, Sheridan Lake, and Sylvan Lake. Water quality standards in support of assigned beneficial uses have also been adopted by the state of South Dakota and include criteria that apply to streams and lakes based on these assigned uses [South Dakota Legislature, 2012a].

The SD DENR performed water quality assessments on Sylvan Lake, Sheridan Lake, and Spring Creek and its tributary streams from 2001 to 2004 to determine and document rural and urban sources of impairment from fecal coliform bacteria, sediment, and nutrients within the Spring Creek Watershed. These assessments were then used to develop TMDLs, which were approved by the EPA on Sylvan Lake, Sheridan Lake, and Spring Creek in 2005, 2006, and 2008, respectively. The TMDL target established for the immersion recreation beneficial use on Spring Creek was based on the water quality criteria for fecal coliform bacteria.

Table 1-28 lists the state's water quality criteria for immersion recreation waters. Water quality criteria for immersion recreation waters require that (1) no sample exceeds 400 colony-forming units (cfu)/100 milliliters (mL) and (2) during a 30-day period, the geometric mean of a minimum of five samples collected during separate 24-hour periods must not exceed 200 cfu/100 mL. Also, *E. coli* water quality criteria exists for immersion recreation waters that state (1) no sample exceeds 235 cfu/100 mL and (2) during a 30-day period, the geometric mean of a minimum of five samples collected during separate 24-hour periods must not exceed 126 cfu/100 mL. Both criteria are applicable from May 1 to September 30 [South Dakota Legislature, 2012a].

Table 1-28. South Dakota Water Quality Criteria for Immersion Recreation Waters

Parameter	Criteria	Unit of Measure	Special Conditions
Dissolved oxygen (DO) (as measured anywhere in the water column of a nonstratified waterbody or in the epilimnion and metalimnion of a stratified waterbody)	$\geq$ 5.0	mg/L	Daily minimum
Fecal coliform	$\leq$ 200	/100 mL	Geometric mean based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period, and they may not exceed this value in more than 20 percent of the samples examined in this same 30-day period
	$\leq$ 400		In any one sample
E. coli	$\leq$ 126	/100 mL	Geometric mean based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period
	$\leq$ 235		In any one sample

1.5.2 303(d) Lists and Integrated Reports

In 1998, Spring Creek was included on the South Dakota 303(d) list because information from SD DENR's water quality monitoring site (WQM 54) on Spring Creek near Sheridan Lake and data collected by the USFS indicated that Spring Creek was impaired by fecal coliform bacteria [SD DENR, 1998]. Sylvan Lake was also included on the list because lake assessment data indicated impairment from a trophic state index (TSI) [SD DENR, 1998]. In 2006, Spring Creek's immersion recreation was again impaired by fecal coliform bacteria because of livestock and OWTS [SD DENR, 2006a]. Also in 2006, Sylvan and Sheridan Lakes' coldwater permanent fish use was impaired because of dissolved oxygen (DO); however, Sylvan Lake was delisted for TSI [SD DENR, 2006a].

The *2008 South Dakota Integrated Report for Surface Water Quality Assessment* stated that Spring Creek's coldwater permanent fish life beneficial use was impaired because of temperature, and its immersion recreation beneficial use was impaired because of fecal coliform bacteria [SD DENR, 2008b]. The integrated report also indicated that Sheridan Lake's coldwater permanent fish life beneficial use was impaired because of DO, pH, temperature, and TSI, and Sylvan Lake's coldwater permanent fish life beneficial use was impaired because of pH, temperature, and TSI [SD DENR, 2008b].

In 2010, Spring Creek's immersion recreation impairment was delisted because a fecal coliform bacteria TMDL was approved by the EPA. Sheridan Lake's coldwater permanent fish use was listed as impaired because of DO and temperature. Sylvan Lake's coldwater permanent fish use was impaired because of temperature, and both lakes were delisted for pH, because the applicable water quality standards were attained [SD DENR, 2010a]. In 2012, coldwater permanent fish life beneficial use was listed as impaired because of temperature from natural sources for Spring Creek, DO and temperature for Sheridan Lake, and temperature for Sylvan Lake. [SD DENR, 2012b]. Spring Creek, Sheridan Lake, and Sylvan Lake are scheduled for TMDL development to address temperature impairments in 2016, 2018, and 2020, respectively [SD DENR, 2012b].

1.6 PAST STUDIES AND ASSESSMENTS

In 1969, a water quality study of the Spring Creek area evaluated existing and potential pollution problems and found that the major pollutants—silt and bacteria—in the watershed were originating from grazing; roads; logging; and municipal, residential, and commercial wastewater [SD DENR, 2008a]. Since 1976, the USFS and the SD DENR have collected fecal coliform bacteria samples at various locations along Spring Creek. In 2002, the SDSM&T and the SD DENR monitored water quality as part of a TMDL assessment study and found that, from May 2002 to July 2003, approximately 17 percent of the samples collected on Spring Creek exceeded fecal coliform criteria. The maximum concentrations ranged from 2,000 cfu/100 mL to greater than 20,000 cfu/100 mL. Most of the samples that exceeded criteria were collected during storm or runoff events [SD DENR, 2008a; Putnam et al., 2008].

In 2008, the USGS, West Dakota Water Development District (WDWDD), and SD DENR completed a cooperative study that characterized water quality effects and indicators of OWTS. Researchers selected study areas in the east-central Black Hills underlain by fractured or carbonate bedrock, and shallow unconsolidated deposits overlying bedrock [Putnam et al., 2008]. From 2006 through 2008, Putnam et al. [2008] characterized water quality effects and indicators of OWTS. Water samples were collected and analyzed from 25 monitoring wells, 34 private wells, and 1 spring for chemical, microbiological, and organic indicators of OWTS effluent. Putnam et al. [2008] reported that 108 groundwater samples were collected and analyzed with fecal coliform bacteria detected in 9 samples and *E. coli* detected in 14 samples (8.3 and 13 percent, respectively).

As part of a water quality investigation in the Black Hills, Sawyer [2008] evaluated groundwater near an OWTS for a residential site near Hill City and found nitrate-nitrogen concentrations from less than 0.1 to 1.4 mg/L and total phosphorus (TP) concentrations from 0.28 to 10 mg/L. Detections of *E. coli* and fecal coliform bacteria were found in monitoring wells that were in close proximity to the OWTS absorption field, which is an area where a drinking-water well could not legally be installed because of setback requirements and no other parameters were analyzed near the OWTS, which exceeded water quality standards [Sawyer, 2008]. Sawyer [2008] also installed five monitoring wells to investigate subsurface conditions around the wastewater treatment lagoons near the city of Hill City. *E. coli* bacteria were detected in one well near the largest and furthest upstream lagoon (Cell 1), and fecal coliform bacteria were detected in a monitoring well upgradient of the lagoons, which was approximately 40 feet from Spring Creek. Sawyer [2008] concluded that Spring Creek could possibly be the source of the fecal coliform bacteria detected in the well. Additionally, five OWTS were within approximately 600 feet of the northern, eastern, and southern perimeters of the lagoon system, and the nearest of these is located within the same alluvial deposit [Sawyer, 2008].

1.6.1 Total Maximum Daily Loads

A TMDL is an estimation of the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards. The TMDL is an effort to calculate a waterbody's assimilative or loading capacity from all pollutant sources within the drainage or watershed. Sources can be either point (direct discharges) or nonpoint (diffuse areas) and often include both anthropogenic and natural sources of a pollutant. TMDLs also include a margin of safety (MOS) to account for the uncertainty in predicting how well pollutant reduction will result in meeting water quality standards and account for seasonal variations.

In 1998, and again in 2006 and 2008, Spring Creek was listed as impaired because of fecal coliform bacteria criteria exceedences [SD DENR, 2008a]. The fecal coliform bacteria-impaired segment of Spring Creek has a length of approximately 28 miles and ends where Spring Creek empties into Sheridan Lake. In response to this listing, the SD DENR and the SDSM&T initiated a watershed assessment to determine the fecal coliform bacteria TMDL for Spring Creek in 2002 [SD DENR, 2008a]. In 2008, the *Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Spring Creek, Pennington County, South Dakota*, was completed by the SD DENR and SDSM&T and approved by the EPA in 2008 [SD DENR, 2012b].

Critical conditions occur during the recreation season when increased numbers of livestock and tourists (i.e., trail rides and camping) cause a peak in bacteria sources, which are combined with thunderstorms to produce a significant fecal coliform bacteria load in the watershed [SD DENR, 2008a]. Table 1-29 provides a summary of the TMDL load allocations for fecal coliform bacteria within the watershed. The recommended load reductions range from 0 percent in the midrange (6.8–13 cubic feet per second [cfs]) and dry (2.2–6.7 cfs) flow zones up to a 90 percent reduction in the high (48–525 cfs) flow zone.

Table 1-29. Total Maximum Daily Load Allocations by Flow Zone for Spring Creek

TMDL Component	Flow Zone (cfs)				
	High	Moist	Midrange	Dry	Low
	48–525 cfs	14–47 cfs	6.8–13 cfs	2.2–6.7 cfs	0–2.1 cfs
Load Allocation (LA) (expressed as cfu × 10^9/day)	2,443.07	328.99	94.09	40.26	1.11
Waste Load Allocation (WLA) (expressed as cfu × 10^9/day)	3.78	3.78	3.78	3.78	3.78
MOS (expressed as cfu × 10^9/day)	362.13	88.09	29.36	16.64	15.66
TMDL (expressed as cfu × 10^9/day)	2,808.98	420.86	127.24	60.68	20.55
Current Load (expressed as cfu × 10^9/day)	27,575.98	502.09	118.43	18.45	33.01
Percent Load Reduction (%)	90	16	0	0	38

1.6.2 Watershed Modeling

Watershed modeling results from the approved TMDL estimated that more than half (63.5 percent) of the fecal coliform bacteria load originates from livestock and other agricultural land uses, and the remaining load originates from urban runoff (13.7 percent) and other human sources (14.8 percent) [SD DENR, 2008a]. The estimated 14.8 percent of the fecal coliform bacteria load contributed by human sources included failing septic systems and leaking sanitary sewers [SD DENR, 2008a; Schwickerath, 2004]. Schwickerath [2004] used computer models, Hydrologic Simulation Program – FORTRAN (HSPF) and Bacteria Indicator Tool (BIT), to model bacteria sources, fecal coliform bacteria loading, and combinations of BMPs.

In the TMDLs for Sheridan Lake and Spring Creek, although a significant number of OWTS were in the watershed, limited information was available regarding their ages, conditions, and contributions between failing systems and leaking sanitary sewers [Schwickerath, 2004; SD DENR, 2008a]. Schwickerath [2004] used a system failure rate of 7 percent because that failure rate produced a similar percentage of simulated fecal coliform from humans, which was illustrated by the bacterial ribotyping sampling in the watershed. Schwickerath [2004] also modeled combinations of BMPs for reducing bacteria loads on Spring Creek and suggested that reducing 50 to 60 percent of the human bacteria sources could result in a 7 to 9 percent contribution of human bacteria to Spring Creek.

In addition, Swanson [2004] analyzed phosphorus loads and reductions in Spring Creek using FLUX, which is a U.S. Army Corp of Engineers (USACE) program that uses flow records and concentration values to estimate nutrient or contaminant loadings to streams. A lake phosphorus model was developed to simulate the movement of phosphorus in and through Sheridan Lake. In the Sheridan Lake TMDL, the city of Hill City's wastewater treatment facility (WWTF) was not a significant source of phosphorus, but stormwater runoff in the Palmer Creek, Hill City, and Spring Creek areas contributed significant amounts of phosphorus [SD DENR, 2006b; Swanson, 2004].

During Segment 1 of the Spring Creek project, questions and concerns were raised by the Spring Creek Watershed Advisory Group members regarding the accuracy of the modeling results; therefore, additional data, including water quality monitoring, land-use, septic locations and failure rates, livestock and wildlife populations, and installed BMPs within the watershed, have been collected and gathered to improve the watershed planning effort. In 2010, Schmitz [2011] used computer models, HSPF, BIT, and ArcGIS 9.3.1 to develop a high-resolution hydrologic model that is more capable of modeling water quality on a smaller scale than previous modeling efforts to identify the most effective BMP areas and types for implementation. The model was generated at a very small scale and comparisons were made with previous modeling efforts.

The 2010 hydrologic model developed by Schmitz [2011] was more accurate than the model developed by Schwickerath [2004] because it used NEXRAD hourly precipitation data in addition to long-term precipitation data. Because elements of the model developed by Schmitz [2011] contradict the *Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Spring Creek* allocations for urban area, further investigation into the bacteria source load allocations applied in the Schmitz [2011] HSPF model is necessary before any conclusions are made [Rausch et al., 2012].

Schmitz [2011] found that the forestland use, although it makes up over 90 percent of the watershed, only accounts for roughly 5 percent of the sediment contribution to Spring Creek. Bed and bank erosion and impervious areas were the largest contributors of suspended sediment to Spring Creek at 35 percent and 34 percent, respectively, as shown in Figure 1-19.

Schmitz [2011] also stated that OWTS within 300 feet of a stream could have the greatest impact on water quality, and 311 of the 651 septic systems modeled were located within 300 feet of Spring Creek and its tributaries. Schmitz [2011] recommended that the 2010 model could be used to test BMP effectiveness but needed to be improved by establishing long-term flow gages and hourly precipitation gages by using NEXRAD data and small-scale models in conjunction with HSPF to better simulate water quality. Also as part of Segment 1, the SDSM&T assessed stormwater runoff and treatment for impervious areas in and surrounding the city of Hill City and the SDDOT-controlled highway areas. Rausch et al. [2012] used the EPA's Storm Water Management Model (SWMM) to simulate rainfall-runoff events to help identify current capacities and prioritize future stormwater runoff BMPs. The results from Rausch et al. [2012] are described in the *Stormwater Management Plan for the Spring Creek Watershed* by Rausch and Krajewski [2013].

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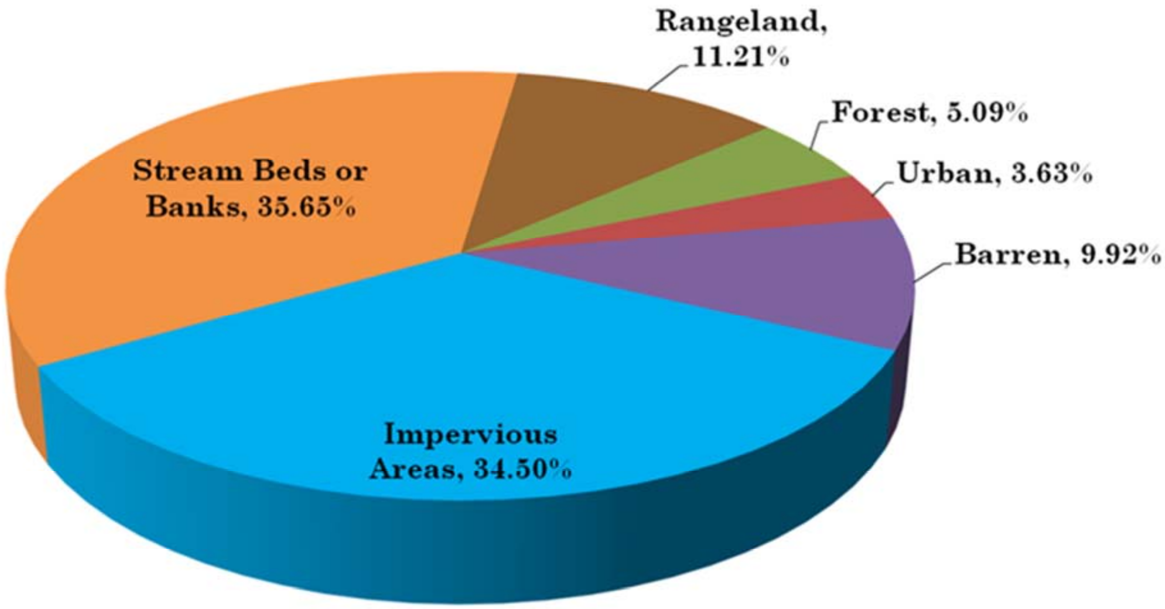


Figure 1-19. Percent Contribution of Total Suspended Sediment Load in Spring Creek Above Sheridan Lake From May Through September 2010 [Schmitz, 2011].

1.7 WATER QUALITY MONITORING

As part of Segments 1 and 2 of the Spring Creek Watershed Management and Implementation Project, Pennington County, SDSM&T, RESPEC, and local volunteers monitored ambient and stormwater quality in Spring Creek and its tributaries from April through October 2010, June through September 2011, and April through October 2012. The purpose of the monitoring was to collect baseline information and monitor BMP effectiveness within the project area.

The following accomplishments are a result of this monitoring effort:

- Collected 499 water quality samples and 114 QA/QC samples at 28 sites from 2010 through 2012
  - Collected 169 samples at 17 sites from April to October 2010
  - Collected 120 samples at 17 sites from June to September 2011
  - Collected 210 samples at 21 sites from April to October 2012
- Sampled water quality during 36 monitoring events
  - 20 monthly ambient by Pennington County and SDSM&T

  - 16 storm events by RESPEC and SDSM&T
  - 3 BMP project sites were monitored by the county, SDSM&T, and volunteers
- Monitored 19 field and laboratory parameters or variables including:
  - Fecal coliform bacteria, *E. coli*, Enterococci, total coliform bacteria total suspended solids (TSS), TP, and nitrate-nitrogen (NO3-N)
  - Alkalinity, total dissolved solids (TDS), dissolved phosphorus (DP), ammonia as nitrogen (NH3-N), bicarbonate, carbonate, and nitrite+nitrate-nitrogen (NO2+NO3)
  - Conductivity, DO, pH, water temperature, and turbidity
- Conducted three different microbiological analyses including fecal coliform bacteria, *E. coli*, and Enterococci at a certified laboratory located in Rapid City, South Dakota
  - Fecal coliform bacteria were analyzed in 2010 and 2012, but not in 2011
  - Enterococci were sampled in 2011 and 2012
  - *E. coli* was sampled in 2010, 2011, and 2012
- Performed quality assurance/quality control (QA/QC) on 5,375 water quality results.

1.7.1 Monitoring Sites

During 2010, 2011, and 2012, Pennington County, SDSM&T, and RESPEC conducted water quality monitoring at 28 locations from 2010 through 2012, as provided in Table 1-30 and Figure 1-20. Four USGS gage stations and one SD DENR WQM site are located within the project area, as illustrated in Figure 1-21. Seventeen sites were monitored in 2010, with 11 sites located on Spring Creek and 6 on tributaries.

In 2011, 17 sites were monitored and included 13 sites on Spring Creek and 4 on tributaries. Twenty-one sites were monitored in 2012 with 14 sites on Spring Creek, 3 on Palmer Creek, 2 on Newton Fork, and 2 on storm drains. ISCO automatic samplers were installed at six sites and collected flow-weighted composite data during storm events. These six sites are listed in Table 1-30 as “Ambient–Storm” types and include four sites (SPC200, SPC250, SPC450, SPC500) located on Spring Creek and two sites (PCT410 and PCT470) on Palmer Creek.

1.7.2 Monitoring Results

This section summarizes the results of the monitoring effort on Spring Creek and its tributaries within the project area in 2010, 2011, and 2012. Grab samples were collected during 20 monthly ambient monitoring events at 28 sites. Flow-weighted composite samples were collected during 16 storm events at four sites on Spring Creek and two sites on Palmer Creek in 2010, 2011, and 2012.

Table 1-30. Water Quality Monitoring Sites in the Spring Creek Watershed

Site Name	Site Location	Site Type	Apr–Oct 2010	Jun–Sept 2011	Apr–Oct 2012
SPC025	Spring Creek at Bobcat Road	Ambient		X	X
SPC050	Spring Creek below Spring Creek Road West	Ambient	X	X	X
SPC100	Spring Creek above confluence of Sunday Gulch	Ambient	X	X	X
SPC125	Spring Creek below confluence of Sunday Gulch	Ambient		X	X
SPC130	Spring Creek above confluence of Reno Gulch	Ambient		X	X
SPC200	Spring Creek upstream of Tracy Park	Ambient-Storm	X	X	X
SPC250	Spring Creek above confluence of Newton Fork	Ambient	X	X	X
SPC290	Spring Creek below Hill City	Ambient		X	X
SPC300	Spring Creek below Hill City and above confluence of China Gulch	Ambient	X	X	X
SPC350	Spring Creek upstream of Mitchell Lake	Ambient-Storm	X	X	X
SPC400	Spring Creek downstream of Mitchell Lake	Ambient	X	X	X
SPC450	Spring Creek above U.S. Highway 16	Ambient-Storm	X	X	X
SPC485	Spring Creek above confluence of Palmer Creek	Ambient			X
SPC500	Spring Creek upstream of Sheridan Lake	Ambient-Storm	X	X	X
SPC550	Spring Creek downstream of Sheridan Lake	Ambient	X		
SPC600	Spring Creek upstream of Loss Zone	Ambient	X		
ALG343	Storm sewer at Walnut Street and Elm Street	Storm			X
BWT580	Blue Wing upstream of Sheridan Lake	Ambient	X		
DFR350	Storm sewer near U.S. Highway 385 and Mickelson Trail	Storm			X
HCT580	Horse Creek upstream of Sheridan Lake	Ambient	X		
NFT340	Newton Fork above Deerfield Road	Ambient		X	X
NFT380	Newton Fork below Major Lake	Ambient		X	X
PCT410	Palmer Creek above SD Highway 244	Ambient-Storm	X	X	X
PCT440	Palmer Creek at Old Hill City Road	Ambient			X
PCT470	Palmer Creek above U.S. Highway 16	Ambient-Storm		X	X
PCT480	Palmer Creek above confluence with Spring Creek	Ambient	X		
SGT110	Sunday Gulch above SD Highway 87	Ambient	X		
SGT180	Sunday Gulch above confluence with Spring Creek	Ambient	X		

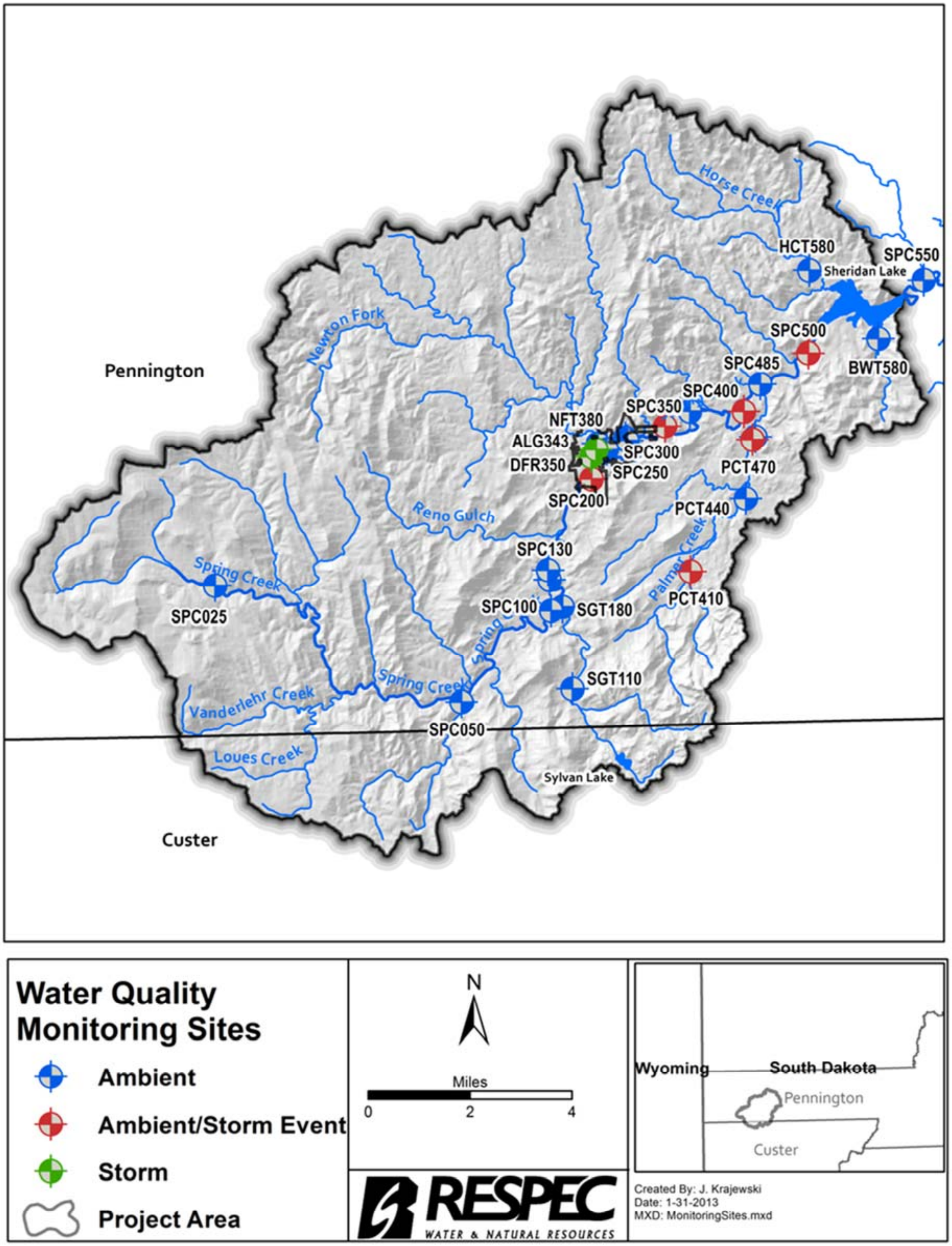


Figure 1-20. Water Quality Monitoring Sites in the Spring Creek Watershed.

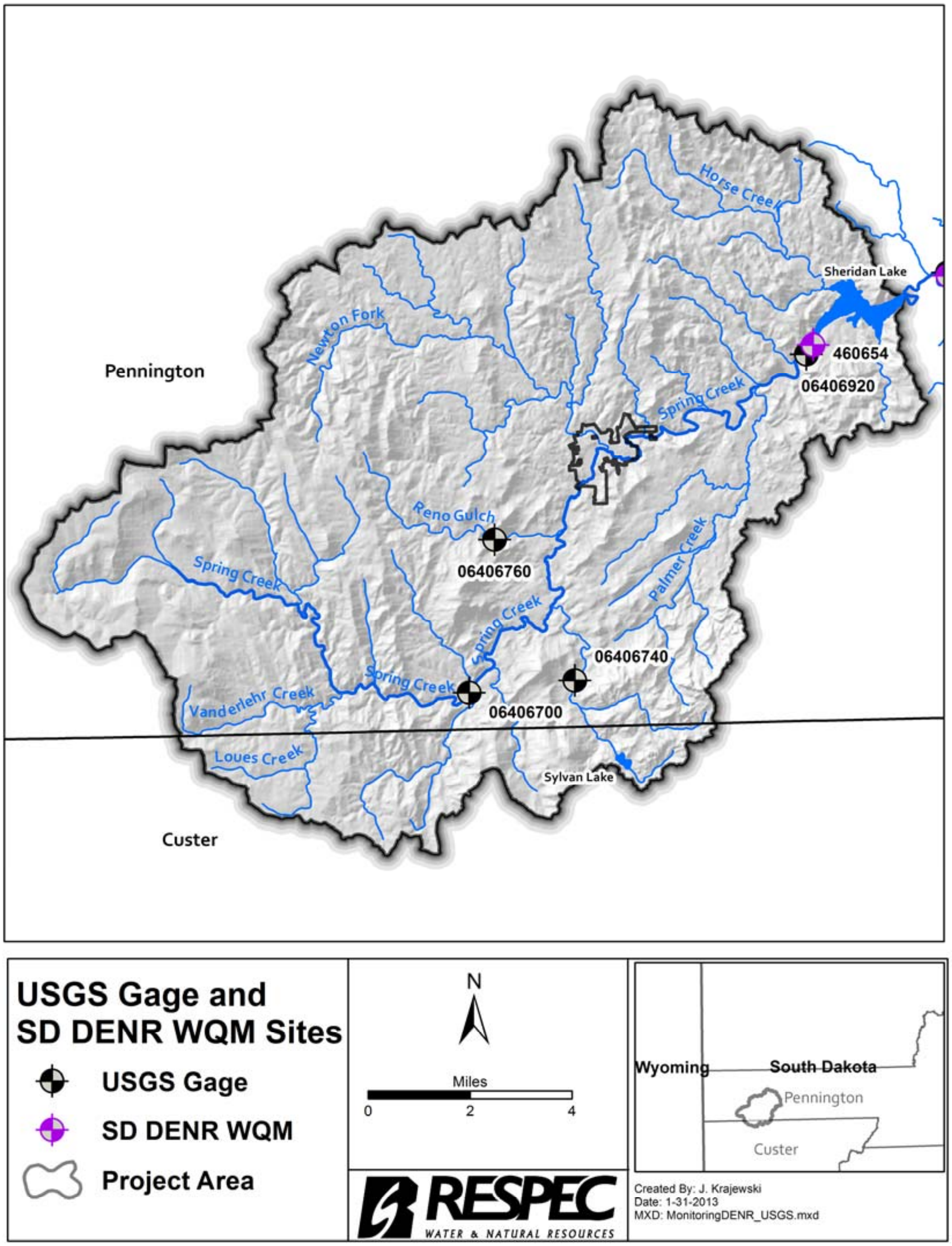


Figure 1-21. South Dakota Department of Environment and Natural Resources Water Quality Sites and U.S. Geological Survey Gage Stations in the Watershed.

1.7.2.1 Fecal Coliform Bacteria

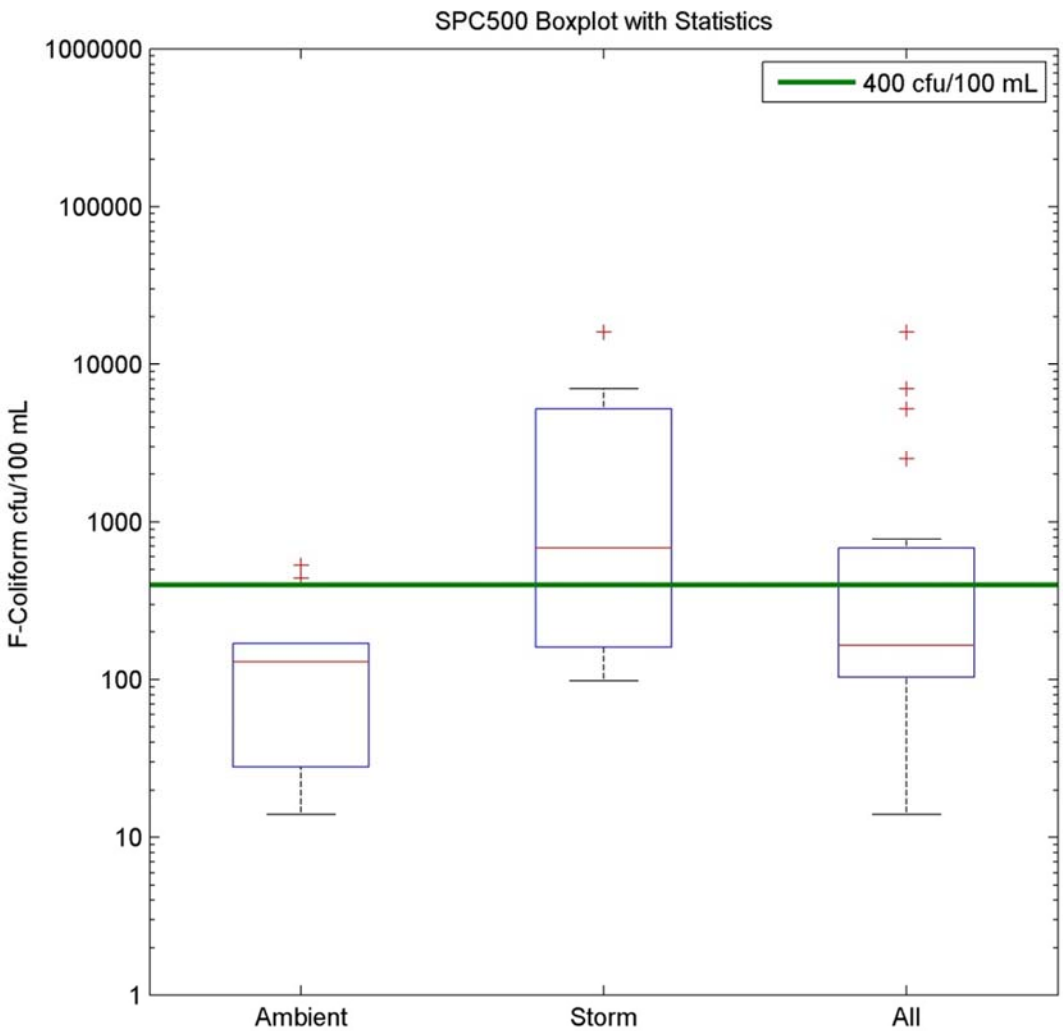
Monitoring results were compared to the fecal coliform bacteria single-sample criterion of 400 cfu/100 mL for immersion recreation waters during the recreation season (May 1 to September 30), as described in Section 1.5.1 and illustrated in Table 1-28. In the 2010 and 2012 recreation seasons, 120 fecal coliform bacteria samples were collected during monthly ambient sampling at 14 monitoring sites on Spring Creek. Of those 120 ambient samples, 3, or 2.5 percent, had fecal coliform bacteria concentrations that exceeded the fecal coliform water quality criterion of 400 cfu/100 mL.

For the ambient samples, fecal coliform concentrations ranged from 2 cfu/100 mL to 540 cfu/100 mL and had a median of 36 cfu/100 mL. Also, 10 percent of the ambient samples collected at SPC450 and 20 percent of the ambient samples collected at SPC500 had fecal coliform concentrations that exceeded the criterion of 400 cfu/100 mL. All of the fecal coliform bacteria water quality criterion exceedances in the ambient monitoring occurred during the 2012 recreation season. Fecal coliform concentrations at the other 12 sites on Spring Creek did not exceed the fecal coliform criterion of 400 cfu/100 mL during 2010 and 2012.

In the 2010 and 2012 recreation seasons, 35 fecal coliform bacteria flow-weighted composite samples were collected during storm event sampling at four monitoring sites on Spring Creek within the project area. Of those 35 samples, 21 (60 percent) had fecal coliform concentrations that exceeded the criterion of 400 cfu/100 mL. For the 35 storm flow-weighted composite storm event samples, fecal coliform concentrations ranged from 12 cfu/100 mL to 16,000 cfu/100 mL with a median of 500 cfu/100 mL. The storm flow-weighted composite samples collected at sites SPC200 (60 percent), SPC350 (78 percent), SPC450 (33 percent), and SPC500 (60 percent) also exceeded the fecal coliform criterion of 400 cfu/100 mL in 2010 and 2012.

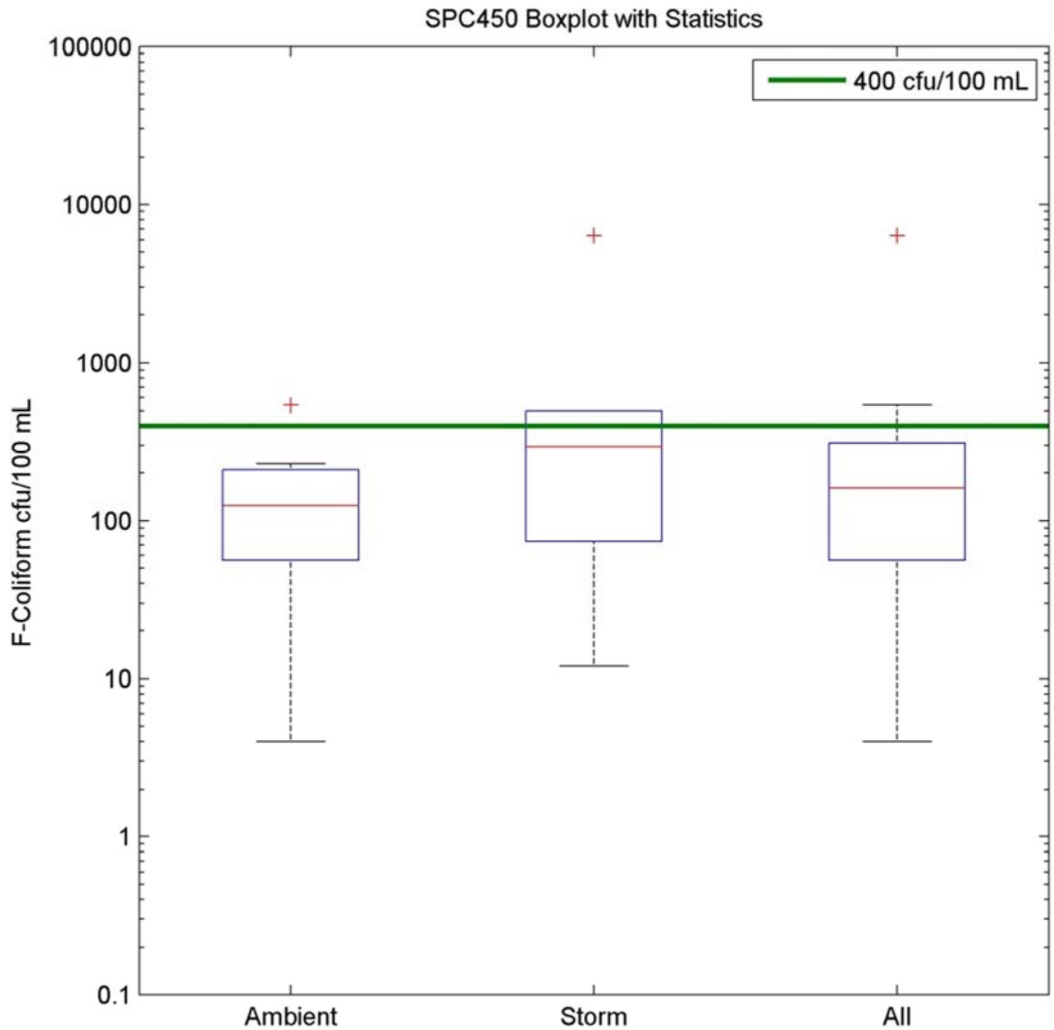
In Figures 1-22 through 1-41, the bacteria monitoring results during the recreation season from 2010 and 2012 are displayed in boxplots (which are also called “box and whisker” plots). The bottom line of the boxplot indicates the 25th percentile, the red line inside the boxplot is the median (or the 50th percentile), and the top line of the boxplot shows the 75th percentile. The lines or “whiskers” extending past the box indicate the largest and smallest values. In general, the length of the box is the difference between the 25th and 75th percentiles and implies the variability, or spread, of the data. The red crosses are outlier values and show the range of data.

Figure 1-22 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC500 located on Spring Creek above Calumet Road above Sheridan Lake. There were ten ambient and ten storm fecal coliform bacteria samples were collected at SPC500. The ambient fecal coliform bacteria samples had a median concentration of 130 cfu/100 mL. The boxplot shows that two of the ten (20 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL.



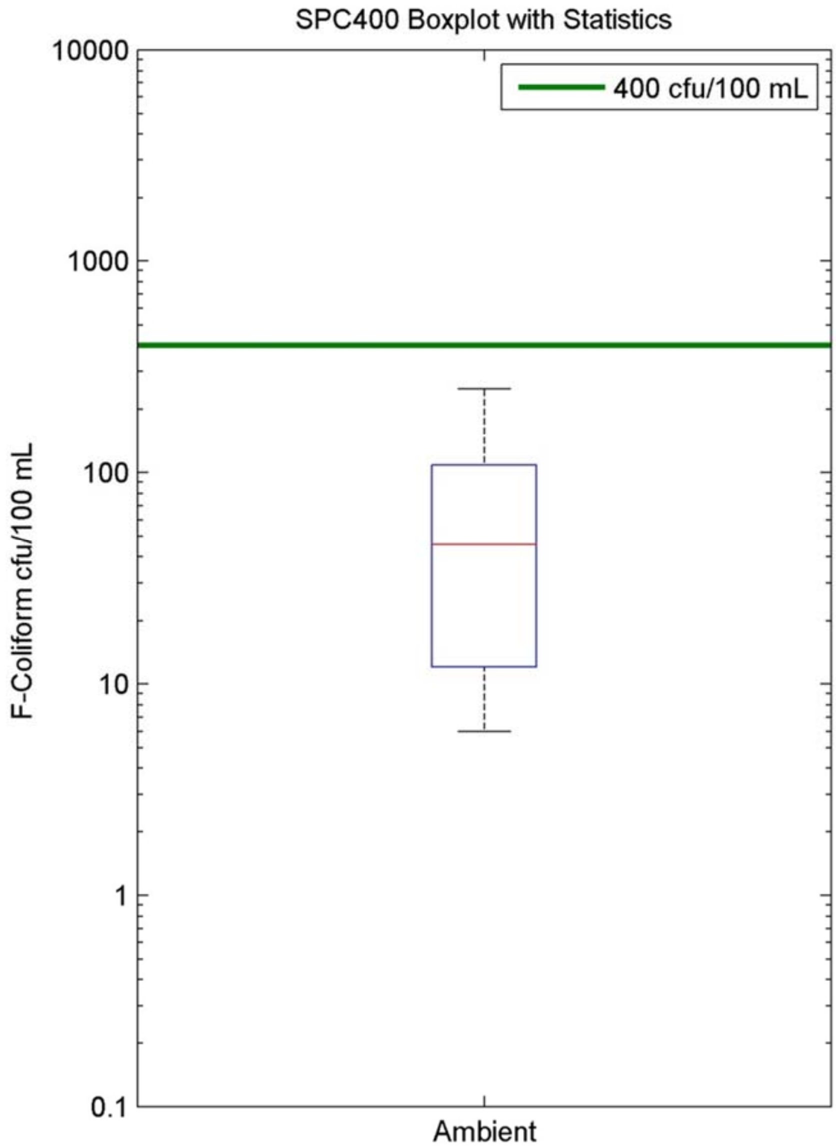
	Ambient	Storm	All
n	10	10	20
Min	14	98	14
Max	530	16000	16000
q1	28	160	104
Median	130	680	165
q3	170	5200	680
Mean	165	3261	1713
% Exceeded	20	60	40
Standard	400	400	400

Figure 1-22. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC500.



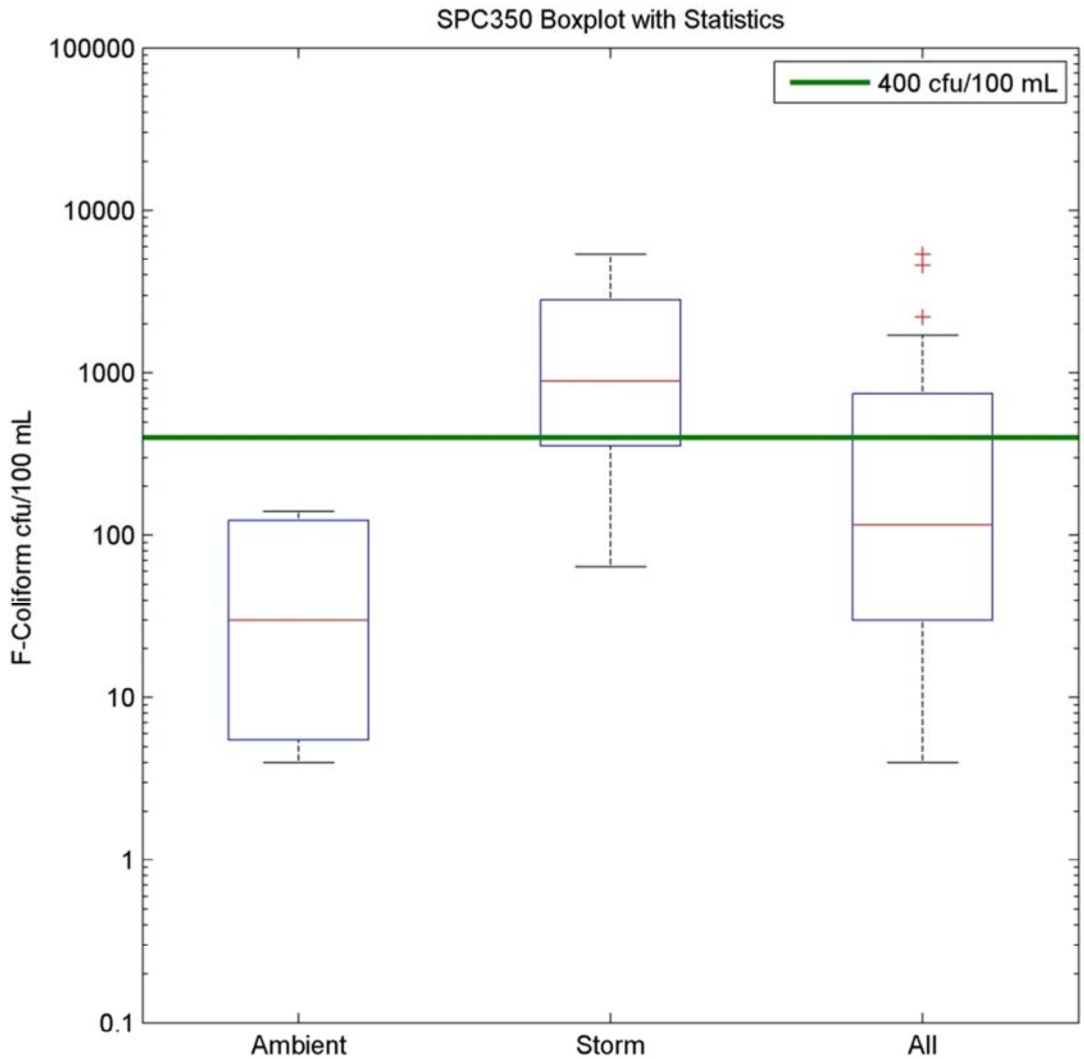
	Ambient	Storm	All
n	10	6	16
Min	4	12	4
Max	540	6400	6400
q1	56	74	56
Median	125	295	160
q3	210	500	310
Mean	154	1263	570
% Exceeded	10	33	19
Standard	400	400	400

Figure 1-23. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC450.



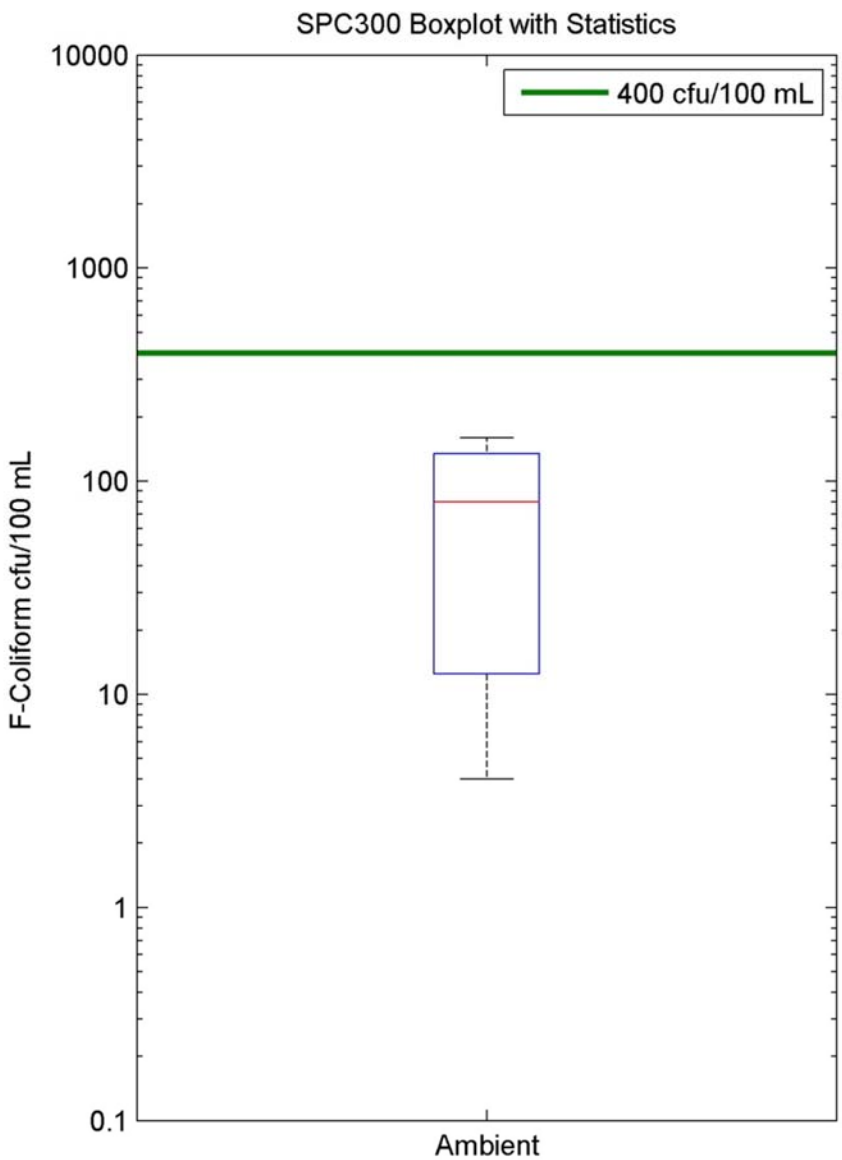
	Ambient
n	11
Min	6
Max	250
q1	12
Median	46
q3	109
Mean	69
% Exceeded	0
Standard	400

Figure 1-24. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC400.



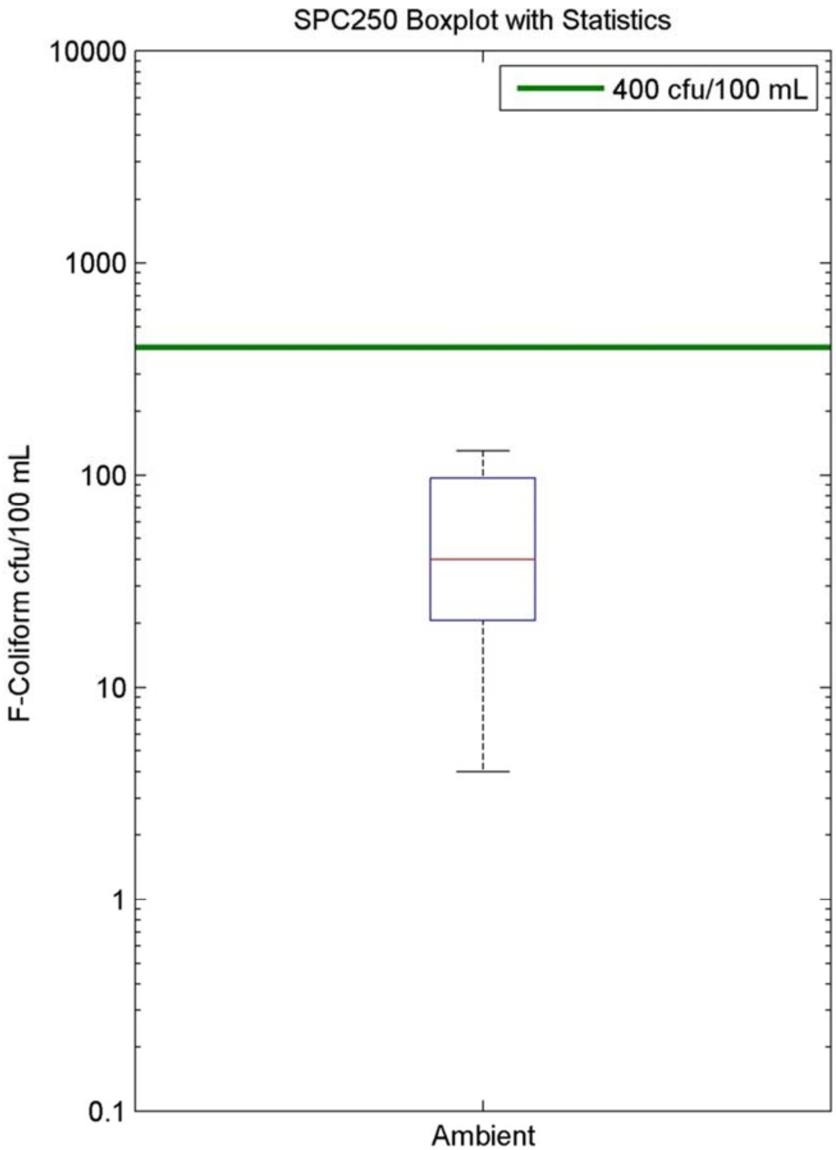
	Ambient	Storm	All
n	11	9	20
Min	4	64	4
Max	140	5400	5400
q1	6	355	30
Median	30	890	115
q3	123	2800	745
Mean	59	1775	831
% Exceeded	0	78	35
Standard	400	400	400

Figure 1-25. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC350.



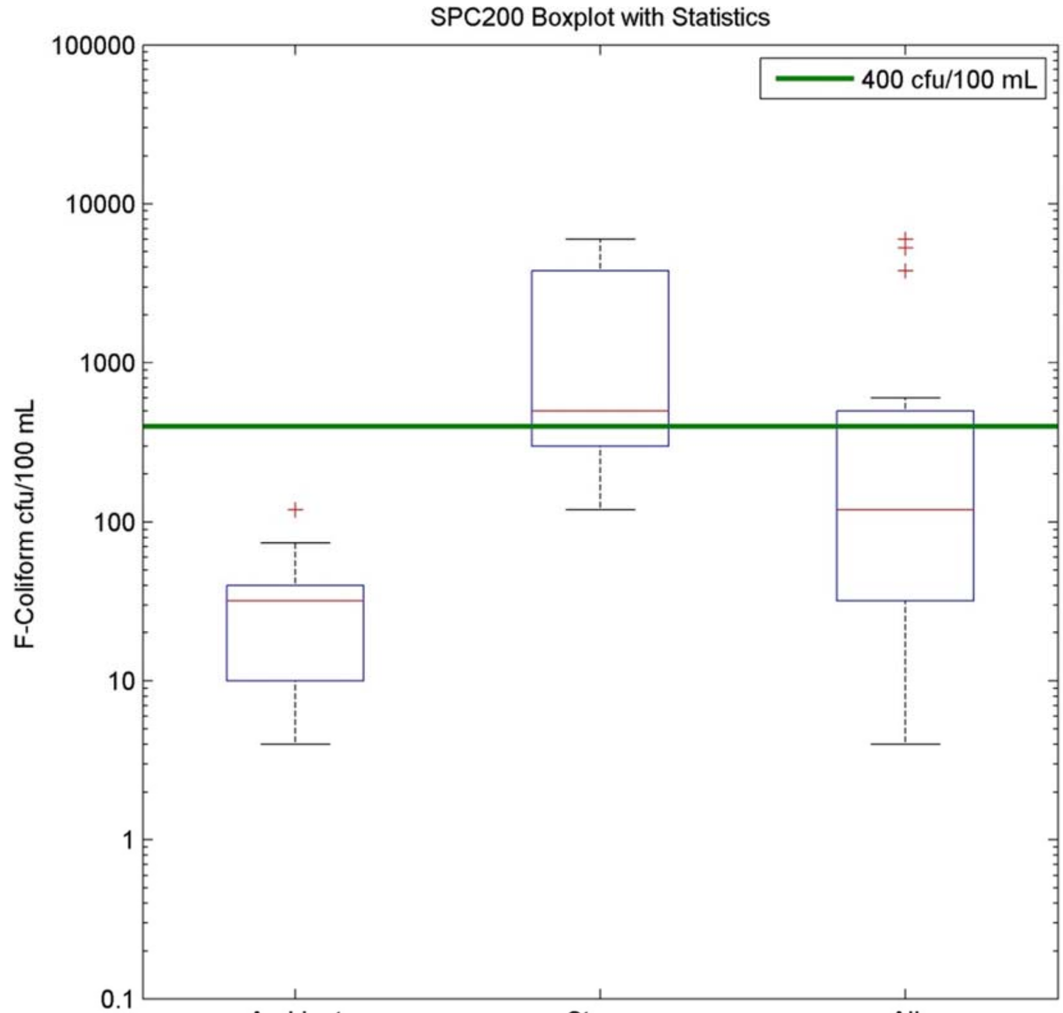
	Ambient
n	11
Min	4
Max	160
q1	13
Median	80
q3	135
Mean	76
% Exceeded	0
Standard	400

Figure 1-26. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC300.



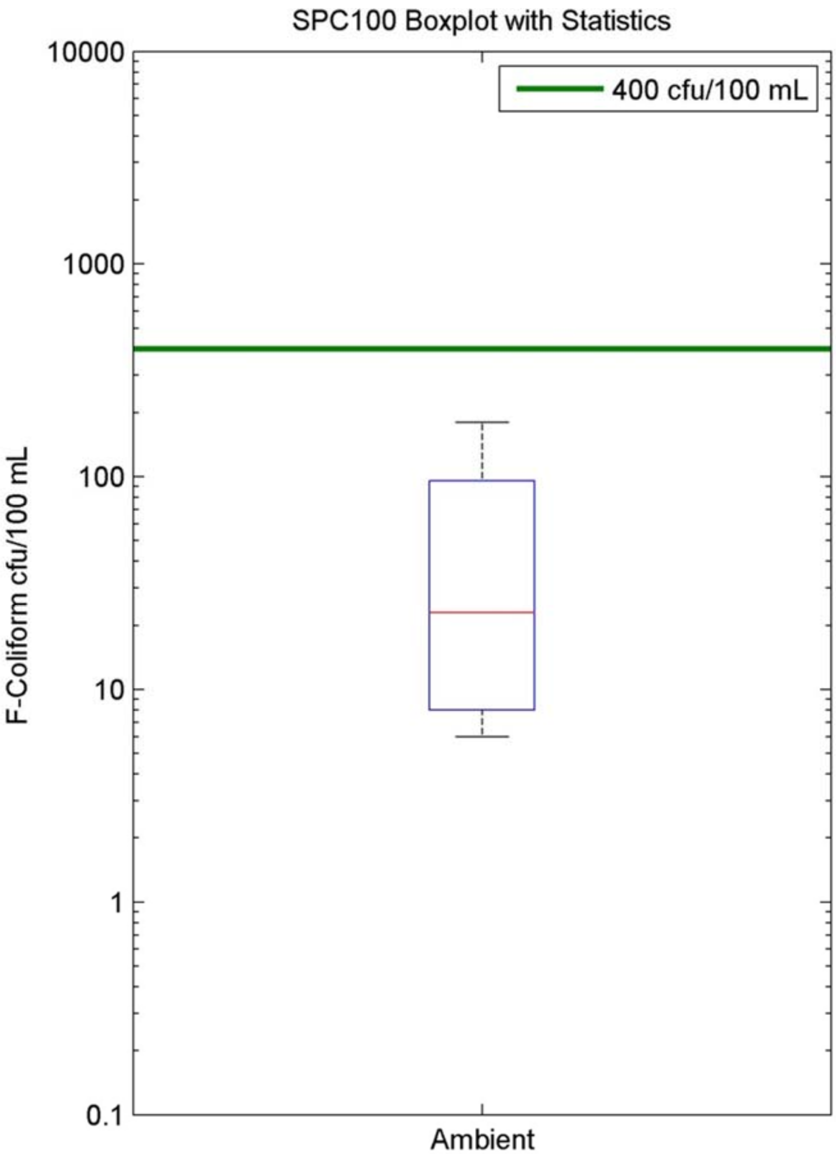
	Ambient
n	11
Min	4
Max	130
q1	21
Median	40
q3	97
Mean	57
% Exceeded	0
Standard	400

Figure 1-27. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC250.



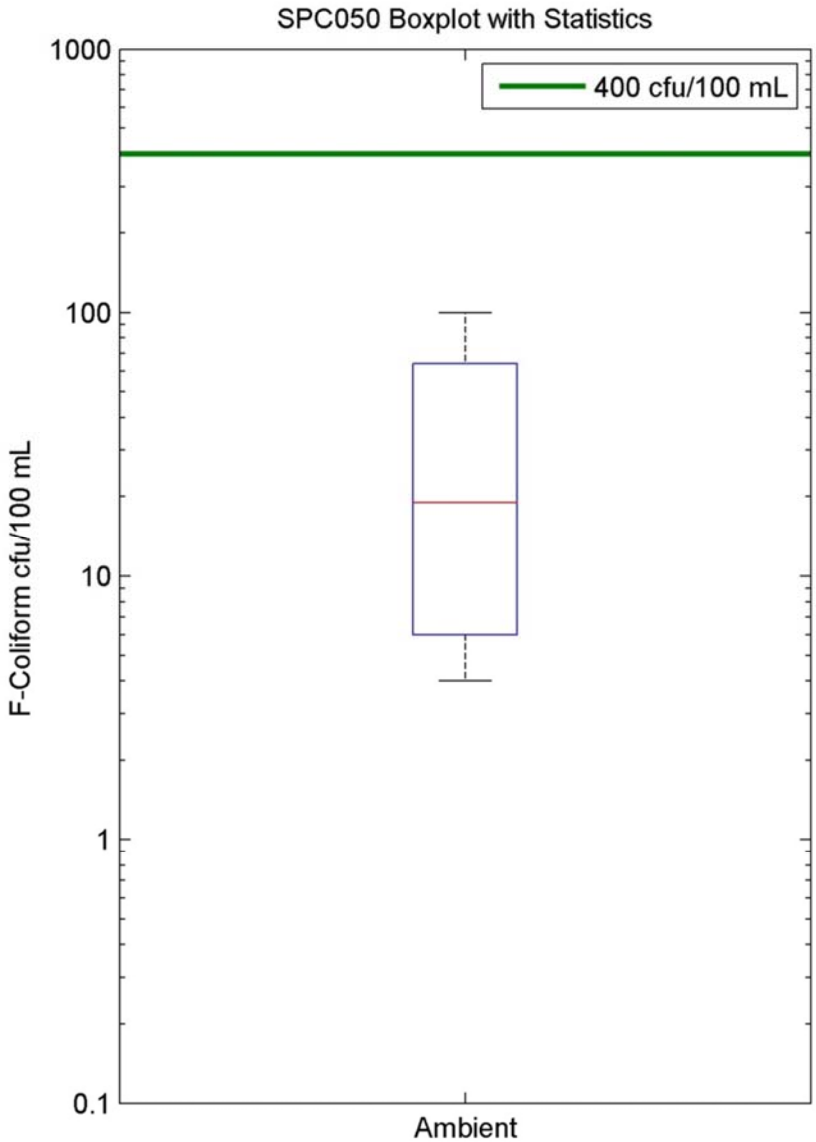
	Ambient	Storm	All
n	10	10	20
Min	4	120	4
Max	120	6000	6000
q1	10	300	32
Median	32	500	120
q3	40	3800	500
Mean	37	1763	900
% Exceeded	0	60	30
Standard	400	400	400

Figure 1-28. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC200.



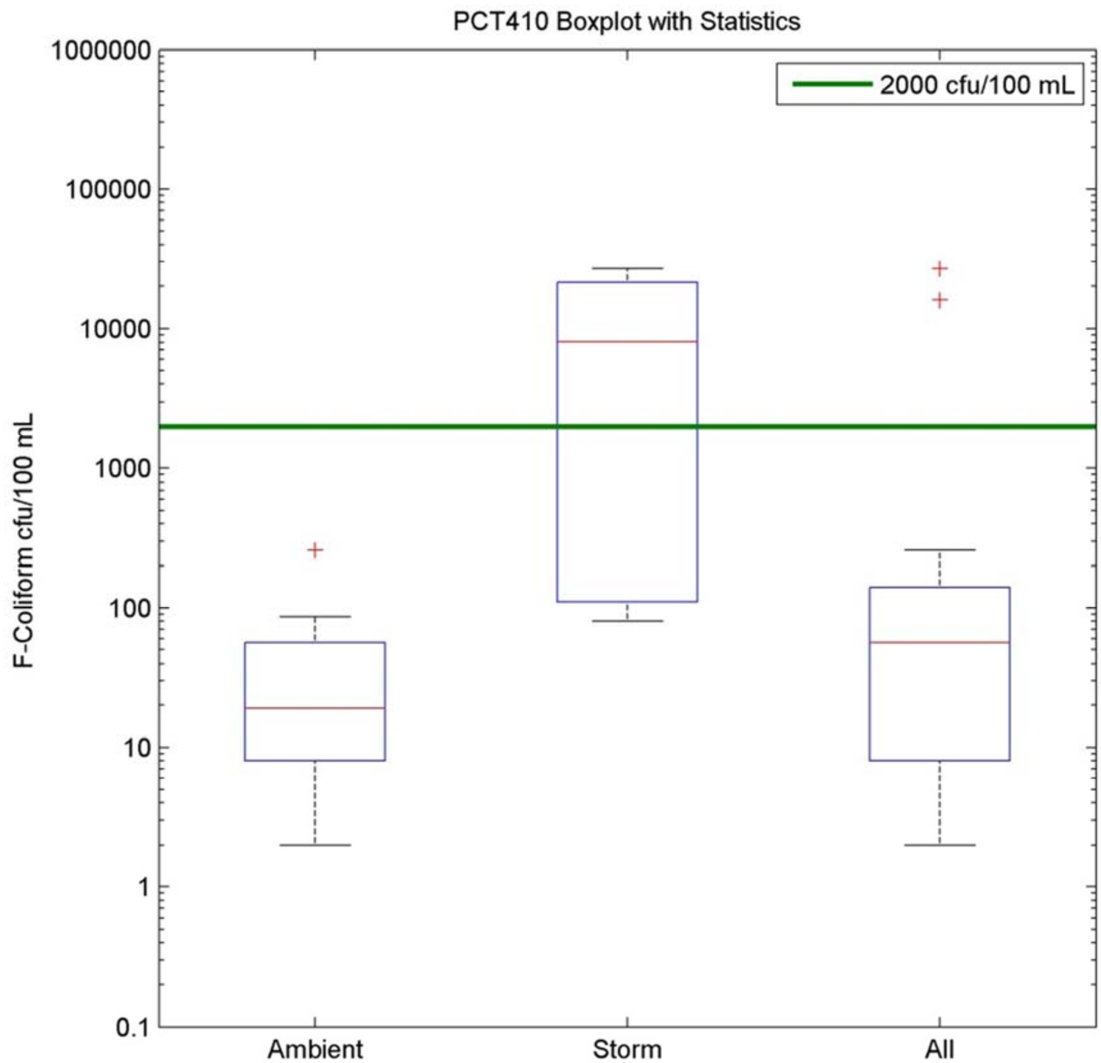
n	10
Min	6
Max	180
q1	8
Median	23
q3	96
Mean	51
% Exceeded	0
Standard	400

Figure 1-29. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC100.



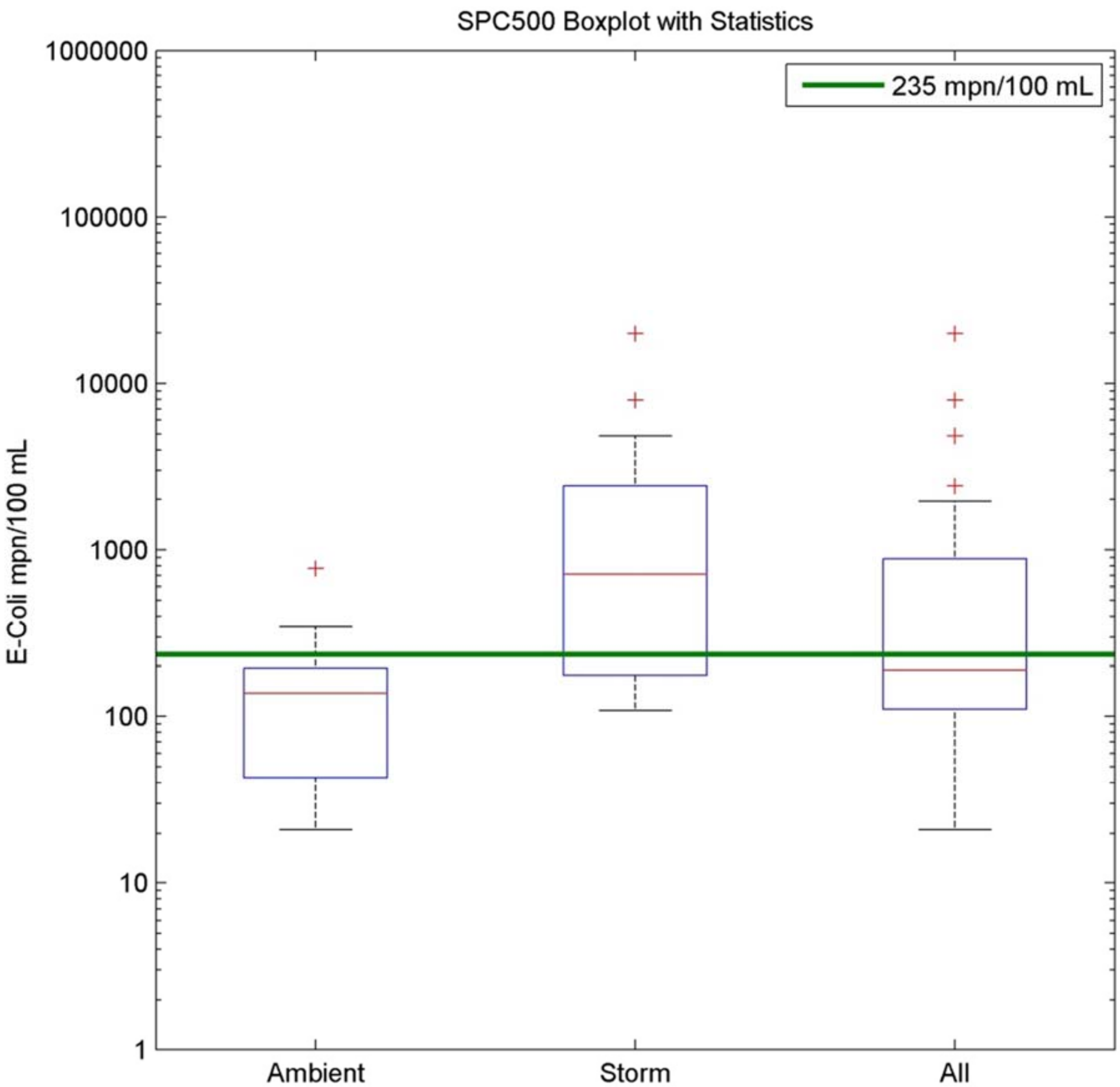
	Ambient
n	10
Min	4
Max	100
q1	6
Median	19
q3	64
Mean	36
% Exceeded	0
Standard	400

Figure 1-30. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site SPC050.



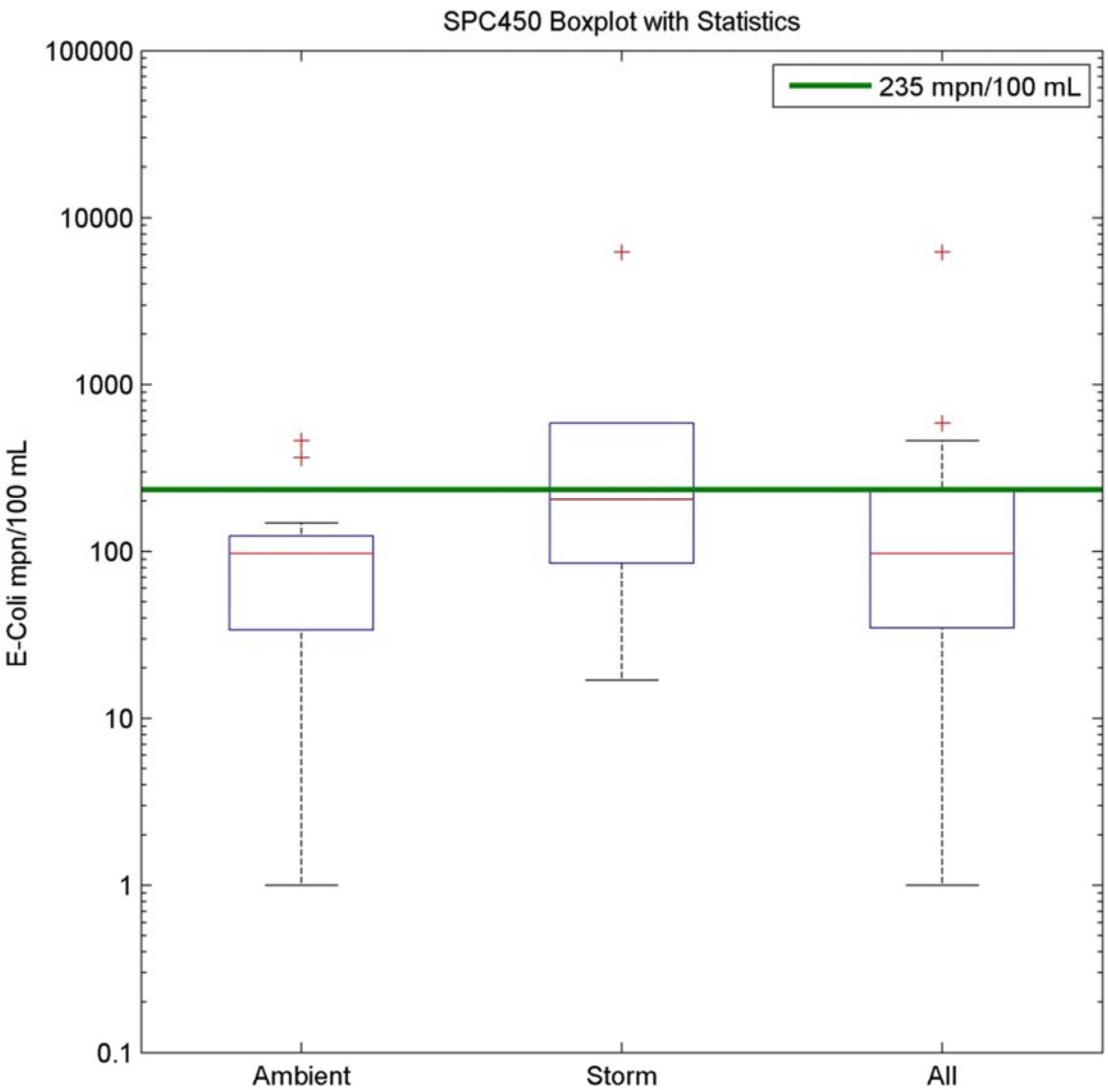
	Ambient	Storm	All
n	10	4	14
Min	2	80	2
Max	260	27000	27000
q1	8	110	8
Median	19	8070	56
q3	56	21500	140
Mean	52	10805	3124
% Exceeded	0	50	14
Standard	2000	2000	2000

Figure 1-31. 2010 and 2012 Fecal Coliform Bacteria Results at Monitoring Site PCT410.



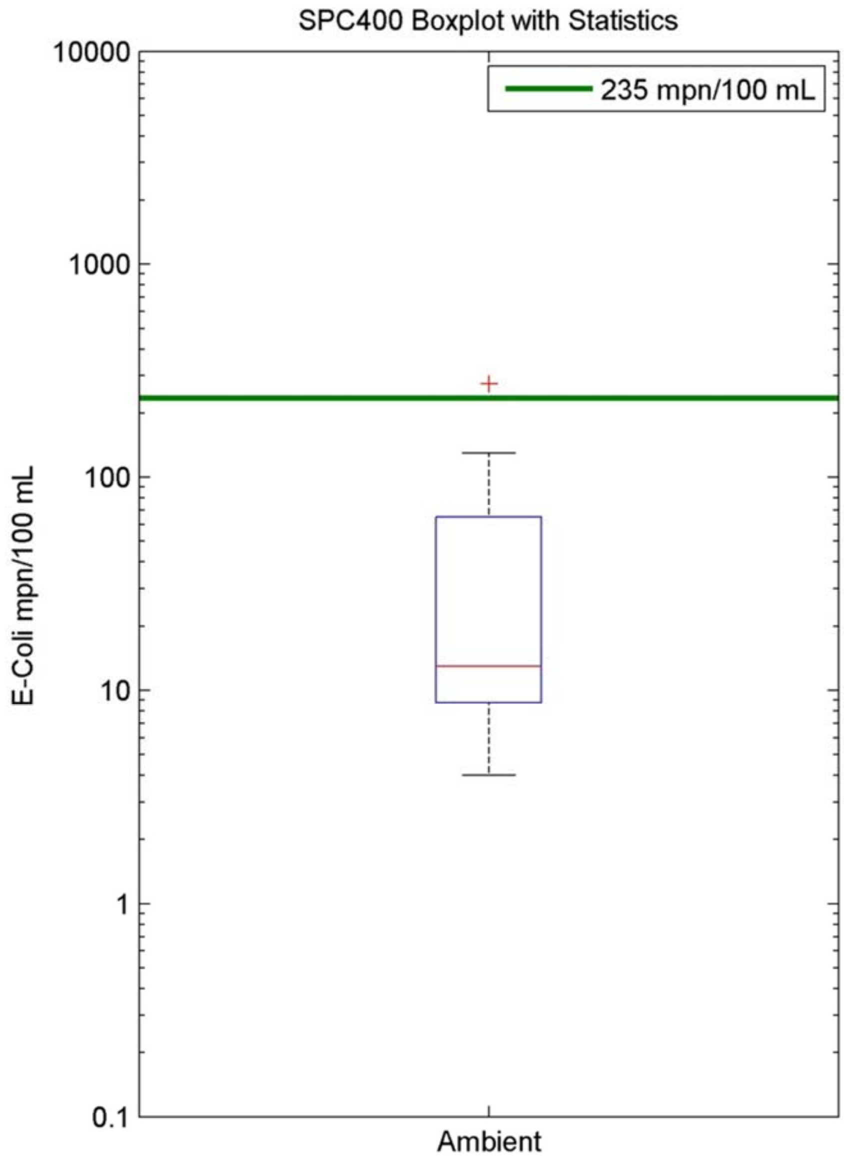
	Ambient	Storm	All
n	14	14	28
Min	21	109	21
Max	770	19900	19900
q1	43	177	110
Median	138	714	191
q3	196	2420	883
Mean	173	3000	1587
% Exceeded	14	71	43
Standard	235	235	235

Figure 1-32. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC500.



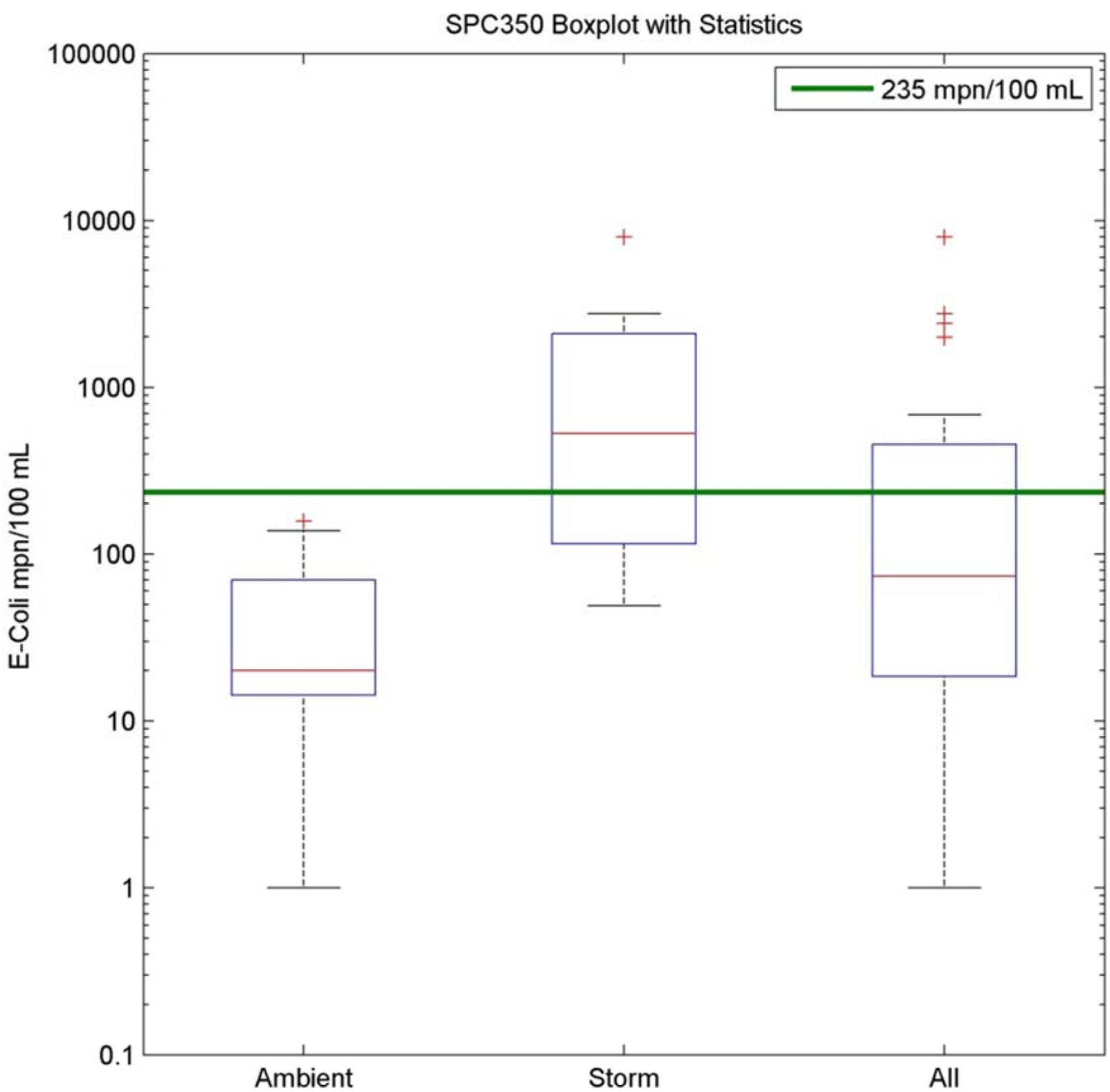
	Ambient	Storm	All
n	14	6	20
Min	1	17	1
Max	461	6210	6210
q1	34	85	35
Median	98	205	98
q3	124	587	235
Mean	119	1218	449
% Exceeded	14	50	25
Standard	235	235	235

Figure 1-33. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC450.



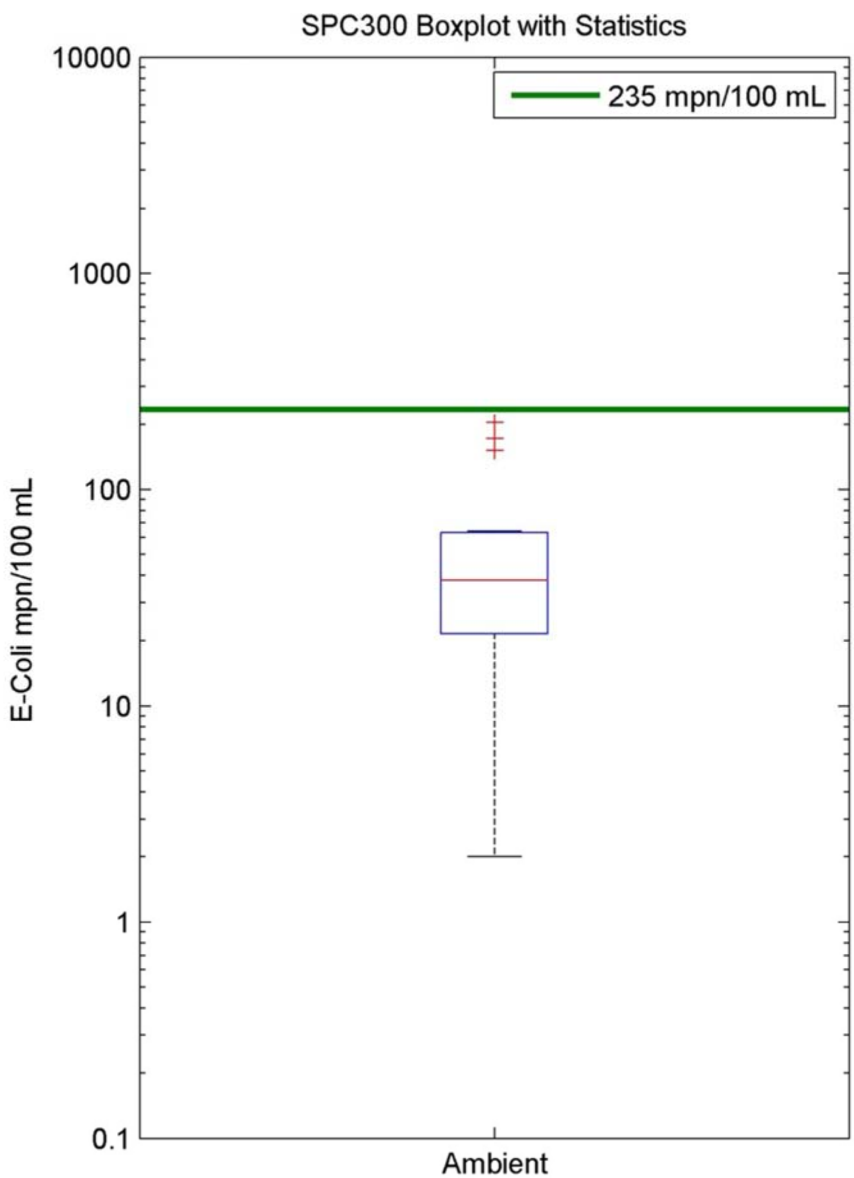
n	15
Min	4
Max	276
q1	9
Median	13
q3	65
Mean	53
% Exceeded	7
Standard	235

Figure 1-34. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC400.



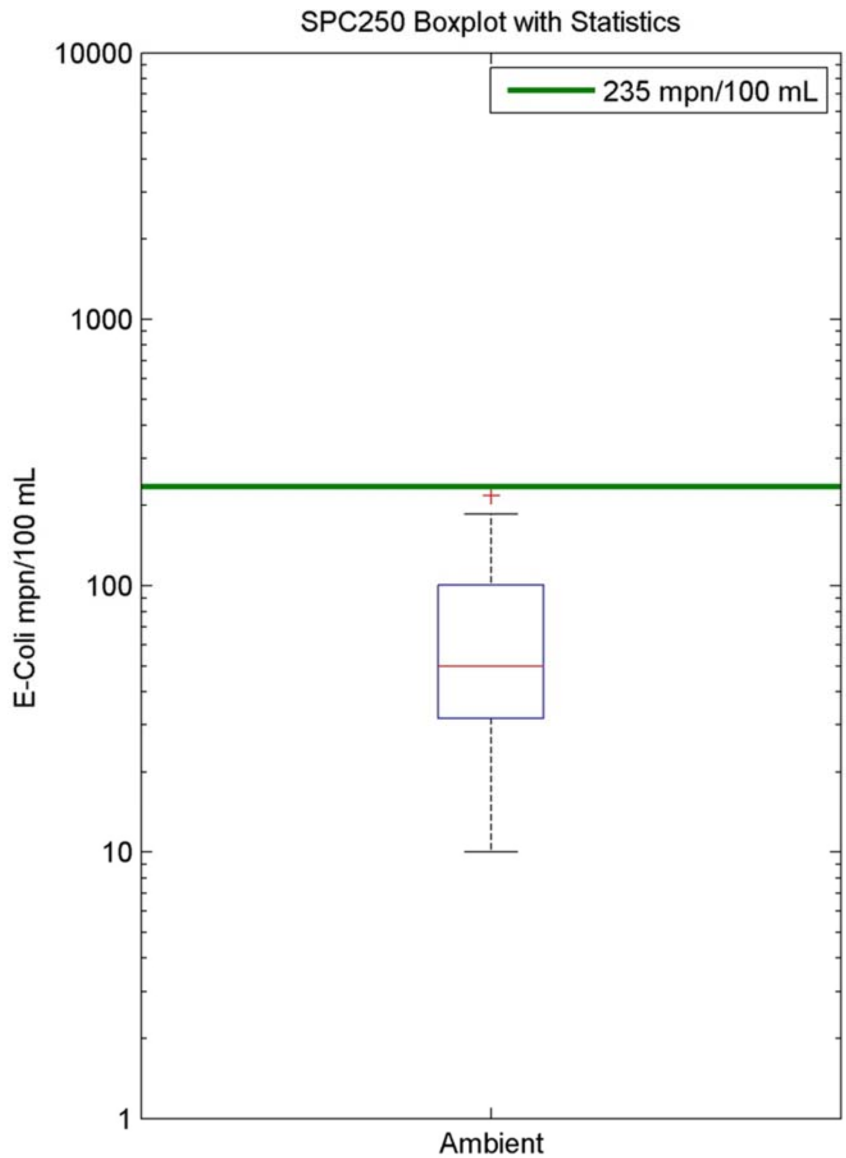
	Ambient	Storm	All
n	15	13	28
Min	1	49	1
Max	157	7950	7950
q1	14	116	19
Median	20	529	74
q3	70	2097	455
Mean	46	1378	665
% Exceeded	0	69	32
Standard	235	235	235

Figure 1-35. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC350.



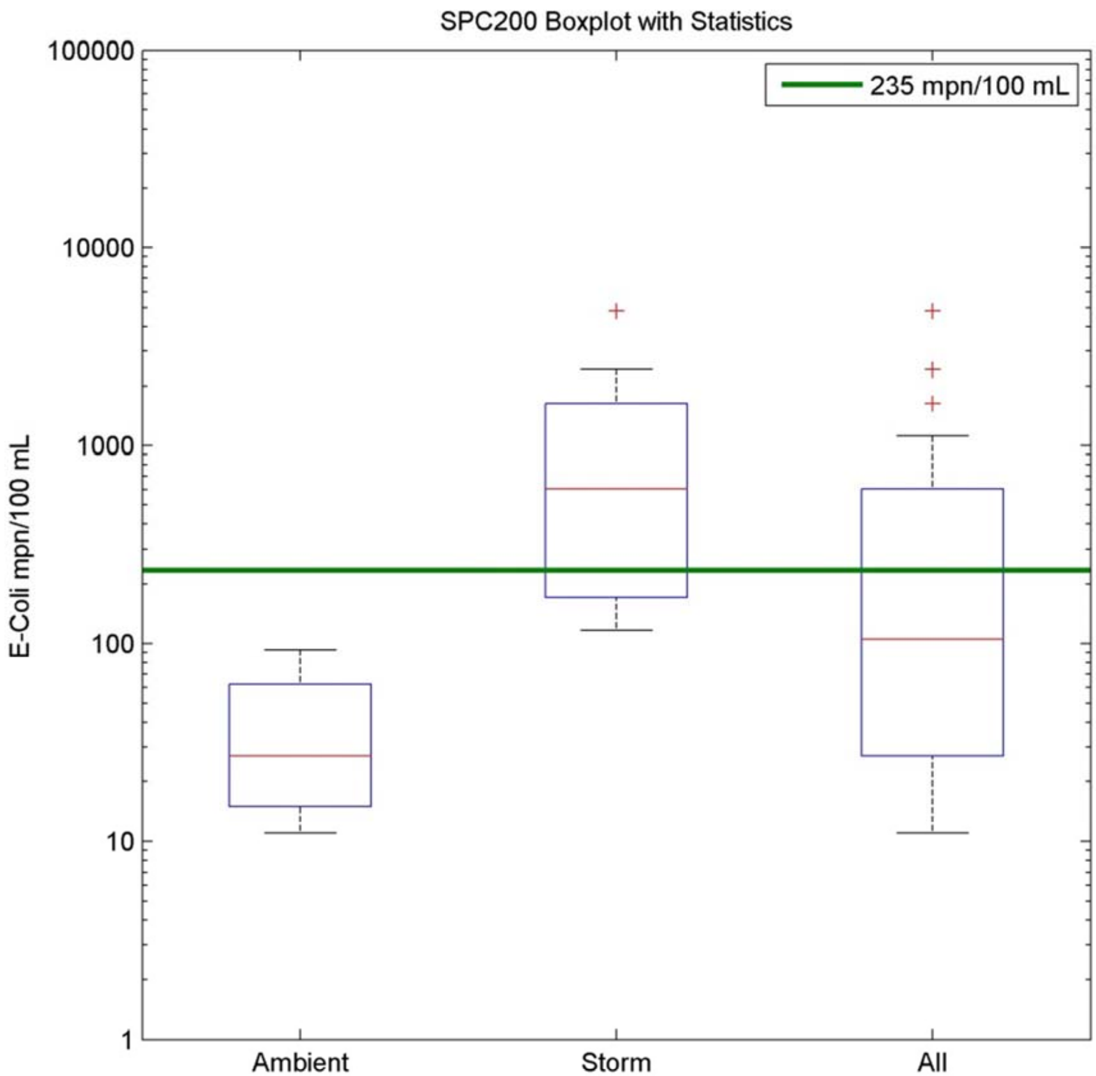
	Ambient
n	15
Min	2
Max	204
q1	22
Median	38
q3	63
Mean	63
% Exceeded	0
Standard	235

Figure 1-36. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC300.



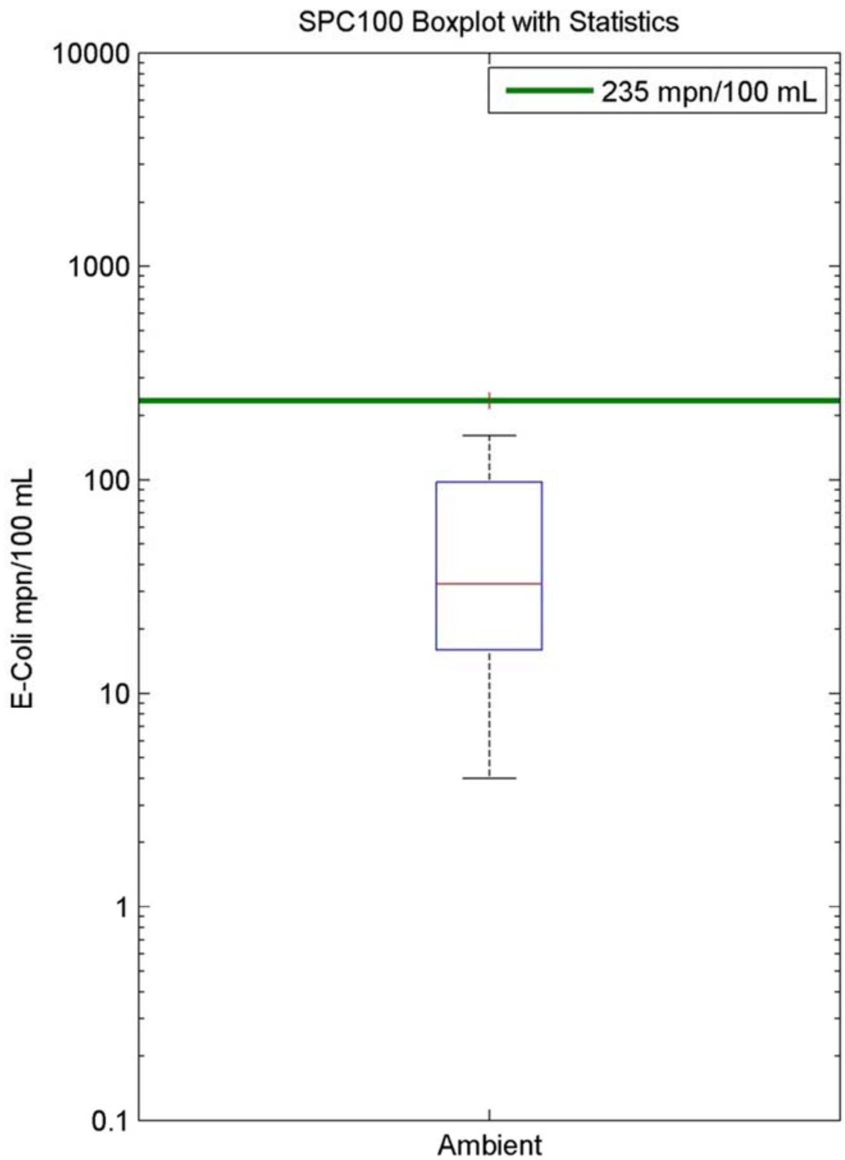
n	15
Min	10
Max	218
q1	32
Median	50
q3	101
Mean	76
% Exceeded	0
Standard	235

Figure 1-37. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC250.



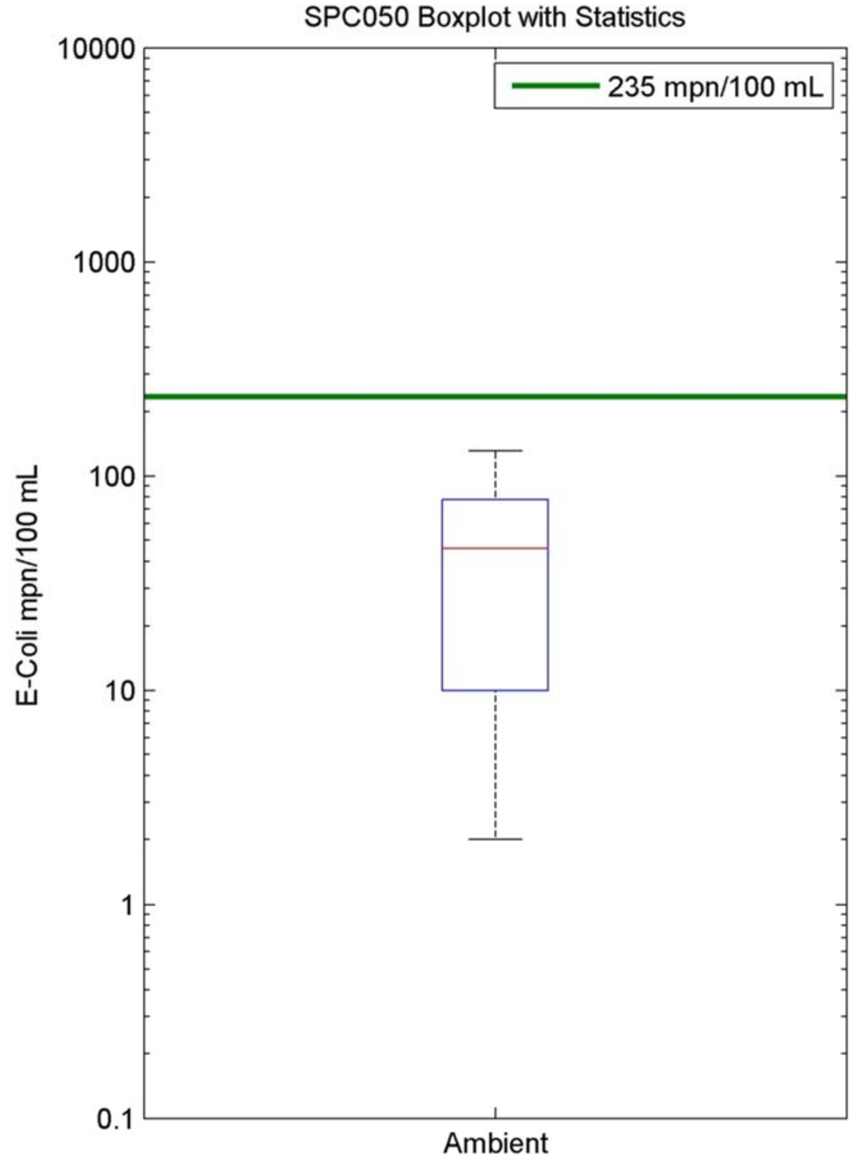
	Ambient	Storm	All
n	14	14	28
Min	11	117	11
Max	93	4810	4810
q1	15	171	27
Median	27	604	105
q3	62	1640	604
Mean	37	1274	656
% Exceeded	0	64	32
Standard	235	235	235

Figure 1-38. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC200.



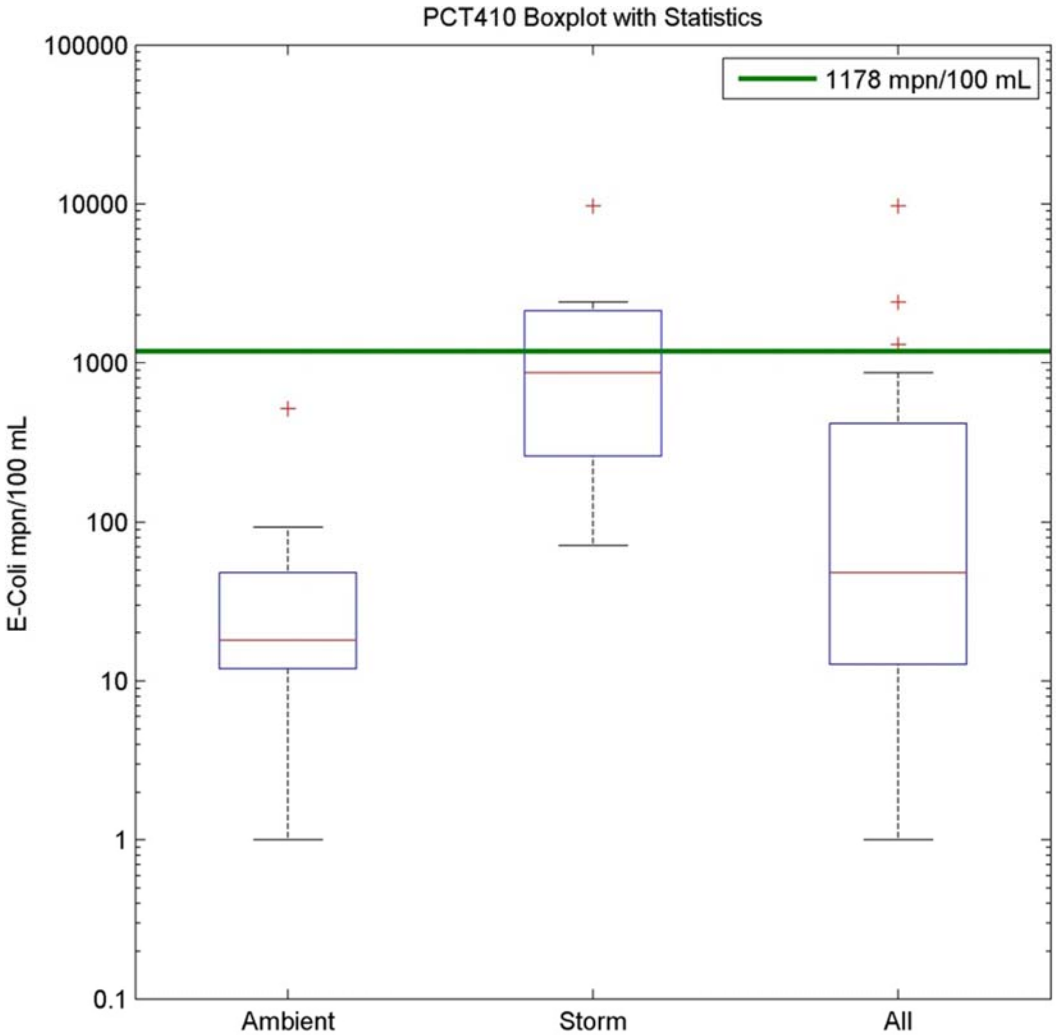
	Ambient
n	14
Min	4
Max	236
q1	16
Median	33
q3	98
Mean	62
% Exceeded	7
Standard	235

Figure 1-39. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC100.



	Ambient
n	14
Min	2
Max	131
q1	10
Median	46
q3	78
Mean	49
% Exceeded	0
Standard	235

Figure 1-40. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site SPC050.



	Ambient	Storm	All
n	14	7	21
Min	1	71	1
Max	517	9678	9678
q1	12	260	13
Median	18	866	48
q3	48	2140	417
Mean	65	2134	755
% Exceeded	0	43	14
Standard	1178	1178	1178

Figure 1-41. 2010, 2011, and 2012 *E. coli* Results at Monitoring Site PCT410.

The storm fecal coliform bacteria samples had a median concentration of 680 cfu/100 mL. The boxplot indicates that six of the ten (60 percent) storm samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. All (both ambient and storm) fecal coliform bacteria samples had a median concentration of 165 cfu/100 mL. The boxplot indicates that 8 of the 20 (40 percent) of all ambient and storm samples had bacteria concentrations that exceeded the criterion of 400 cfu/100 mL.

Figure 1-23 displays a boxplot created with fecal coliform data from site SPC450, which is located on Spring Creek above U.S. Highway 16. Ten ambient and six storm fecal coliform bacteria samples were collected at SPC450. The ambient fecal coliform bacteria samples had a median concentration of 125 cfu/100 mL. The boxplot indicates that one of the ten (10 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL.

The storm fecal coliform bacteria samples had a median concentration of 295 cfu/100 mL. The boxplot indicates that two of the six (33 percent) storm samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. All (both ambient and storm) fecal coliform bacteria samples had a median concentration of 160 cfu/100 mL. The boxplot shows that 3 of the 16 (19 percent) of all ambient and storm samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL.

Figure 1-24 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC400, which is located on Spring Creek downstream of Mitchell Lake. There were 11 ambient fecal coliform bacteria samples collected at SPC400. The ambient fecal coliform bacteria samples had a median concentration of 46 cfu/100 mL. The boxplot indicates that 0 of the 10 (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/ 100 mL. No storm fecal coliform bacteria samples were collected at SPC400.

Figure 1-25 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC350, which is located on Spring Creek upstream of Mitchell Lake. Eleven ambient and nine storm fecal coliform bacteria samples were collected at SPC350. The ambient fecal coliform bacteria samples had a median concentration of 30 cfu/100 mL. The boxplot indicates that none of the ten (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL.

The storm fecal bacteria samples had a median concentration of 890 cfu/100 mL. The boxplot shows that seven of the nine (78 percent) storm samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. All (both ambient and storm) fecal coliform bacteria samples had a median concentration of 745 cfu/100 mL. The boxplot shows that 7 of the 20 35 percent of all (ambient and storm) samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/ 100 mL.

Figure 1-26 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC300, which is located on Spring Creek below Hill City and above the confluence of China Gulch. Eleven ambient fecal coliform bacteria samples were collected at SPC300. The ambient fecal coliform bacteria samples had a median concentration of 80 cfu/100 mL. The boxplot shows that none of the ten (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. No storm fecal coliform samples were collected at SPC300.

Figure 1-27 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC250 located on Spring Creek in Hill City above the confluence of Newton Fork. Eleven ambient fecal coliform bacteria samples collected at SPC250. The ambient fecal coliform bacteria samples had a median concentration of 40 cfu/100 mL. The boxplot shows that none of the ten (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. No storm fecal coliform samples were collected at SPC250.

Figure 1-28 displays a boxplot created with fecal coliform data from monitoring site SPC200 located on Spring Creek above Tracy Park in Hill City. Ten ambient and ten storm fecal coliform bacteria samples collected at SPC200. The ambient fecal coliform bacteria samples had a median concentration of 32 cfu/100 mL. The boxplot indicates that none of the ten (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL.

The storm fecal bacteria samples had a median concentration of 500 cfu/100 mL. The boxplot shows that six of the ten (60 percent) storm samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. All (both ambient and storm) fecal coliform bacteria samples had a median concentration of 120 cfu/100 mL. The boxplot shows that 6 of the 20 (30 percent) of all ambient and storm samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/ 100 mL.

Figure 1-29 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC100, which is located on Spring Creek above the confluence of Sunday Gulch. There were ten ambient fecal coliform bacteria samples were collected at SPC100. The ambient fecal coliform bacteria samples had a median concentration of 23 cfu/100 mL. The boxplot shows that none of the ten (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/100 mL. No storm fecal coliform samples were collected at SPC100.

Figure 1-30 displays a boxplot created with fecal coliform bacteria data from monitoring site SPC050, which is located on Spring Creek below Spring Creek Road West. Ten ambient fecal coliform bacteria samples were collected at SPC050. The ambient fecal coliform bacteria samples had a median concentration of 19 cfu/100 mL. The boxplot indicates that none of the ten (0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the criterion of 400 cfu/ 100 mL. No storm fecal coliform samples were collected at SPC050.

Figure 1-31 displays a boxplot created with fecal coliform bacteria data from monitoring site PCT410, which is located on Palmer Creek above State Highway 244. Ten ambient and 4 storm fecal coliform bacteria samples were collected at PCT410. The ambient fecal coliform bacteria samples had a median concentration of 19 cfu/100 mL. The boxplot shows that none of the ten

(0 percent) ambient samples had fecal coliform bacteria concentrations that exceeded the limited-contact recreation fecal coliform bacteria criterion of 2,000 cfu/100 mL.

The storm fecal coliform bacteria samples had a median concentration of 8,070 cfu/100 mL. The boxplot indicates that two of the four (50 percent) storm samples had fecal coliform bacteria concentrations that exceeded the limited-contact recreation fecal coliform bacteria criterion of 2,000 cfu/100 mL. All (both ambient and storm) fecal coliform bacteria samples had a median concentration of 56 cfu/100 mL. The boxplot shows that 2 of the 14 (14 percent) of all ambient and storm samples had fecal coliform bacteria concentrations that exceeded the limited-contact criterion of 2,000 cfu/100 mL.

1.7.2.2 E. coli

Monitoring results were compared to the *E. coli* single-sample criterion of 235 most probable number/100 milliliters (mpn/100 mL) for immersion recreation waters during the recreation season (May 1 to September 30), as described in Section 1.5.1 and illustrated in Table 1-28. During the recreation seasons in 2010 and 2012, a total of 169 *E. coli* samples were collected during monthly ambient sampling at 14 monitoring sites on Spring Creek. Of those 169 ambient samples, 8 (or 4.7 percent) had *E. coli* concentrations that exceeded the *E. coli* water quality criterion of 235 mpn/100 mL. For the ambient samples, *E. coli* concentrations ranged from 1 mpn/100 mL to 770 mpn/100 mL and had a median of 38 mpn/100 mL.

The ambient samples collected at sites SPC100 (7 percent), SPC400 (7 percent), SPC450 (14 percent), SPC485 (40 percent), and SPC500 (14 percent) had *E. coli* concentrations that exceeded the immersion recreation water quality criterion of 235 mpn/100 mL. All of the *E. coli* water quality criterion exceedances in the ambient monitoring occurred during the 2012 recreation season. *E. coli* concentrations at the other nine monitoring sites on Spring Creek did not exceed the *E. coli* criterion of 235 mpn/100 mL during 2010, 2011, and 2012.

A total of 47 *E. coli* flow-weighted composite samples were collected during storm event sampling during the recreation season in 2010, 2011, and 2012 at four monitoring sites on Spring Creek. Of those 47 samples, 31 (66 percent) of the storm flow-weighted composite samples had *E. coli* concentrations that exceeded the immersion recreation water quality *E. coli* criterion of 235 mpn/100 mL. For the 47 storm flow-weighted composite samples, *E. coli* concentrations ranged from 17 mpn/100 mL to 19,900 mpn/100 mL and had a median of 529 mpn/100 mL. The storm flow-weighted composite samples that were collected at sites SPC200 (64 percent), SPC350 (69 percent), SPC450 (50 percent), and SPC500 (71 percent) exceeded the immersion recreation water quality *E. coli* criterion of 235 mpn/100 mL in 2010, 2011, and 2012.

In Figures 1-32 through 1-41, the *E. coli* monitoring results during the recreation season in years 2010, 2011, and 2012 are displayed in boxplots. Figure 1-32 displays a boxplot created with *E. coli* concentration data from monitoring site SPC500 located on Spring Creek above Calumet Road above Sheridan Lake. Fourteen ambient and 14 storm *E. coli* samples were collected at SPC500. The ambient samples had a median *E. coli* concentration of 138 mpn/

100 mL. The boxplot shows that two of the fourteen (14 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

The storm samples had a median *E. coli* concentration of 714 mpn/100 mL. The boxplot shows that ten of the fourteen (71 percent) storm samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. All (both ambient and storm) samples had a median *E. coli* concentration of 191 mpn/100 mL. The boxplot shows that 12 of the 28 (43 percent) samples (ambient and storm) had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

Figure 1-33 displays a boxplot created with *E. coli* concentration data from monitoring site SPC450, which is located on Spring Creek above U.S. Highway 16. Fourteen ambient and 6 storm *E. coli* samples were collected at SPC450. The ambient samples had a median *E. coli* concentration of 98 mpn/100 mL. The boxplot indicates that two of the fourteen (14 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

The storm samples had a median *E. coli* concentration of 205 mpn/100 mL. The boxplot shows that three of the six (50 percent) storm samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. All (both ambient and storm) samples had a median *E. coli* concentration of 98 mpn/100 mL. The boxplot shows that 5 of the 20 (25 percent) of all ambient and storm samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

Figure 1-34 displays a boxplot created with *E. coli* data from monitoring site SPC400, which is located on Spring Creek downstream of Mitchell Lake. Fifteen ambient *E. coli* samples were collected at SPC400. The ambient samples had a median *E. coli* concentration of 13 mpn/ 100 mL. The boxplot indicates that none of the ten (0 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. No storm *E. coli* samples were collected at SPC400.

Figure 1-35 displays a boxplot created with *E. coli* concentration data from monitoring site SPC350, which is located on Spring Creek upstream of Mitchell Lake. Fifteen ambient and 13 storm *E. coli* samples were collected at SPC350. The ambient samples had a median *E. coli* concentration of 20 mpn/100 mL. The boxplot shows that none of the 15 (0 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

The storm samples had a median *E. coli* concentration of 529 mpn/100 mL. The boxplot shows that 9 of the 13 (69 percent) storm samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. All (both ambient and storm) samples had a median *E. coli* concentration of 74 mpn/100 mL. The boxplot indicates that 9 of the 28 (32 percent) of all ambient and storm samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

Figure 1-36 displays a boxplot created with *E. coli* concentration data from monitoring site SPC300, which is located on Spring Creek below Hill City and above the confluence of China Gulch. Fifteen ambient *E. coli* samples were collected at SPC300. The ambient samples had a median *E. coli* concentration of 38 mpn/100 mL. The boxplot shows that none of the 10 (0 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. No storm *E. coli* concentration samples were collected at SPC300.

Figure 1-37 displays a boxplot created with *E. coli* concentration data from monitoring site SPC250 located on Spring Creek in Hill City above the confluence of Newton Fork. Fifteen ambient *E. coli* samples were collected at SPC250. The ambient samples had a median *E. coli* concentration of 50 mpn/100 mL. The boxplot indicates that none of the ten (0 percent) ambient samples had *E. coli* concentration concentrations that exceeded the criterion of 235 mpn/ 100 mL. No storm *E. coli* concentration samples were collected at SPC250.

Figure 1-38 displays a boxplot created with *E. coli* concentration data from monitoring site SPC200, which is located on Spring Creek above Tracy Park in Hill City. Fourteen ambient and 14 storm *E. coli* samples collected at SPC200. The ambient samples had a median *E. coli* concentration of 27 mpn/100 mL. The boxplot shows that none of the 14 (0 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

The storm samples had a median *E. coli* concentration of 604 mpn/100 mL. The boxplot shows that 9 of the 14 (64 percent) storm samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. All (both ambient and storm) samples had a median *E. coli* concentration of 105 mpn/100 mL. The boxplot shows that 9 of the 28 (32 percent) samples (ambient and storm) had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL.

Figure 1-39 displays a boxplot created with *E. coli* data from monitoring site SPC100 located on Spring Creek above the confluence of Sunday Gulch. Fourteen ambient *E. coli* samples were collected at SPC100. The ambient samples had a median concentration of 33 mpn/100 mL. The boxplot indicates that one of the fourteen (1 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. No storm *E. coli* samples were collected at SPC100.

Figure 1-40 displays a boxplot created with *E. coli* data from monitoring site SPC050 located on Spring Creek below Spring Creek Road West. Fourteen ambient *E. coli* samples collected at SPC050. The ambient samples had a median *E. coli* concentration of 46 mpn/100 mL. The boxplot indicates that none of the 10 (0 percent) ambient samples had *E. coli* concentrations that exceeded the criterion of 235 mpn/100 mL. No storm *E. coli* samples were collected at SPC050.

Figure 1-41 displays a boxplot created with *E. coli* data from monitoring site PCT410 located on Palmer Creek above State Highway 244. Fourteen ambient and seven storm *E. coli* samples collected at PCT410. The ambient samples had a median *E. coli* concentration of 18 mpn/ 100 mL. The boxplot indicates that none of the 10 (0 percent) ambient samples had *E. coli* concentrations that exceeded the limited-contact recreation *E. coli* criterion of 1,178 mpn/100 mL.

The storm samples had a median *E. coli* concentration of 866 mpn/100 mL. The boxplot shows that 3 of the 7 (43 percent) storm samples had *E. coli* concentrations that exceeded the limited-contact recreation *E. coli* criterion of 1,178 mpn/100 mL. All (both ambient and storm) samples had a median *E. coli* concentration of 48 mpn/100 mL. The boxplot shows that 3 of the 21 (14 percent) of all ambient and storm samples had *E. coli* concentrations that exceeded the limited-contact criterion of 1,178 mpn/100 mL.

2.0 ON-SITE WASTEWATER TREATMENT SYSTEMS

Approximately 23 percent of the estimated 115 million homes in the U.S. are served by OWTS, and this has changed little since 1970 [U.S. EPA, 2002]. In 1990, an estimated 78,000 South Dakotans (approximately 11 percent of South Dakota's population) were living in residences served by an OWTS and less than 1 percent (approximately 6,000 people) were living in residences with outhouses or privies [U.S. Census Bureau, 1990; U.S. EPA, 2002]. In Custer County, approximately 31 percent (1,913 people) were living in residences that have OWTS. In Pennington County, approximately 7 percent, or 6,098 people, were living in residences that have OWTS [U.S. Census Bureau, 1990]. In 2008, an estimated 9,000 OWTS were in the Black Hills [Sawyer, 2008; Putnam et al., 2008]. In 2012, the Pennington County Planning Department estimated that there were approximately 5,800 OWTS were within the county [Molitor, 2012].

For this plan, an OWTS is defined as a system designed to contain, distribute, or treat wastewater on or near the location where the wastewater is generated. Examples include sewers, septic tanks, absorption fields, mound systems, evapotranspiration systems, vault privies, holding tanks, subsurface sand filters, graywater systems, pumping stations, dosing chambers, or any equipment related to OWTS or other alternative or experimental system [Pennington County, 2012b].

Data for the OWTS assessment were provided by Pennington County, Custer County, the SD DENR, the USGS, and property owners within the watershed [Hoogestraat, 2009; SD DENR, 2010b; Custer County Planning Department, 2012; Rossknecht, 2011; Pennington County, 2012a]. These data were gathered from building and septic permits submitted to Custer County and Pennington County in addition to permits submitted to the SD DENR and OWTS cost-share applications submitted to Pennington County for the Spring Creek Watershed Implementation and Management Project. This dataset consists of the addressed location, geographic coordinates, legal description, tax parcel, permit, year built, year septic, tank capacity, drainfield size, and maximum daily flow for OWTS locations within the watershed.

Detailed information and data regarding OWTS within the project area are described in the *On-Site Wastewater Management Plan* [Krajewski, 2013]. The *On-Site Wastewater Management Plan* contains data sources, OWTS types and descriptions, wastewater effluent characterics, and wastewater pollutants and pathogens. Additionally, a detailed assessment of the current OWTS conditions in addition to the applicable rules and regulations, codes, and ordinances are included in the *On-Site Wastewater Management Plan* [Krajewski, 2013]. The following sections are a summary of the number and types of OWTS within the project and their approximate locations regarding Spring Creek and its tributaries.

2.1 ASSESSMENT OF ON-SITE WASTEWATER TREATMENT SYSTEMS

In 2004, an estimated 662 OWTS were located above Sheridan Lake, as provided in Table 2-1 [SD DENR, 2008a]. Current address data obtained for this plan were more accurate because they were updated as part of the E-911 effort in Custer and Pennington Counties. In 2012, an estimated 916 OWTS are located in the project area, as shown in Table 2-2. The number of OWTS was estimated to assist in modeling the contribution of fecal coliform bacteria from OWTS. These 916 OWTS occur at 910 addressed structures, as illustrated in Figure 2-1. Additionally, an estimated 5 (0.5 percent) of the 910 addressed structures had no OWTS installed and were considered straight pipes. Approximately 867 OWTS are located in Pennington County and 37 OWTS in Custer County.

Table 2-1. Estimated Number of On-Site Wastewater Treatment Systems in the Spring Creek Total Maximum Daily Load Study Area in 2004

Subwatershed	Study Area	Study Area (%)
Lower Spring Creek	315	47.6
Palmer Gulch	94	14.2
Newton Fork	140	21.1
Upper Spring Creek	113	17.1
Total	**662**	**100.0**

Table 2-2. Estimated Number of On-Site Wastewater Treatment Systems by City and County Within the Watershed

Addressed Structures and OWTS per Address	Pennington County	Custer County	City of Hill City	Project Area	Project Area (%)
Number of Addressed Structures	860	38	532	1,430	100.0
Estimated Number of Addressed Structures With No OWTS	4	1	0	5	0.5
Number of Addresses With OWTS	856	37	12	905	99.5
Number of Multiple OWTS (2 OWTS per Address)	50	2	0	52	5.7
Number of Combined OWTS (0.5 OWTS per Address)	12	2	0	14	1.5
Number of Single OWTS (1 OWTS per Address)	805	33	12	850	92.8
Total	**867**	**37**	**12**	**916**	**100.0**

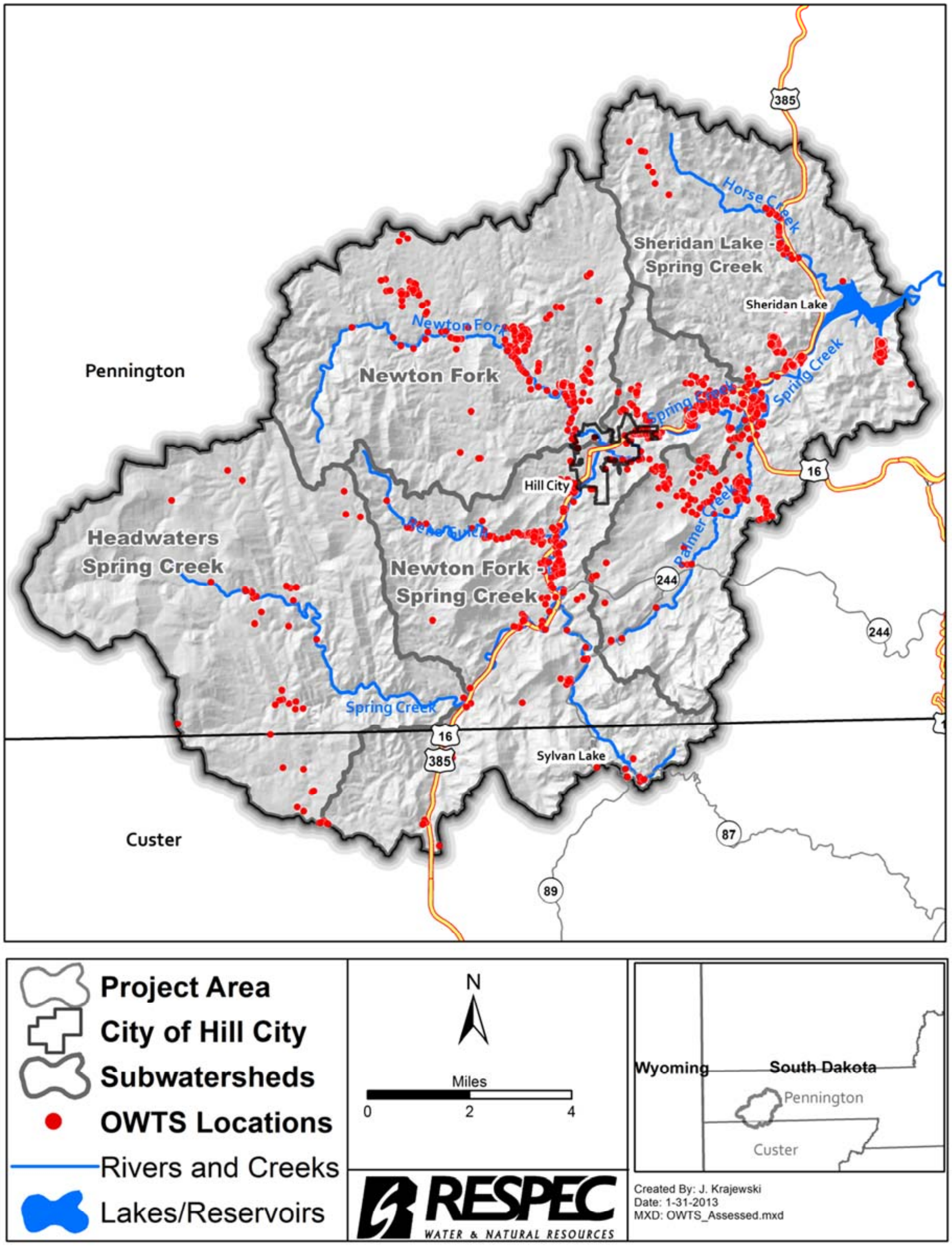


Figure 2-1. Estimated On-Site Wastewater Treatment System Locations Within the Project Area by Subwatershed.

2.1.1 Estimated Number of On-Site Wastewater Treatment Systems by Subwatershed

The locations of assessed and nonassessed OWTS structures in the subwatersheds within the project area are illustrated in Table 2-3 and Figure 2-2. Four subwatersheds are located within the project area: Sheridan Lake–Spring Creek, Newton Fork–Spring Creek, Headwaters Spring Creek, and Newton Fork, which contain approximately 343 (37.4 percent), 365 (39.8 percent), 42 (4.6 percent), and 166 (18.1 percent) of the estimated number of OWTS, respectively. The density (number of OWTS per square mile) of the estimated OWTS locations within the project area is provided in Table 2-3 and Figure 2-3. The Newton Fork–Spring Creek Subwatershed had the greatest density with 9.6 OWTS per square mile in the project area.

Table 2-3. Number of Estimated and Assessed On-Site Wastewater Treatment System by Subwatershed

Area	Area (mi^2)	Area (%)	Estimated OWTS	Estimated OWTS (%)	Estimated OWTS per Mile^2	Assessed OWTS	Assessed OWTS (%)
Newton Fork–Spring Creek	38.1	26.3	365	39.8	9.6	123	13.4
Sheridan Lake–Spring Creek	39.0	26.9	343	37.4	8.8	167	18.2
Headwaters Spring Creek	36.1	24.9	42	4.6	1.2	13	1.4
Newton Fork	31.8	21.9	166	18.1	5.2	69	7.5
Project Area	**145.0**	**100.0**	**916**	**100.0**	**6.3**	**372**	**40.5**

2.1.2 Structure Types With Assessed On-Site Wastewater Treatment Systems

Approximately 139 assessed OWTS (37.5 percent) structure types were unknown, 104 OWTS (27.9 percent) were cabins, and 50 OWTS (13.4 percent) were houses, as provided in Figure 2-4 and Table 2-4. Also, 8 percent and 3 percent of cabins and houses, respectively, were categorized as “plus” that had more than one structure. Commercial and campground types comprised approximately 4 percent and 1 percent of the assessed OWTS structure types, respectively.

2.1.3 Types of Systems for Assessed On-Site Wastewater Treatment Systems

Approximately 577 (63 percent) of the assessed OWTS in the project area were unknown types of systems. The predominant type of assessed OWTS was a conventional system, which consists of a building sewer; septic tank; and an absorption system with a standard trench, chambered trench, or an absorption bed for one addressed structure. Approximately 252 (27.5 percent) conventional, 50 (5.5 percent) portable or porta-potties, 30 (3.3 percent) holding tanks, 4 (0.4 percent) graywaters, and 3 (0.3 percent) mound or at-grade systems were assessed in the project area, as shown in Table 2-5 and Figure 2-5.

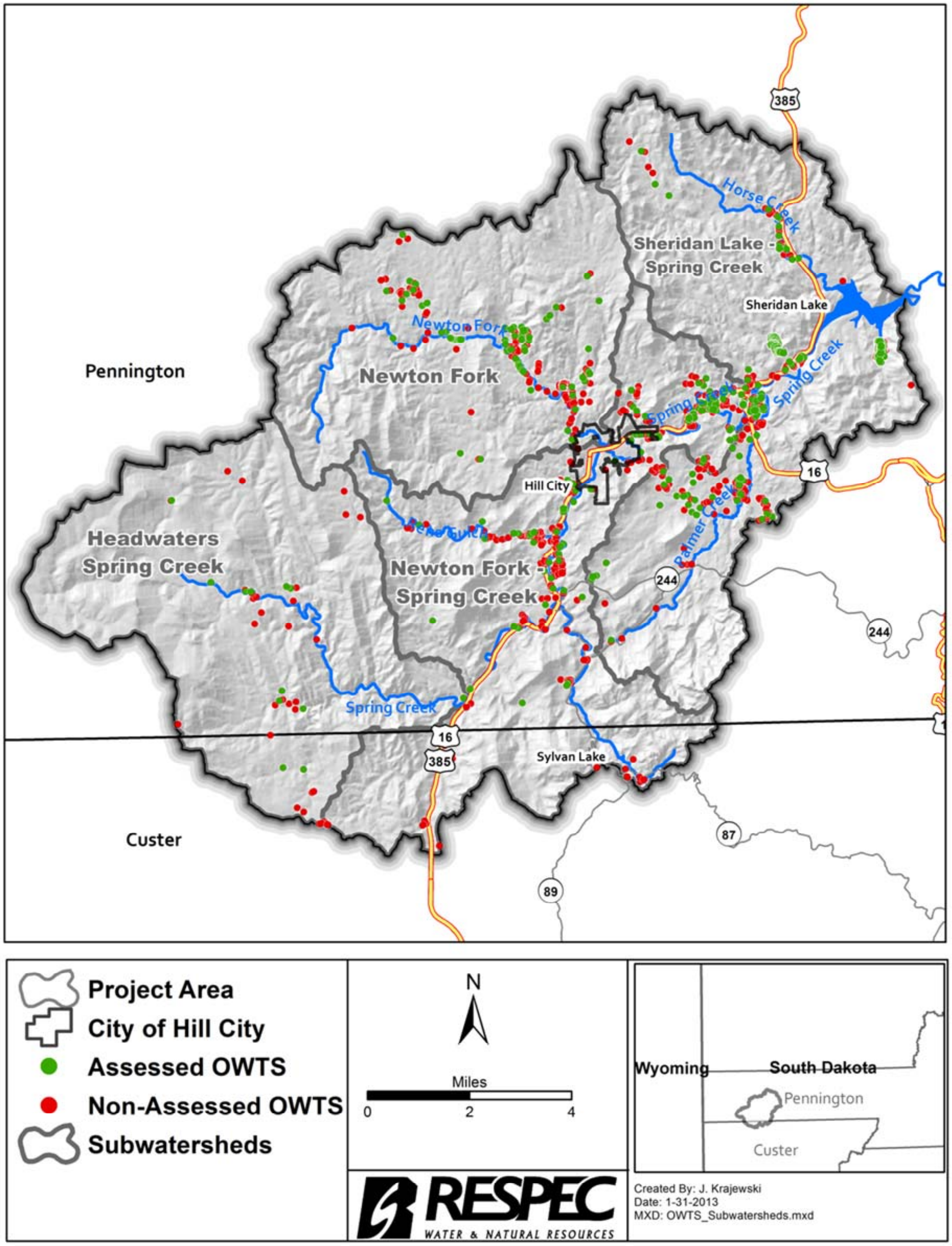


Figure 2-2. Assessed and Nonassessed On-Site Wastewater Treatment Systems in the Project Area by Subwatershed.

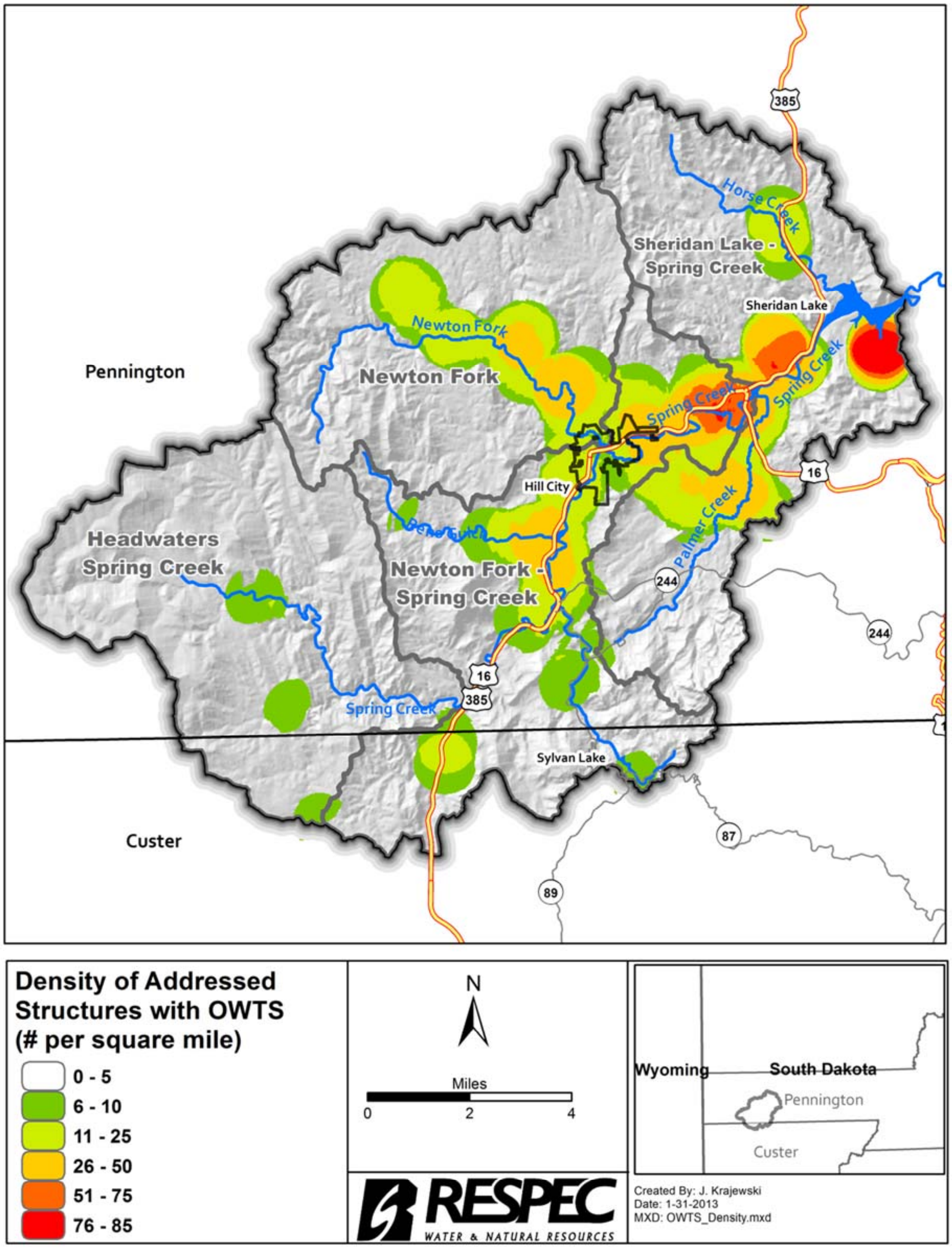


Figure 2-3. Density of Estimated On-Site Wastewater Treatment System Locations in the Spring Creek Watershed.

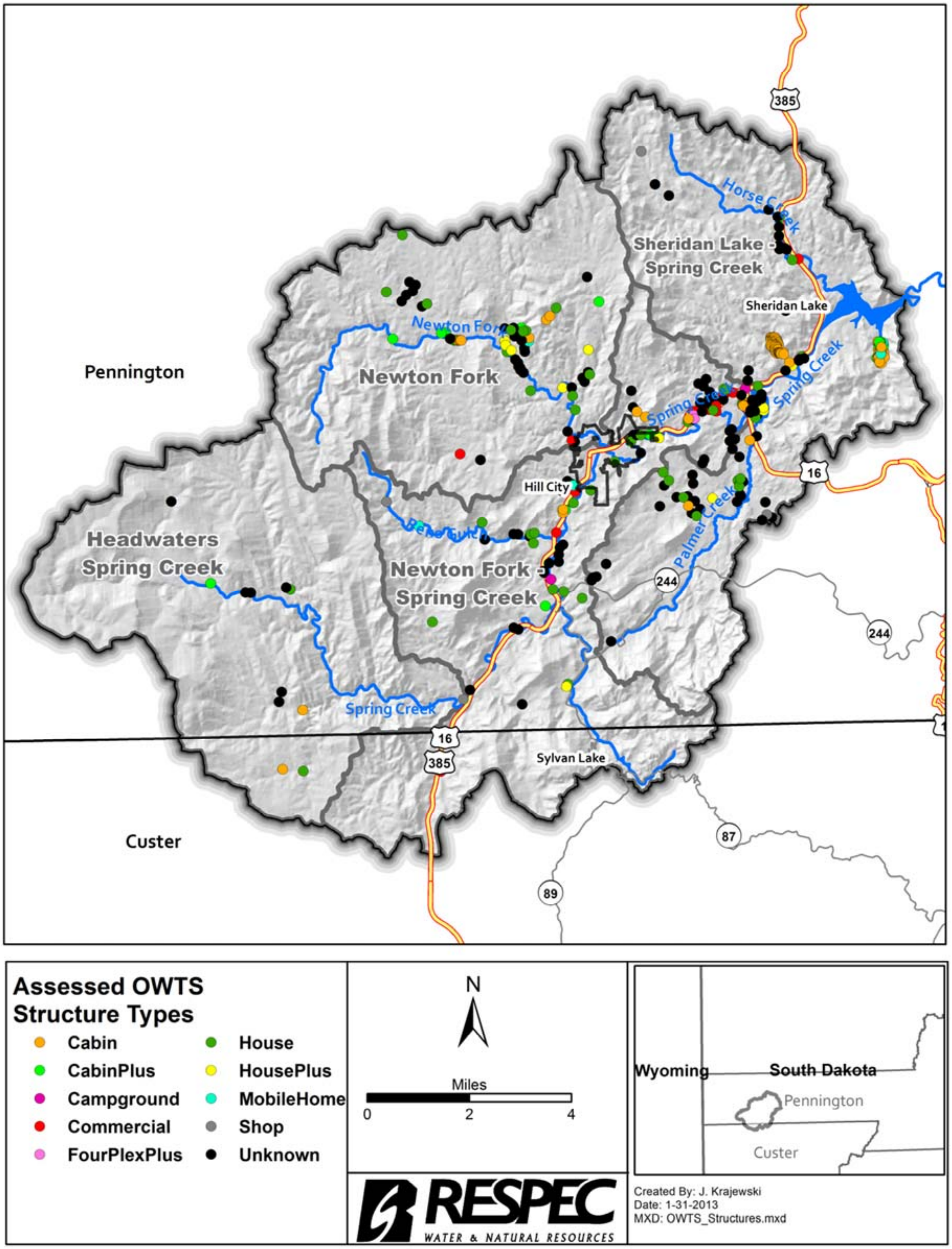


Figure 2-4. Types of Structures for Assessed On-Site Wastewater Treatment Systems in the Spring Creek Watershed.

Table 2-4. Structure Types of Assessed On-Site Wastewater Treatment Systems

Assessed OWTS Structure Type	Assessed OWTS Structure	Assessed OWTS Structure (%)
Cabin	104	27.9
CabinPlus	31	8.3
Campground	4	1.1
Commercial	15	4.0
FourPlexPlus	5	1.3
House	50	13.4
HousePlus	13	3.5
Mobile Home	7	1.9
Shop	4	1.1
Unknown	139	37.5
Project Area	**372**	**100.0**

Table 2-5. Types of On-Site Wastewater Treatment Systems

Type	Pennington County	Custer County	City of Hill City	Project Area	Project Area (%)
Conventional	252			252	27.5
Graywater	4			4	0.4
Holding Tank	30			30	3.3
Mound	3			3	0.3
Portable	50			50	5.5
Unknown	528	37	12	577	63.0
Project Area	**867**	**37**	**12**	**916**	**100.0**

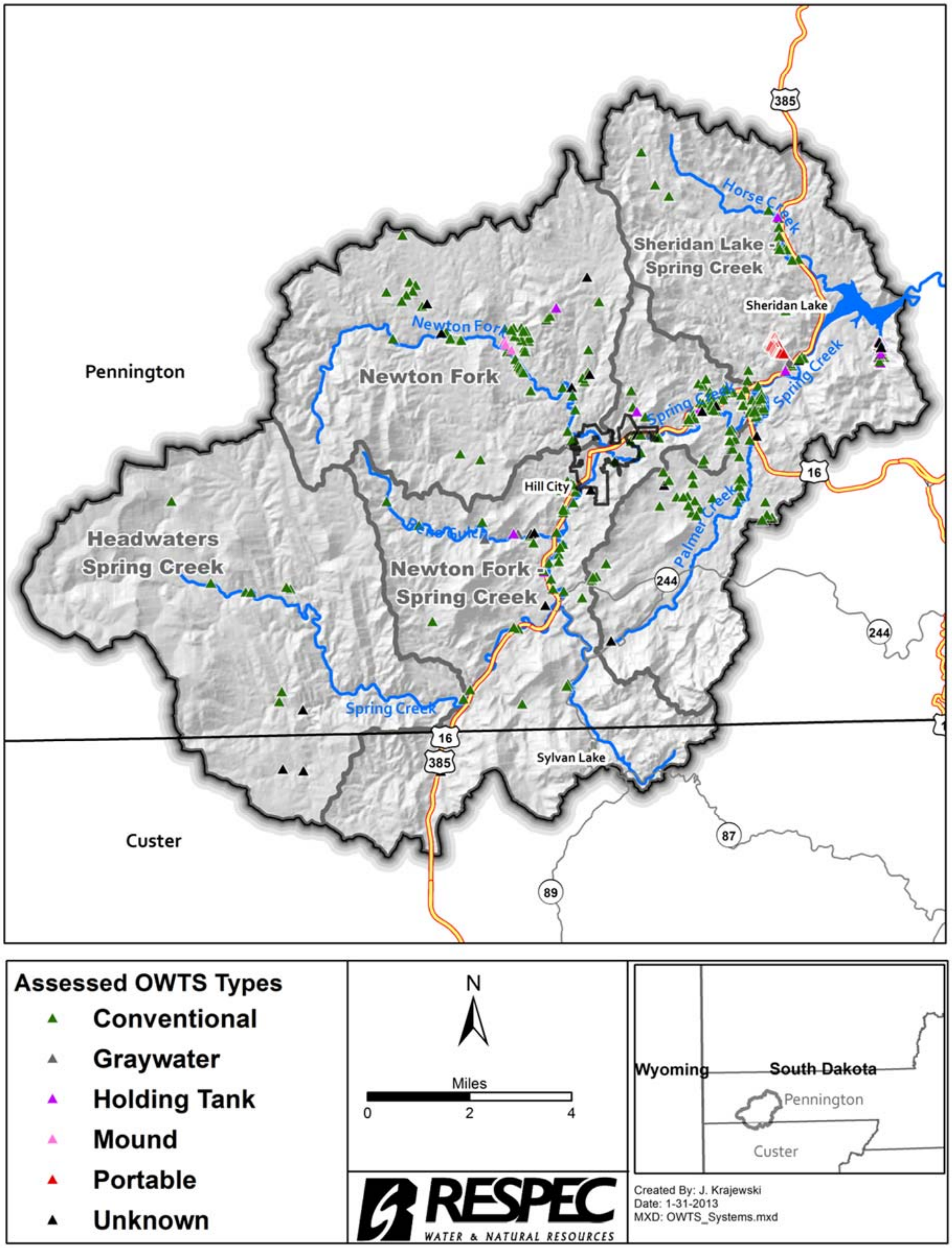


Figure 2-5. Types of Systems for Assessed On-Site Wastewater Treatment Systems in the Spring Creek Watershed.

2.1.4 Types of Septic Tanks for Assessed On-Site Wastewater Treatment Systems

As provided in Table 2-6 and Figure 2-6, 224 assessed OWTS (60.2 percent) had septic tanks that were concrete. Also, 51 assessed OWTS (13.7 percent) were poly, which are polyurethane or polyethylene tanks or porta-potties. Five steel septic tanks (1.3 percent) and approximately 92 septic tanks (24.8 percent) that were unknown types.

Table 2-6. Types of Septic Tanks for Assessed On-Site Wastewater Treatment Systems

Septic Tank Type	Septic Tank (number)	Septic Tank (%)
Concrete	224	60.2
Poly	51	13.7
Steel	5	1.3
Unknown	92	24.8
Project Area	**372**	**100.0**

2.1.5 Permit Years and Estimated Ages for On-Site Wastewater Treatment Systems

The OWTS permit year data was categorized for 372 assessed OWTS (40.6 percent) of the estimated 916 OWTS within the project area, as provided in Figure 2-7 and Table 2-7. Approximately 198 assessed OWTS (21.6 percent) were permitted from 2002 to 2012. The number of OWTS permitted from 1992 to 2001 was 150 (16.4 percent). The remaining were permitted from 1976 to 1991 (1.0 percent) and before 1976 (1.6 percent).

There were 544 OWTS (59.4 percent) that were not assessed and permit or construction years are unknown. As illustrated in Table 2-8 and Figure 2-8, the ages were estimated and categorized for 372 assessed OWTS (40.6 percent) of the estimated 916 OWTS within the project area. Approximately 103 assessed OWTS (11.2 percent) were constructed or permitted approximately 6 to 10 years ago. In addition, 97 OWTS (10.6 percent) constructed or permitted approximately 11 to 15 years ago. Another 95 OWTS were constructed or permitted within the last 5 years (10.4 percent), and approximately 77 assessed OWTS were constructed from 16 to over 35 years ago (8.4 percent). Table 2-9 shows the numbers of estimated OWTS by subwatershed and the estimated years they were constructed or permitted.

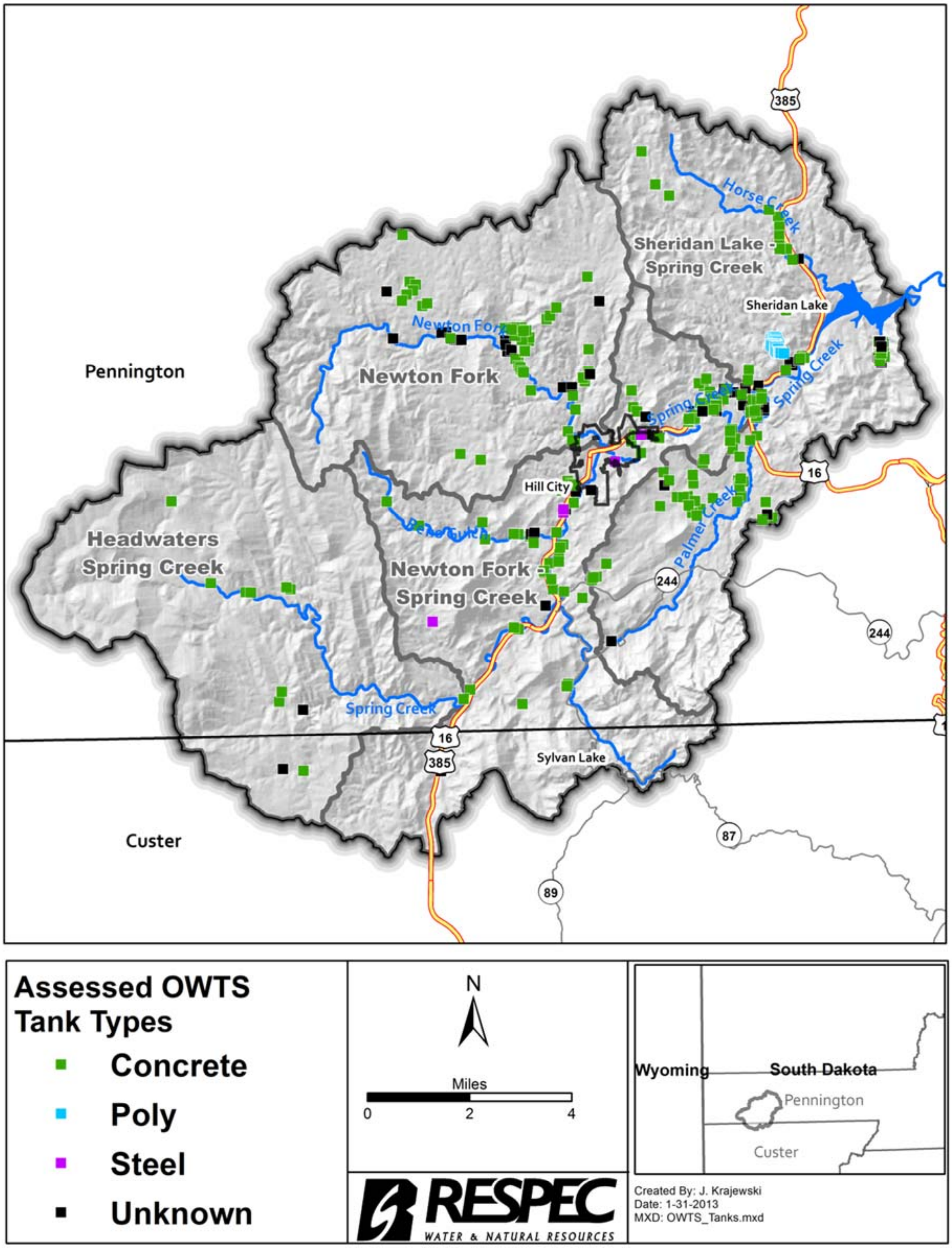


Figure 2-6. Types of Septic Tanks of Assessed On-Site Wastewater Treatment Systems in the Spring Creek Watershed.

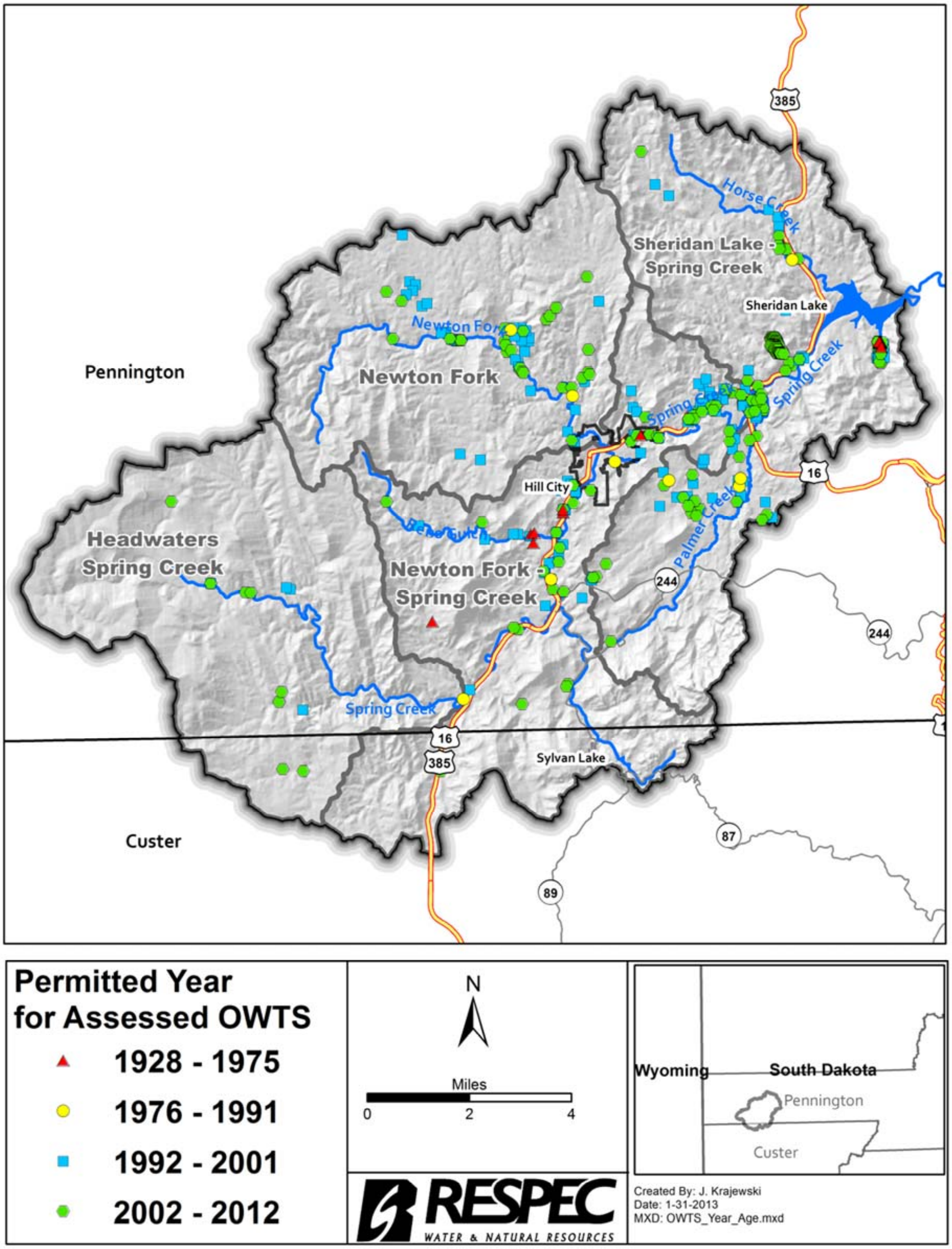


Figure 2-7. Estimated Permit Years of Assessed On-Site Wastewater Treatment Systems in the Spring Creek Watershed.

Table 2-7. Permit Year for Assessed On-Site Wastewater Treatment Systems

Permit Year	OWTS (number)	OWTS (%)
Before 1976	15	1.6
1976–1991	9	1.0
1992–2001	150	16.4
2002–2012	198	21.6
Unknown	544	59.4
Project Area	**916**	**100.0**

Table 2-8. Estimated Age for Assessed On-Site Wastewater Treatment Systems

Age (years)	OWTS (number)	OWTS (%)
0–5	95	10.4
6–10	103	11.2
11–15	97	10.6
16–20	53	5.8
21–35	9	1.0
> 35	15	1.6
Unknown	544	59.4
Project Area	**916**	**100.0**

2.1.6 On-Site Wastewater Treatment System Repair Data

The Pennington County [2012a] major and minor repair data for OWTS were obtained and show that 225 OWTS inspections were made in Pennington County from 2010 to 2012, as illustrated in Table 2-10, and Table 2-11 shows that 16 of the 225 inspections were in the project area. Major repairs were needed on 129 systems (57.4 percent) in Pennington County, and 10 systems (62.5 percent) needed repair within the project area. Only 1 of the 16 OWTS inspected in the project area was determined to be a “failure” because the site conditions indicated that wastewater effluent had surfaced and potentially reached a waterbody. That OWTS has been sufficiently repaired. Moreover, from 2010 through 2012, no straight pipe discharges were documented through inspections or inventories of OWTS within the watershed.

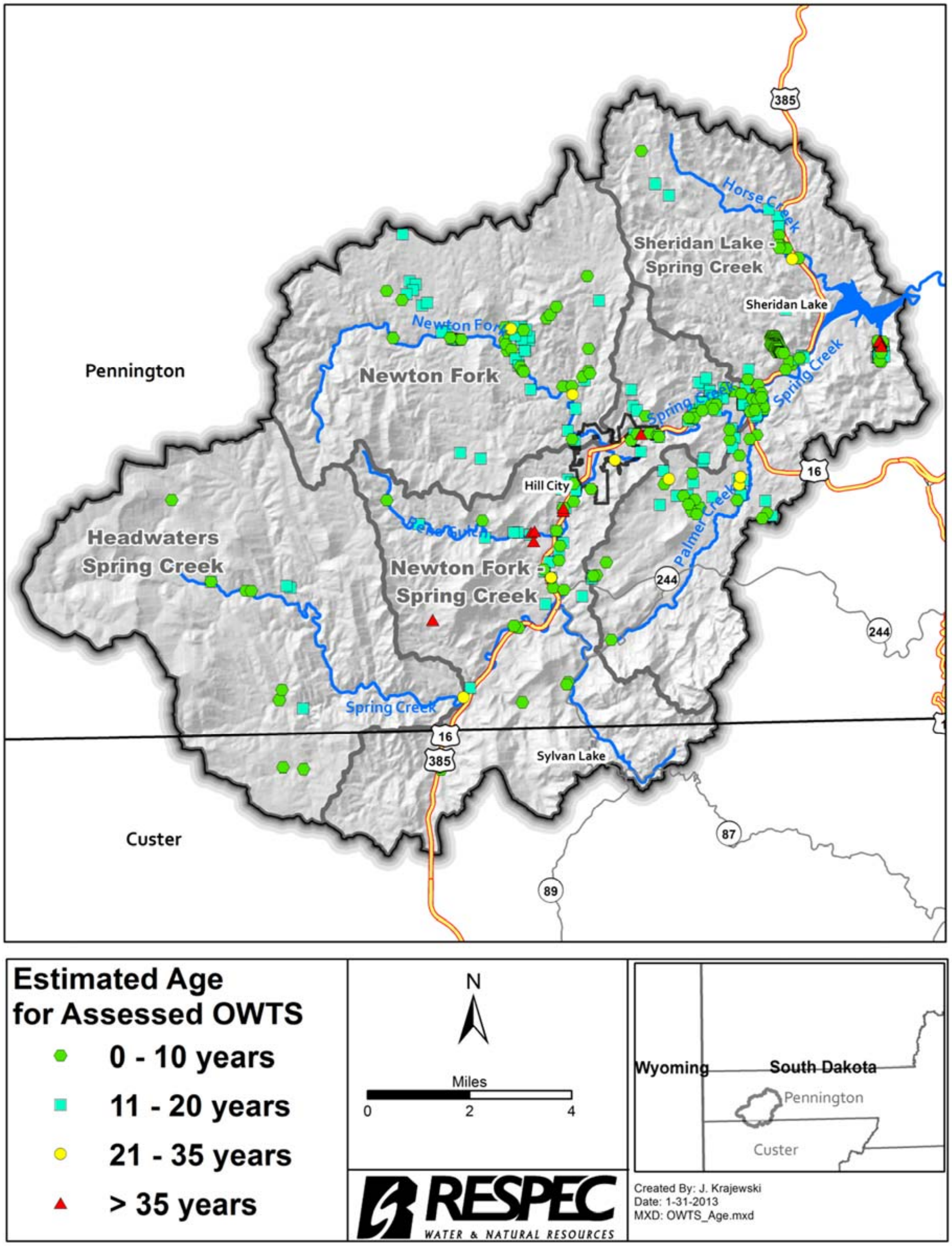


Figure 2-8. Estimated Ages of Assessed On-Site Wastewater Treatment Systems in the Spring Creek Watershed.

Table 2-9. Estimated On-Site Wastewater Treatment Systems Years for All Systems by Subwatershed in the Project Area

Subwatershed	Total OWTS	Estimated OWTS by Year		
		Before 1976	1976–1991	1992–2012
Newton Fork–Spring Creek	365	139	71	155
Sheridan Lake–Spring Creek	343	141	61	141
Headwaters Spring Creek	42	13	8	21
Newton Fork	166	43	33	90
Project Area	**916**	**336**	**173**	**407**

Table 2-10. On-Site Wastewater Treatment Systems Needing Repairs Within Pennington County

Repair Type	Repairs	Repairs (%)
Both Major and Minor Repairs	15	6.7
Major Repairs	114	50.7
Minor Repairs	96	42.7
Total	**225**	**100.0**

Table 2-11. Inspected On-Site Wastewater Treatment Systems Needing Repairs Within the Spring Creek Watershed

Repair Type	Repairs	Repairs (%)
Major Repairs	10	62.5
Minor Repairs	6	37.5
Project Area	**16**	**100.0**

2.1.7 Estimated On-Site Wastewater Treatment Systems Failure Rates

Although this data indicates the amount of major OWTS repairs needed, it does not indicate the type of failure rate used for modeling fecal coliform and *E. coli* bacteria loading to Spring Creek. The OWTS repair data certainly helps determine the OWTS failure rate in the watershed. In the Cheyenne River TMDL, a septic system failure rate of 20 percent was used to estimate fecal coliform and *E. coli* bacteria loading to the Cheyenne River in Pennington County [McCutcheon, 2010]. Schwickerath [2004] used a system failure rate of 7 percent because it produced a similar percentage of simulated fecal coliform from humans as what was illustrated by the bacterial ribotyping sampling in the watershed. Schmitz [2011] modeled OWTS within the watershed and estimated fecal coliform bacteria loadings using the BIT and an assumed OWTS failure rate of 20 percent.

Table 2-12.Estimated On-Site Wastewater Treatment System Failure Rates by Addressed Structure Age

Age Category	Estimated Failures (%)	Straight Pipe Discharges for Addressed Structures (%)
Before 1976	20.0	0.5
1976–1991	6.0	0.0
1992–2012	1.0	0.0

The Bacteria Source Load Calculator (BSLC) [Center for TMDL and Watershed Studies, 2007] was used to estimate fecal coliform and *E. coli* bacteria loading to Spring Creek. The estimated OWTS failure rates and the percent of straight pipe discharges for the addressed structure ages were made, as shown in Table 2-12, to use in the BSLC to estimate fecal coliform bacteria contribution within the watershed. These assumptions and estimates were based on inspection, inventory, and repair data for OWTS collected as part of this planning effort.

The addressed structures built before 1976 were given an OWTS failure rate of 20 percent, structures built from 1976 to 1991 were given a failure rate of 6 percent, and structures built from 1992 to 2012 were given an OWTS failure rate of 1 percent. Although no straight pipe discharges were documented to date in the project area, seepage pits and pit privies have been observed for calculating OWTS bacteria loading using the BSLC. Based on this observation, 0.5 percent of the addressed structures built before 1975 were assumed to have no OWTS and are estimated to have a straight pipe discharge.

2.2 PROXIMITY OF ON-SITE WASTEWATER TREATMENT SYSTEMS TO SPRING CREEK AND TRIBUTARIES

An estimated 25 (2.7 percent) of the assessed and nonassessed OWTS are within 100 feet of Spring Creek, and another 180 (19.7 percent) are within 600 feet of Spring Creek, as shown in Table 2-13 and Figure 2-9. An estimated 42 (4.6 percent) of the assessed and nonassessed OWTS are located within 100 feet of a perennial tributary, and another 154 (16.8 percent) OWTS are within 100 to 600 feet of a perennial tributary, as illustrated in Table 2-14.

Table 2-13. Proximity of Assessed, Nonassessed, and Total On-Site Wastewater Treatment Systems to Spring Creek

Distance to Spring Creek (feet)	Assessed OWTS	Nonassessed OWTS	Total OWTS	Total OWTS (%)
0–100	13	12	25	2.7
101–300	43	63	106	11.6
301–600	26	48	74	8.1
Total (0–600)	82	123	205	22.4
> 600 or Tributary	290	421	711	77.6
Project Area	**372**	**544**	**916**	**100.0**

Table 2-14. Proximity of Assessed, Nonassessed, and Total On-Site Wastewater Treatment Systems to Perennial Tributaries

Distance to Perennial Tributary (ft)	Assessed OWTS	Nonassessed OWTS	Total OWTS	Total OWTS (%)
0–100	20	22	42	4.6
101–300	24	65	89	9.7
301–600	26	39	65	7.1
0–600	70	126	196	21.4
> 600 or Spring Creek	302	418	720	78.6
Project Area	**372**	**544**	**916**	**100.0**

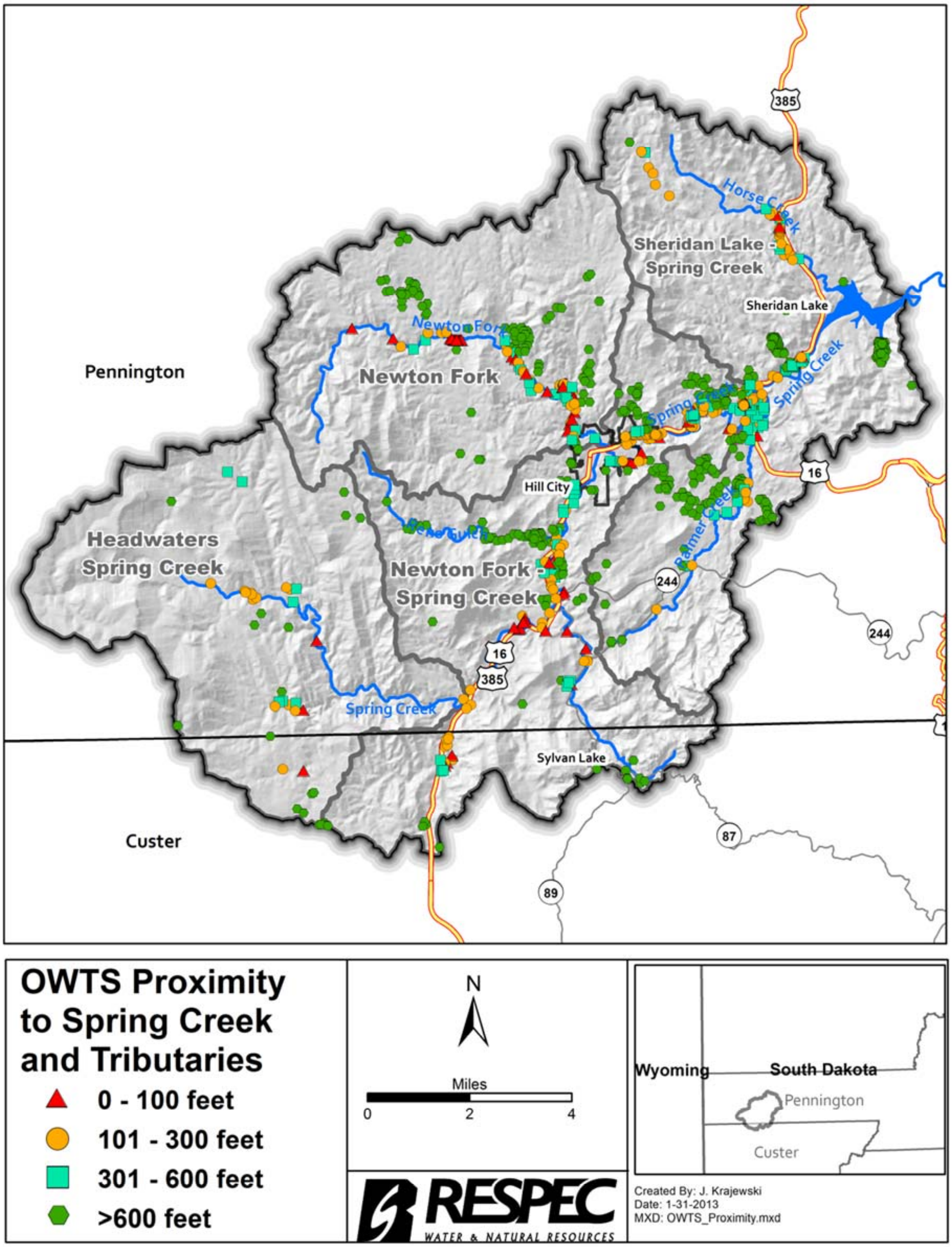


Figure 2-9. Proximity of On-Site Wastewater Treatment Systems to Spring Creek and Perennial Tributaries Within the Spring Creek Watershed.

2.3 ESTIMATED ON-SITE WASTEWATER TREATMENT SYSTEMS BACTERIA LOAD CONTRIBUTIONS

The BSLC software tool was used to estimate the fecal bacteria source production from OWTS and straight pipes from addressed structures within the watershed. The BSLC was developed by the Center for TMDL and Watershed Studies at Virginia Tech University to assist with the bacterial source characterization and to automate the creation of input files for water quality modeling [Center for TMDL and Watershed Studies, 2007]. The BSLC was used to distinguish how the bacterial loads are spatially and temporally distributed in the watershed and to calculate bacteria production from addressed structures. Most of the addressed structures within Hill City are on a sewer system, which is routed to a WWTF, and were not considered in the BSLC. Also, the other two surface water discharge-permitted point sources for sewerage and wastewater were not included in the bacteria production estimates for this plan.

The BSLC calculates a direct loading based on the number of houses with straight pipe discharges, the bacterial production rate per person, and the average number of people and pets living in each addressed structure that is not routed to a WWTF. It also calculates surface loadings from failing OWTS based on each addressed structure's age, an age-specific failure rate, the bacterial production rate per person, and the average number of people living in each addressed structure. The bacterial production rate per person was estimated at 2,000,000,000 cfu per day (expressed as 2.00 cfu $\times 10^{9}$ per day), as defined by the reference values given in the BSLC [Center for TMDL and Watershed Studies, 2007]. Estimated OWTS failure rates and percent of straight pipes for the addressed structures by age or year were described in Section 2.1.7 and Table 2-12 for use in the BSLC to estimate fecal coliform bacteria production.

An estimated 2,015 people reside in 910 addressed structures or households with approximately 916 OWTS and 5 straight pipe discharges in the areas of Hill City, Custer County, and Pennington County within the project area, as given in Table 2-15. The average number of persons per structure (2.2) was estimated by averaging the household sizes of Custer and Pennington Counties at 2.06 and 2.38, respectively. In Table 2-16, the estimated results from the BSLC are illustrated for the recreation season, nonrecreation season, and annual bacteria production from addressed structures with failed OWTS and straight pipes in the project area.

Approximately 5,856.84 cfu $\times 10^{10}$ (54.6 percent) of the total fecal coliform production from addressed structures within the project area occurred during the recreation season (May through September). Furthermore, an estimated 2,423.52 cfu $\times 10^{10}$ (41.4 percent) and 2,288.88 cfu $\times 10^{10}$ (39.1 percent) of the fecal coliform production from addressed structures occurs within the Newton Fork–Spring Creek and Sheridan Lake–Spring Creek subwatersheds, respectively, during the recreation season. These two subwatersheds account for over 80 percent of the total estimated fecal coliform production from addressed structures within the project area during the recreation season.

Table 2-15. Estimated Number of On-Site Wastewater Treatment Systems, Persons per On-Site Wastewater Treatment System, and Straight Pipes by Structure and/or On-Site Wastewater Treatment Systems Years by Subwatershed in the Spring Creek Watershed

Subwatershed	Persons per OWTS	Total OWTS	Total Persons	Estimated OWTS by Year			Estimated Straight Pipes by Year		
				Before 1976	1976–1991	1992–2012	Before 1976	1976–1991	1992–2012
Newton Fork–Spring Creek	2.2	365	803	139	71	155	2	0	0
Sheridan Lake–Spring Creek	2.2	343	755	141	61	141	1	0	0
Headwaters Spring Creek	2.2	42	92	13	8	21	1	0	0
Newton Fork	2.2	166	365	43	33	90	1	0	0
Project Area	**2.2**	**916**	**2,015**	**336**	**173**	**407**	**5**	**0**	**0**

Table 2-16. Recreation and Nonrecreation Fecal Coliform Bacteria Production From Addressed Structures With On-Site Wastewater Treatment Systems and Straight Pipes in the Spring Creek Watershed

Subwatershed	Fecal Coliform Bacteria Source	Recreation Season (cfu × 10^{10})	Nonrecreation Season (cfu × 10^{10})	Annual Production (cfu × 10^{10})	Subwatershed/ Project Area (%)
Newton Fork–Spring Creek	Failed OWTS	2,288.88	1,905.16	4,194.04	41.5
	Straight Pipes	134.64	112.07	246.71	40.0
	Subtotal	**2,423.52**	**2,017.22**	**4,440.74**	**41.4**
Sheridan Lake–Spring Creek	Failed OWTS	2,221.56	1,849.12	4,070.68	40.2
	Straight Pipes	67.32	56.03	123.35	20.0
	Subtotal	**2,288.88**	**1,905.16**	**4,194.04**	**39.1**
Headwaters Spring Creek	Failed OWTS	201.96	168.10	370.06	3.7
	Straight Pipes	67.32	56.03	123.35	20.0
	Subtotal	**269.28**	**224.14**	**493.42**	**4.6**
Newton Fork	Failed OWTS	807.84	672.41	1,480.25	14.6
	Straight Pipes	67.32	56.03	123.35	20.0
	Subtotal	**875.16**	**728.44**	**1,603.60**	**14.9**
Project Area	Failed OWTS	5,520.24	4,594.79	10,115.03	100.0
	Straight Pipes	336.60	280.17	616.77	100.0
	Subtotal	**5,856.84**	**4,874.96**	**10,731.80**	**100.0**

2.4 RULES AND REGULATIONS, CODES, AND ORDINANCES

OWTS are regulated within the project area by the state of South Dakota, city of Hill City, Custer County, or Pennington County, depending on the OWTS location. The SD DENR administers the applicable state rules and regulations, Custer and Pennington Counties administer their local ordinances, and the city of Hill City administers their municipal code in each of their respective jurisdictions within the project area. No sanitary districts are present within the project area [Pennington County, 2009; Christensen, 2013]. In South Dakota, administrative rules for on-site wastewater regulations have not been amended since 1997 [South Dakota Legislature, 2012b].

Because local ordinances in Custer and Pennington Counties and municipal code in the city of Hill City have been adopted and amended during recent years, it is recommended that anyone installing, repairing, or replacing an OWTS contact a certified installer, the planning department at Custer or Pennington Counties, the city of Hill City, or a representative with the SD DENR before commencing.

Specific information regarding rules and regulations, codes, and ordinances adopted by the state of South Dakota, Custer and Pennington Counties, and the city of Hill City are summarized in the *On-Site Wastewater Management Plan* [Krajewski, 2013]. This plan contains information regarding OWTS statutory requirements, administrative rules, current ordinances and codes, system definitions, allowable OWTS types, installer and service provider certification and licensing, site evaluations, and permits. Additionally, information regarding rules and regulations, codes, ordinances, and permits for floodplain development and septage application for the state of South Dakota, Custer and Pennington Counties, and the city of Hill City are included in Krajewski, 2013.

2.5 PROBLEMS, ISSUES, AND CONCERNS

During this assessment and planning effort, many issues, problems, and concerns were brought forward. The following four issues frequently arose regarding OWTS management within the project area and should be considered when evaluating any of these alternatives or recommendations:

1. Managing voluntary and regulatory OWTS approaches
2. Identifying a suitable site for replacing or installing an OWTS
3. Affording the cost of replacing or installing an OWTS
4. Obtaining available information about an existing OWTS.

2.5.1 Managing Voluntary and Regulatory On-Site Wastewater Treatment System Approaches

The Spring Creek Watershed Management and Implementation Project is a voluntary approach that encourages property owners to voluntarily install BMPs that restore beneficial uses on waterbodies within the watershed. Segment 1 of the Spring Creek Watershed Management and Implementation Project began in June 2010, which was also when Pennington County was considering changing their septic ordinance. The Pennington County Planning Commission and Planning Department personnel held public meetings regarding the proposed ordinance changes and received comments, questions, and input from opponents and proponents of the proposed ordinance changes. Because of the increased attention regarding septic systems, an increased amount of property owners expressed interest in the voluntary cost-share opportunities during Segment 1 of the project.

Nineteen property owners voluntarily submitted cost-share applications during the first cost-share application period, and project coordinators visited with several more owners during the summer and fall in 2010. During Segment 1, Pennington County received approximately 55 cost-share applications from property owners within the project area during three sign-up periods. Pennington County approved 16 of the 55 cost-share applications and entered into agreements with the property owners to install OWTS improvements. Of the 16 approved OWTS applications, 7 project agreements have been completed, 3 were withdrawn or cancelled at the request of the property owner, and 6 are in progress pending design or permit approvals.

Since 2010, an estimated 47 property owners have completed repairs, replacements, or improvements on approximately 67 (approximately 7.5 percent) of the estimated 898 addressed structures with OWTS within the project area. Approximately 60 of these projects were completed by property owners on their own, and approximately 7 projects were installed by participants in the Spring Creek Watershed Management and Implementation Project through cost-share agreements with Pennington County.

Almost all of the property owners voiced concerns regarding the proposed ordinance changes, the effects on their property rights, the costs of OWTS improvements, and the need for clean water. Some property owners submitted cost-share applications because they were not certain if their systems would meet the proposed ordinance requirements and wanted to have them inspected and repaired before any changes took effect. Other property owners were in the process of repairing or replacing their systems because the systems had recently malfunctioned and needed improvements. Still, other property owners communicated that the ordinance changes were unnecessary and that they would address OWTS improvements on their own. The regulatory pressure that property owners felt regarding the proposed ordinance changes may have caused many owners to address their OWTS during Segment 1 of the project. However, the voluntary approach of the project, the cost-share opportunities, and technical assistance from project personnel more than likely also contributed to many property owners addressing their OWTS issues during Segment 1 of the project.

2.5.2 Identifying Suitable On-Site Wastewater Treatment System Sites

Proper siting for new or replacement OWTS within the project area has been identified as a key issue because OWTS installation is affected by an area's soil absorption attributes; depth to water or bedrock; and OWTS setback requirements to property boundaries, utilities, waterbodies, and floodplain areas. As described in Section 1.4.5, almost 90 percent of the project area has soil ratings for absorption fields that are categorized as "very limited" (features are unfavorable for OWTS effluent treatment and poor performance and high maintenance). In Section 1.4.9, parcels with addressed structures are described as having an average size of approximately 8 acres, with a median size of approximately 2.6 acres. More than 54 percent of the parcels are 0.1 to 3 acres in size, and almost 70 percent of the parcels are less than 5 acres in size. The majority of these parcels with addressed structures are along Spring Creek or its tributaries, as illustrated in Figure 2-9.

Floodplains in portions of the project area have been mapped by the Federal Emergency Management Agency (FEMA), and floodplain development ordinances have been adopted by the city of Hill City, Custer County, and Pennington County. Construction and development activities, including OWTS installation or replacement, within a floodplain or special flood hazard area must be permitted by the floodplain manager or administrator with the city or counties within the project area. Preliminary OWTS site evaluations conducted by Custer and Pennington Counties, in conjunction with property owners and certified installers, have been essential in determining potential alternatives for installing or replacing OWTS within the project area and should continue in the future.

2.5.3 Affording the Cost of Replacing or Installing an On-Site Wastewater Treatment System

The cost of installing a new OWTS or replacing an existing OWTS is an important consideration for property owners within the project area. Depending on the type and size of system required to be installed, and if the property has a suitable site for a conventional OWTS, a system can cost approximately $7,000 to $10,000. However, if the property does not have a suitable site, then costs can range from $4,000 for a holding tank or up to $25,000 for an alternative or mound system. In comparison to annual median household incomes in Hill City, Custer County, and Pennington County, these OWTS costs can range from approximately 8 percent to over 50 percent of the average median household income of $46,000 (or from approximately 2 percent to over 14 percent of the median of the total residential property value of $170,000). Commercial OWTS installations can typically cost between $25,000 to $75,000, depending on the site conditions, amount and type of wastewater, and complexity of the system design. The OWTS costs for commercial properties can range from approximately 8 percent to over 26 percent of the median of the commercial residential property value of $282,000.

The University of Minnesota's Water Resources Center estimates that the costs associated with a septic system, including the original installation costs, maintenance and repair costs, and replacement costs for an individual OWTS, typically range from $3,000 to greater than $10,000, depending on the size of home, suitable soil conditions, and local ordinances (several documented installations cost between $3,900 and $16,000 per home) [University of Minnesota, 2009]. Annual operation and maintenance, pump, and repair costs occurring over the life of a system lasting 15 to 40 years with a drainfield or mound can range from $30 up to $500 (including replacing pumps in mounds), and annual costs for OWTS that include constructed wetlands or sand and peat filters can range from $50 to $1,700 annually [University of Minnesota, 2009].

The typical total cost for an individual OWTS over a 20-year period is $6,300 to $13,000 for trenches and mounds, and the typical cost is $13,500 to $32,000 for alternative OWTS [University of Minnesota, 2009]. Moreover, estimated costs for multihousehold or clustered systems with a typical trench or mound system range from $18,500 to $25,000 compared to an alternative multihousehold or cluster OWTS, which typically ranges from $18,000 to $44,500 for 20 years of service [University of Minnesota, 2009].

2.5.4 Obtaining Available Information About an Existing On-Site Wastewater Treatment System

From June 2010 through December 2012, project coordinators visited with over 100 property owners regarding their OWTS within the project area. The majority of these visits were with property owners who submitted cost-share applications during Segment 1 of the project. The owners possessed various levels of knowledge regarding their systems. Many of them knew the location, date installed, and the installer. Some owners had installed and/or repaired the systems themselves and had a substantial amount of information about their OWTS. Others knew they had a system but did not know the location or when the system was installed and had typically purchased the property from another owner.

Likewise, variability was found in the type and amount of OWTS permit data for almost 300 systems within the watershed, which were collected and analyzed from building and septic permits from Custer County, Pennington County, and the SD DENR. Most of the data records consisted of at least one or more attributes, including owner, address, geographic coordinates, legal description, year, tank capacity, drainfield size, or maximum daily flow.

2.6 PERMITTED DISCHARGES FOR WASTEWATER

Three active surface water discharge-permitted point sources for sewerage and wastewater are located in the watershed and are listed in Table 2-17 [SD DENR, 2008a; U.S. EPA , 2012]. These discharges are classified as nonmajor or small individual facilities through the National Pollutant Discharge Elimination System (NPDES) and are administered by the SD DENR. In 2007, the city of Hill City completed replacing their three-cell lagoon wastewater system that had been leaking with an advanced, activated sludge WWTF [SD DENR, 2006c; Midwest Assistance Program, 2012]. Hill City's WWTF processes wastewater from a population of approximately 950 residents and a large number of visitors. Also, Hill City monitors their wastewater effluent for fecal coliform bacteria, *E. coli*, ammonia, biological oxygen demand (BOD), nitrate-nitrogen, TP, and TSS [Evans, 2012; U.S. EPA, 2012]. The city of Hill City's WWTF abandoned lagoons have been a concern. In 2009, the EPA contracted URS, Inc. to conduct a Targeted Brownfield Assessment of the wastewater lagoons for Hill City, which drafted a cleanup plan and estimated cleanup costs.

Table 2-17. Sewerage and Wastewater Permitted Discharges in the Watershed

Point-Source Facility	Permit I.D.	Discharge Location	Facility Type	Description
City of Hill City	SDL020885	Spring Creek	Wastewater Treatment	NPDES Individual Permit Sewerage Systems
Horsethief Campground & Resort LLC	SDG828398	Sunday Gulch Creek	Sewerage Treatment	General Permit Covered Sewerage Systems
Recreational Adventures Co.	SDG828533	Palmer Gulch Creek	Sewerage Treatment	General Permit Covered Sewerage Systems

2.7 PAST ON-SITE WASTEWATER TREATMENT SYSTEM PROJECTS

This section provides an estimate of OWTS accomplishments in the project area but certainly is not inclusive of activities carried out on private and public lands. Since 2010, an estimated 47 property owners have completed repairs, replacements, or improvements on approximately 67 addressed structures within the project area. Approximately 60 OWTS projects have been completed by property owners on their own, and approximately 8 OWTS projects were installed by property owners as participants in the Spring Creek Watershed Management and Implementation Project through cost-share agreements with Pennington County. The eight OWTS projects completed through these cost-share agreements were made possible through the technical and financial assistance provided by Pennington County, the South Dakota Nonpoint Source Program, and EPA Section 319. Figure 2-10 depicts the OWTS applications submitted and the approved OWTS projects that are completed or in progress within the project area.

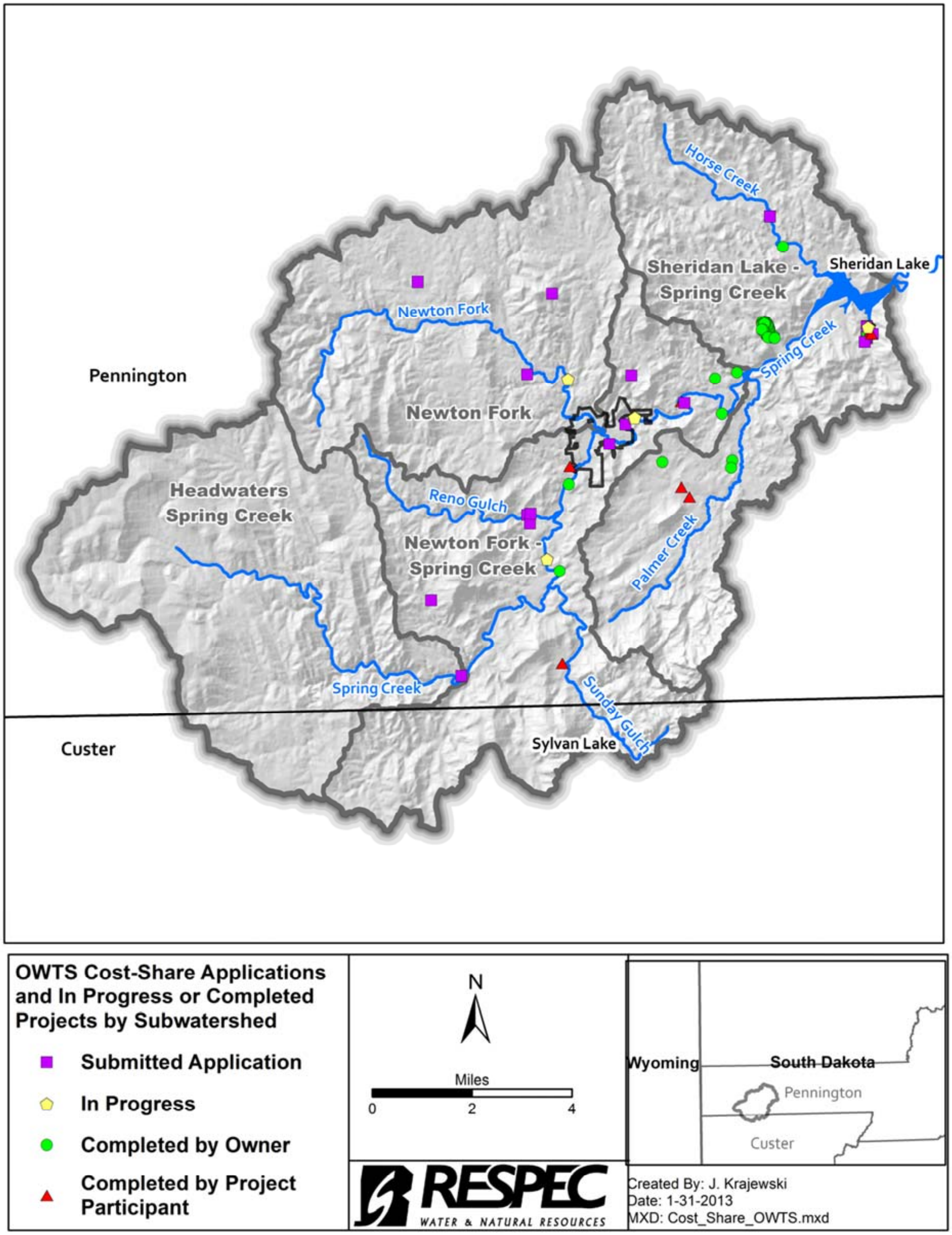


Figure 2-10. Past On-Site Wastewater Treatment System Applications and Projects Within the Spring Creek Watershed.

3.0 STORMWATER ASSESSMENT AND MANAGEMENT

Stormwater is runoff from rainfall, snowmelt, or other surface water runoff and drainage. Generally, stormwater originates from impervious areas in towns; cities; residential developments; and industrial, manufacturing, or agricultural facilities. Stormwater flows accumulate from streets, parking lots, rooftops, catch basins, curbs, gutters, ditches, drainage channels, or storm drains and other impervious surfaces. The majority of the project area is forest and agricultural lands; however, a very small portion of the project area is classified as impervious surface, and stormwater plays a role in the runoff of fecal coliform and *E. coli* bacteria because of the proximity of these impervious areas to the impaired waterbodies.

In the *Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Spring Creek, Pennington County, South Dakota* [SD DENR 2008a], an estimated 2 percent of the watershed was characterized as impervious areas, and approximately 13.7 percent of the fecal coliform bacteria load originates from urban runoff. Load reductions could be partly achieved with the detention, retention, and infiltration of stormwater runoff, and a stormwater management plan (SWMP) was suggested to be developed and implemented for the watershed with emphasis on the Hill City and Palmer Creek areas [SD DENR, 2008a]. Residential, commercial, and urban areas in the watershed that continue to increase with many catchments draining through Hill City do not lie entirely within the city's incorporated limits. Because most of the catchments begin or lie outside of Hill City, coordinating with other property owners and local, state, and federal agencies is vital to address stormwater management issues. Pennington County has developed and adopted an SWMP, which outlines stormwater management measures outside of the incorporated limits of the city of Hill City.

Detailed information and data regarding stormwater assessment within the project area are described in the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013]. The SDSM&T assessed stormwater runoff and treatment for impervious areas in and surrounding the city of Hill City and the SDDOT-controlled highway areas. Rausch et al. [2012] used the EPA's SWMM software to simulate rainfall-runoff events to help identify current capacities and prioritize future stormwater runoff BMPs.

A summary of the stormwater assessment and alternatives for managing stormwater were included in this plan. This section includes information about the stormwater dynamics; existing drainage elements; field visits; and drainage capability of catchments, subcatchments, and drainage infrastructure elements, as well as potential and recommended alternatives for stormwater management. This information was used to develop recommended alternatives and priorities for stormwater management on 16 catchments within the project area.

3.1 CATCHMENTS AND SUBCATCHMENTS

To understand stormwater runoff dynamics, existing drainage elements were identified, studied, and modeled. To identify the important stormwater catchments to focus management efforts on, all urban drainages in and around Hill City were investigated in the field. Catchments connected to the main storm sewer system, as well as any others with high pollutant load contribution potential or poor drainage capabilities, were chosen. Most catchments were divided into smaller areas (called subcatchments) for detailed modeling. The modeled subcatchments are listed in Table 3-1 and illustrated in Figure 3-1.

Table 3-1. Modeled Stormwater Catchments Within the Spring Creek Watershed

Catchment	Area (ac)
Allen Gulch	217.1
Best Western	2.2
Bette Matkins	4.2
Bishop Mountain Drive	40.3
Deerfield Road	57.2
East Chute Rooster Drive	3.8
East Forest Street	47.6
Forest Street	27.3
Kamper Kars	20.4
Krulls Market	1.6
Major Lake	27.7
Mickelson Parking	2.8
Mine Shaft	2.7
North Chute Rooster	4.6
Pine Mtn Avenue	17.3
Rainbow Ridge	3.1
South Main Street	16.3
South Pine Mountain Avenue	0.9
South Truck Route	12.9
Top O Hill	5.8
West Bishop Mountain	189.4
Total	**705.2**

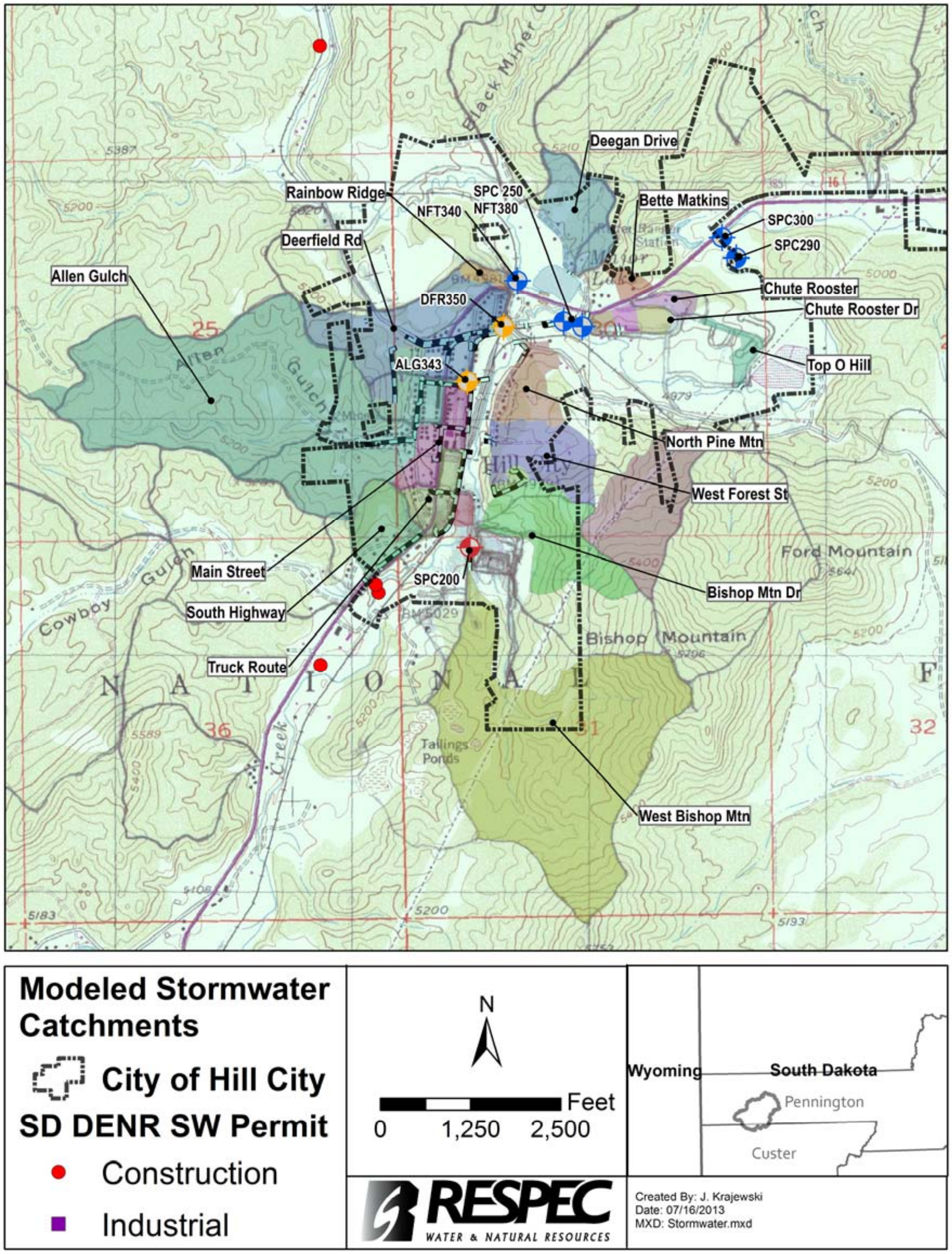


Figure 3-1. Stormwater Catchments and Storm Sewers in and Around the City of Hill City, South Dakota, Within the Spring Creek Watershed.

The boundary of each subcatchment represents the area draining to a single, specified point. The layout and connectivity of the storm sewer system were studied, delineated, and determined by using plans for constructing the highway route through Hill City [SDDOT, 1994] as well as the plans for Phases I, II, and III of the city of Hill City's improvement projects. The source of the 1:24,000 contours was the 7.5-minute "Hill City" quadrangle obtained from the USGS. Permission from property owners was obtained and multiple field visits were conducted to ensure accurate boundary interpretation. Boundaries and field information were also reviewed with the city of Hill City staff.

Each catchment was assigned a name and a three-letter abbreviation. For example, the area at the southern end of Hill City that drains under the highway was named the South Highway Catchment (SHW) The subcatchments were named using the three-letter abbreviation of the catchment plus three numbers. Subcatchment numbers are all in the 100s and generally increase in value from upstream to downstream. For example, the uppermost subcatchment in the SHW Catchment is named SHW110.

All drainage links within the catchment, including pipes, ditches, and open channels, are named with the three-letter catchment abbreviation followed by three numbers. Drainage link numbers are all in the 300s and increase in value from upstream to downstream. The uppermost drainage link in the SHW Catchment is SHW310. Some catchments include storage units; these were named with the catchment abbreviation followed by three numbers, and all are in the 500s. The SHW Catchment has a storage unit named SHW530. All catchment outlets were named with the three-letter catchment abbreviation followed by "out."

3.1.1 Stormwater Model Setup

An important part of the SWMP development was determining the current storm sewer capacity and the ability to convey runoff from 2-year, 10-year, and 100-year storms. To make these determinations, all drainages of interest were modeled using SWMM, which is a dynamic rainfall-runoff simulation model used for a single event or the long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component of SWMM operates on a collection of subcatchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion of SWMM transports this runoff through a system of pipes, channels, storage and treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff generated in each subcatchment and the flow rate, flow depth, and water quality in each pipe and channel during a simulation that comprises multiple time steps [Rossman, 2008]. The subcatchments and the general storm sewer system layout were digitized by using ArcGIS 10 software. ArcGIS was then used to determine the attributes of each subcatchment, including area, average slope, average impervious area, and area-weighted average soil parameters. These characteristics were quantified and applied to each respective subcatchment in SWMM.

Table 3-2 lists the methods used to simulate the different hydrologic and hydraulic processes. The Green and Ampt method was chosen for infiltration because it is widely used and represents infiltration processes based on physical soil parameters. For overland flow, the Manning equation is used in combination with mass conservation and simulates overland sheet flow, as determined by the physical properties of each subcatchment. The Kinematic Wave method was chosen to simulate hydraulic routing because the surcharge of storm sewer inlets onto streets was modeled by using "divider" nodes, and this process requires using kinematic wave. Darcy-Weisbach was used as the force-main equation for pressurized flow, because it is based on the physical parameters and processes for pressure pipe flow.

Table 3-2. Methods Chosen for Different Processes in SWMM

Process	Method
Infiltration	Green and Ampt
Overland Flow	Manning
Hydraulic Routing	Kinematic Wave
Force Main	Darcy-Weisbach

As specified in the *1989 Rapid City Drainage Criteria Manual*, SWMM was set up to run 2-hour design rainstorms [City of Rapid City et al., 1989] that include 2-year, 10-year, and 100-year events. Each rainstorm was designed as per Section 2.3 of the *1989 Rapid City Drainage Criteria Manual*. This method requires determining the 1-hour depth for each frequency from the National Oceanic and Atmospheric Administration TP40 Rainfall Frequency Atlas [Hershfield, 1961] and applying that value to the 2-hour distribution outlined in the *1989 Rapid City Drainage Criteria Manual*. Figure 3-2 shows the incremental depths of these storms.

3.1.2 Stormwater Model Design

Multiple SWMM models were produced to cover all catchments of interest. Subcatchments (smaller divisions of a catchment) that drain to the same sections of storm sewer and nearby individual subcatchments were grouped into the same model. The models were designed so that all subcatchments with effective storm sewer inlets use storm sewer pipe for a main drainage link. Subcatchments without storm sewer inlets generally drain directly to streets, open channels, or roadside ditches. Many of the existing open channels and ditches in the study area are routed through culverts.

For practicality, not all culverts were represented in the model (e.g., small culverts existing on a main drainage were not simulated because the flow is assumed to pass through them and the drainage was modeled as a continuous element). The exclusion of culverts resulted in misrepresenting some open channel and ditch capacities, so the capacities of only closed conduits were addressed. Storm sewer links in the SWMM models were designed to surcharge to streets when the capacity was exceeded; this process was simulated by using diversion nodes. In areas where surcharged runoff had no alternate flow path (e.g., the point of surcharge is locally low in elevation), storage unit nodes were used to simulate and contain stormwater backup.

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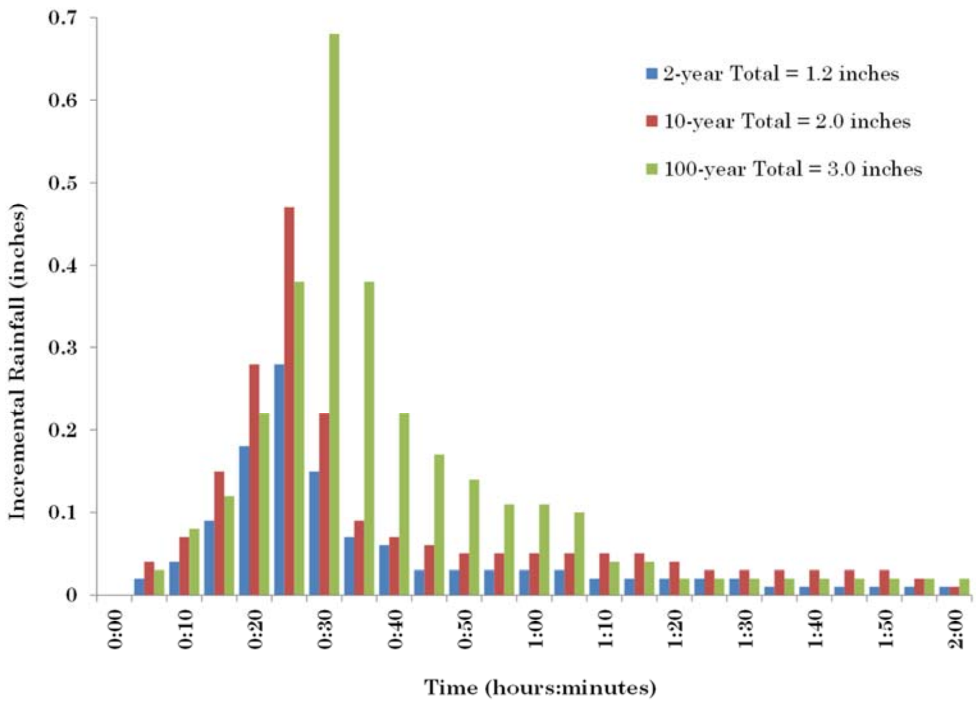

Figure 3-2. Incremental Rainfall Depths of the 2-Year, 10-Year, and 100-Year 2-Hour Design Storms.

3.1.3 Stormwater Model Analyses

All three design storms were simulated over the catchments. The runoff volume from each subcatchment was reported per design storm as well as the runoff volume from the entire catchment. Simulated hydrographs for each pipe drainage link and drainage link capacity and capacity exceedance were studied to identify peak flow for the 2-year and 10-year storms. Capacity was identified by constant, consecutive flow values or a flat line across the hydrograph peak. During a 2-year or 10-year storm, this situation indicated capacity exceedance. For links that did not reach hydraulic capacity during the 100-year storm, the capacity was determined by a nominal modification of the 100-year storm hyetograph to increase runoff.

If drainage link capacity was exceeded during the 2-year or 10-year storm, the required capacity was determined by increasing the pipe size by standard increments until free flow was established. If consecutive drainage links exceeded capacity for the same storm, the downstream link pipe size was increased before increasing the upstream link pipe size, as needed. This procedure ensured that the controlling drainage link was correctly evaluated. Drainage link simulation results are presented in terms of existing capacity, maintained capacity, and required capacities for the 2-year and 10-year storms. The existing capacity represents a drainage link's conveyance ability under current conditions, whether it is partially clogged or free-flowing. Maintained capacity represents a drainage link's conveyance ability without deposited sediment and debris. Required capacity represents the peak flow that a pipe must convey without surcharging during either the 2-year or the 10-year storm. Table 3-3 includes a summary of the catchment attributes, modeling results, and structure capacities.

3.2 STORMWATER ROLES AND RESPONSIBILITIES

The USFS, the state of South Dakota, Pennington County, Custer County, the city of Hill City, private property owners, residential and commercial developments, and road districts are responsible for managing stormwater within the project area. Ninety percent of the watershed is located in Pennington County and the remaining 10 percent is in Custer County. Implementing and maintaining stormwater control measures are ultimately the responsibility of the property owner [Pennington County, 2011].

The U.S. EPA issued rules and initiated a municipal stormwater program in 1990 under the authority of the Clean Water Act (CWA) and relies on the NPDES permit coverage to address stormwater runoff from medium and large municipal separate storm sewer systems (MS4s) that serve populations of 100,000 or greater [Pennington County, 2011; 2012]. The EPA's Stormwater Phase II Final Rule was promulgated in 1999 and requires operators of MS4s in urbanized areas to implement programs and practices to control polluted stormwater runoff through the NPDES program. The SD DENR has primacy for the NPDES program and is tasked with its implementation, which requires MS4 operators to develop a stormwater management program [Pennington County, 2014]. No MS4s are in the watershed; however, MS4s are located in Pennington County.

In 2002, Pennington County submitted a Notice of Intent (NOI) required by the Phase II Stormwater Regulations and was issued a general permit from the SD DENR [Pennington County, 2014]. The county manages their stormwater program through their highway and planning departments, including street maintenance and construction, storm drainage facility management, construction permit issuance, site inspections and complaints, public outreach and education, and Adopt-a-Highway activities. Currently, Pennington County has four urbanized areas (UAs) with MS4s, including Rapid Valley/Green Valley, Colonial Hills, Colonial Pine Hills, and Universal Drive [Pennington County, 2014].

Table 3-3. Summary of Stormwater Catchment Attributes, Modeling Results, and Structure Capacities (Page 1 of 3)

Catchment Attributes					Runoff Volume (ac-ft)			Conveyance Link Attributes				Structure Capacities		
Catchment	Subcatchment	Area (ac)	Impervious Area (%)	Average Slope (%)	2- Year	10-Year	100-Year	Link Name	Link Type	Material	Size (in)	Existing Capacity (cfs)	2-Year Required Capacity (cfs)	10-Year Required Capacity (cfs)
South Highway (SHW)	SHW110	0.3	80	10	0.03	0.04	0.07	SHW310	storm sewer	RCP	18	13.8	0.9	1.5
	SHW120	9.4	35	14.5	0.32	0.54	0.98	SHW320	storm sewer	RCP	24	9.3	10	17.4
	SHW130	10.7	25	14.1	0.26	0.44	0.9	SHW330	storm sewer	RCP	30	18.2	18.6	31.6
West Bishop Mountain (WBM)	WBM110	234.8	1	21.8	0.23	0.3	7.11	WBM310	natural channel	grass	N/A			
	WBM120	5.2	50	7.6	0.26	0.47	0.9	WBM320	ditch	gravel	N/A			
	WBM130	15	3	16	0.04	0.25	1.29	WBM330	storm sewer	RCP	24	22.2	10.8	21.1
Bishop Mountain Drive (BMD)	BMD110	18.8	2	26.2	0.04	0.09	0.98	BMD310	ditch	gravel	N/A			
	BMD120	4.4	50	6.8	0.22	0.42	0.79							
Tracy Park (TRP)	TRP110	21.5	5	22.4	0.11	0.3	1.61	TRP310	natural channel	grass	N/A			
Truck Route (TRT)	TRT110	3.7	55	6.9	0.2	0.39	0.7	TRT310	storm sewer	RCP	18	22.6	7	14.2
	TRT115	5	32	18.5	0.16	0.27	0.6	TRT315	storm sewer	RCP	18	22.2	5.4	9.1
	TRT120	4.2	58	4.5	0.02	0.45	0.8	TRT320	storm sewer	RCP	24	30.9	20.2	38.3
								TRT325	storm sewer	RCP	24	25.7	19	35.7
Main Street (MST)	MST110	9	39	10.3	0.34	0.59	1.24	MST310	storm sewer	RCP	36	63.7	11.8	20.3
	MST120	2.5	61	2.3	0.16	0.31	0.52	MST315	storm sewer	RCP	36	122.7	11.1	19
	MST130	4.8	62	2	0.3	0.59	1	MST320	storm sewer	RCP arch	42	80.5	16	34.9
								MST330	storm sewer	RCP arch	42	83.5	25.3	51.5
								MST335	storm sewer	RCP arch	48	80.8	23.9	46.8
Allen Gulch (ALG)	ALG110	187	1	16.6				ALG310	natural channel	grass	N/A			
	ALG120	14	10	22.9				ALG320	storm sewer	RCP	18	21.2	7.5	14.8
	ALG130	11	24	18				ALG330	storm sewer	RCP	24	35.1	14.7	27.7
	ALG140	5.1	57	2.6				ALG340	storm sewer	RCP	30	49.5	23.3	44
								ALG343	storm sewer	RCP	36	99.5	22.4	42.1
								ALG346	storm sewer	conc arch	48	127.2	21.5	40.6
Deerfield Road (DFR)	DFR110	10.6	2	18	0.02	0.04	0.15	DFR310	natural channel	grass	N/A			
	DFR115	8	8	24.9	0.06	0.15	0.7	DFR312	culvert	CMP	18	7.2	0.7	1.1
	DFR120	11.1	17	12.8	0.18	0.36	1.06	DFR314	ditch	soil	N/A			
	DFR121	11.2	10	14.7	0.11	0.19	0.61	DFR315	storm sewer	RCP	18	16.6	2.2	5.1

Table 3-3. Summary of Stormwater Catchment Attributes, Modeling Results, and Structure Capacities (Page 2 of 3)

Catchment Attributes					Runoff Volume (ac-ft)			Conveyance Link Attributes				Structure Capacities		
Catchment	Subcatchment	Area (ac)	Impervious Area (%)	Average Slope (%)	2- Year	10-Year	100-Year	Link Name	Link Type	Material	Size (in)	Existing Capacity (cfs)	2-Year Required Capacity (cfs)	10-Year Required Capacity (cfs)
Deerfield Road (DFR) (cont.)	DFR123	3.9	59	2.8	0.23	0.45	0.77	DFR318	open channel	grass	N/A	68.9	8.2	14.9
	DFR130	2.1	42	4.8	0.08	0.15	0.3	DFR320	storm sewer	RCP *2	18			
	DFR140	0.6	100	1.2	0.06	0.1	0.15	DFR322	storm sewer	RCP	36	110.4	10.8	19.2
	DFR143	4.6	50	2.9	0.23	0.49	0.87	DFR323	storm sewer	RCP *2	18	19.3	7.6	14.4
	DFR146	5.1	30	7.8	0.15(a)	0.30(a)	0.71(a)	DFR326	storm sewer	RCP	24	28.3	7.2	11.5
								DFR330	storm sewer	RCP	18			
								DFR340	storm sewer	RCP	36	74.6	21.9	37.9
								DFR344	storm sewer	RCP	18	9.1	6.1	11.6
								DFR350	storm sewer	RCP	36	80.8	26.2	44.1
Rainbow Ridge Court (RRC)	RRC110	3.1	50	24.4	0.15	0.25	0.45							
West Forest Street (WFS)	WFS110	24.1	5	17.1	0.12	0.18	1.04	WFS310	ditch	grass	N/A	55.6	3.3	5.4
	WFS120	2.7	18	17.1	0.05	0.1	0.29	WFS315	culvert	CMP	24	36.1	1.6	2.9
	WFS125	1.2	43	20.2	0.06	0.09	0.15	WFS325	culvert	RCP	18	30.5	4.5	7.7
								WFS330	culvert	CMP	24	3.3	1.6	2.6
								WFS340	culvert	CMP	24			
North Pine Mountain (NPM)	NPM110	4.8	30	18.6	0.15	0.25	0.52	NPM320	storm sewer	RCP	18	33.9	12.2	20.6
	NPM120	7.9	30	11.2	0.25	0.4	0.74	NPM330	storm sewer	RCP	24	66.1	17.5	29.4
	NPM130	6	27	17.8	0.15	0.28	0.58	NPM340	storm sewer	RCP	30	33.2	17.4	29.2
Deegan Drive (DED)	DED110	27.7	20	14.3	0.54	0.91	1.82	DED310	ditch	gravel	N/A			
								DED320	culvert	CMP	18	4.7	14.8	25.2
Bette Matkins Avenue (BMA)	BMA110	4.2	30	7.2	0.12	0.21	0.43	BMA110					3.8	6.4
Best Western (BEW)	BEW110	2.2	73	7.7	0.17	0.31	0.5	BEW310	gutter	concrete	N/A			
	BEW120	0.2	95	5	0.02	0.03	0.05	BEW320	storm sewer	RCP	12	7.4	5.3	10.5
	BEW123	0.4	80	5	0.03	0.05	0.08	BEW330	ditch	soil	N/A			
	BEW127	0.1	95	5	0.01	0.01	0.02	BEW333	road shoulder	asphalt	N/A			
								BEW337	road shoulder	asphalt	N/A			
								BEW340	culvert	CMP	18	3.5	5.9	11.4

Table 3-3. Summary of Stormwater Catchment Attributes, Modeling Results, and Structure Capacities (Page 3 of 3)

Catchment Attributes					Runoff Volume (ac-ft)			Conveyance Link Attributes				Structure Capacities		
Catchment	Subcatchment	Area (acres)	Impervious Area (%)	Average Slope (%)	2- Year	10-Year	100-Year	Link Name	Link Type	Material	Size (in)	Existing Capacity (cfs)	2-Year Required Capacity (cfs)	10-Year Required Capacity (cfs)
Chute Rooster (CHR)	CHR110	2.9	22	4	0.06	0.11	0.16							
	CHR120	1.1	54	6.1	0.06	0.1	0.18							
Chute Rooster Drive (CRD)	CRD110	2.7	25	4.6	0.07	0.12	0.33							
	CRD120	3.8	45	6.8	0.17	0.34	0.66							
Top O Hill (TOH)	TOH110	5.8	25	8	0.16	0.37	0.6	TOH310	ditch	gravel	N/A			
								TOH320	culvert	CMP	24	14.2	3.5	7.4

Pennington County developed the *Pennington County Storm Water Quality Manual* in 2011 to address the needs of the county and provide criteria and guidance for erosion and sediment control [Pennington County, 2011]. The manual was based on the city of Rapid City's *Stormwater Quality Manual* because the county's MS4 is located within Rapid City's 3-mile platting and the 1-mile OWTS jurisdiction. The county wanted the stormwater and erosion control requirements, guidelines, and criteria to be consistent [Pennington County, 2011]. Currently, Pennington County informs residents, property owners, businesses, and contractors regarding stormwater issues through mailings, permits, trainings, Adopt-a-Highway programs, and one-on-one contact with highway and planning department personnel. No designated UAs or MS4s are located in Custer County; however, compliance is required with all ordinances and regulations regarding health, plumbing, electrical, building, stormwater discharge, fire prevention, and all other applicable ordinances and regulations [Custer County Planning Department, 2007].

The SDDOT adopted their SWMP in 2003, and it covers right-of-ways and roads, rest areas, weigh stations, and other properties located in the designated UAs within the state of South Dakota. The SDDOT's MS4s at state and interstate highways and right-of-ways (which include streets, roads, bridges, maintenance facilities, service areas, and rest areas) must have MS4 permit coverage areas within the cities of Aberdeen, Watertown, Brookings, Huron, Mitchell, Pierre, Yankton, Vermillion, Rapid City, North Sioux City, Sturgis, and Spearfish, as well as within Pennington County [SDDOT, 2003]. South Dakota has an existing operative policy agreement with the South Dakota Municipal League that grants responsibility for maintaining the state highway system within city boundaries to cities with populations of 2,500 and above, unless there is a written agreement stating otherwise [SD DDOT, 2003].

The SDDOT typically serves in a secondary role in these MS4 areas because many of the Phase II requirements are maintenance measures and interpreted to be the responsibilities of the individual cities [SDDOT, 2003]. Furthermore, the SDDOT can work with individual cities to create written agreements on stormwater maintenance activities to address measures such as public education and outreach, public participation and involvement, illicit discharge detection and elimination, and pollution prevention/good housekeeping.

3.2.1 Stormwater Quantity

Stormwater regulation can be grouped into quantity and quality, and their general aspects are discussed below. This SWMP identifies a number of recommended alternatives for managing stormwater quantity and quality. Stormwater management and regulations consist of temporary pollution prevention during construction and permanent stormwater system operation and maintenance.

The first component of stormwater quantity regulation concerns specifying the duration, magnitude, and frequency of rainfall that is used to estimate the stormwater runoff, peak flow, and volume to be controlled by stormwater systems. Describing storm sewer systems in terms of minor and major facilities is common. Minor facilities (e.g., storm sewers, street curbs, and gutters) are designed to convey storms that occur frequently (2-year to 10-year return period storm runoff events). Minor stormwater systems are designed to alleviate nuisance flooding from these storms, and major systems are designed to convey significant flooding (typically the 100-year return period runoff event). These systems incorporate full street flow, major drainage channels, and detention pond facilities.

The second component of stormwater quantity regulation concerns predevelopment and postdevelopment runoffs, peak flows, and volume controls. As development occurs, the amount of impervious area increases, which causes the stormwater runoff magnitude and volume to increase. In general, regulations require new development to either maintain predevelopment runoff conditions (peak and sometimes peak and volume) or ensure that downstream drainage facilities are sized to convey the increase in peak flows and runoff volumes. If downstream facility capacities are exceeded, detention facilities are designed on site or regionally, as needed.

3.2.2 Stormwater Quality

The first component of stormwater quality regulation addresses the control of stormwater runoff from construction sites and includes BMPs for postconstruction stormwater quality control. The SD DENR requires general permits for stormwater discharge from construction that disturbs 1 or more acres of total land area. The SD DENR's general permits require developing stormwater pollution prevention plans (SWPPPs) that identify the BMPs to be implemented to prevent erosion and pollution discharge from the construction site. The SD DENR requirements are identified in ordinances for Rapid City, Sturgis, Spearfish, and Pennington County.

The second component of stormwater quality regulation addresses stormwater runoff quality after construction is completed and the final site stabilization is achieved. As part of the overall stormwater control system, BMPs are sized to capture and treat the water quality capture volume (WQCV). The WQCV depends on various factors, including the rainfall characteristics of the region, the impervious area of the catchment drainage area, and the type of BMP being sized. Several references provide methods to estimate the WQCV. One specific criterion necessary for sizing and implementing WQCV BMPs is the volume of runoff to be treated.

This criterion also varies based on rainfall characteristics of the region, types of pollutants, and the level of treatment to be achieved. For example, Pennington County's design goal for BMPs is to remove 80 percent of TSS from the first 0.5 inch of rainfall at a designated site [Pennington County, 2014]. This basically reflects the runoff from impervious areas where pollutants build up and are washed off during frequent storm events. Thus, stormwater quality control typically includes small, frequent rainfall events, and stormwater quantity control addresses large, less frequent rainfall events.

3.2.3 Construction and Industrial Stormwater Permits

The SD DENR issues stormwater permits under the provisions of the South Dakota Water Pollution Control Act and the Administrative Rules of South Dakota (ARSD) Chapters 74:52:01 through 74:52:11 [SD DENR, 2013a]. The SD DENR's stormwater permits require operators of stormwater discharges from construction and industrial activities to obtain coverage under the general permit by submitting a Notice of Intent (NOI) that prevents stormwater from becoming polluted before leaving the site and implements an SWPPP before construction begins [SD DENR, 2013a].

Any construction activity that disturbs 1 or more acres must have coverage under the SD DENR's stormwater permit. Additionally, Pennington County requires a construction permit for construction activity on sites that disturb 10,000 square feet or larger, and it does not replace the requirement for the operator to obtain any required permits from the SD DENR [Pennington County, 2011]. Since 1993, the SD DENR has issued three industrial permits and nine construction permits within the project area, and over half of the permits were issued after 2010 [SD DENR, 2013b]. Stormwater permits issued in the project area are listed in Table 3-4.

Table 3-4. South Dakota Department of Environment and Natural Resources-Issued Stormwater Permits Within the Spring Creek Watershed

Permit I.D.	Type	Project Name	County	Receiving Water	Issue Date
SDR00A220	Industrial	Pacer Corporation	Custer	Tenderfoot Creek	03/30/1993
SDR00A273	Industrial	Rushmore Forest Products, Inc.	Pennington	Spring Creek	06/16/1993
SDR00A618	Industrial	Pacer Corporation	Pennington	Spring Creek	07/25/2003
SDR10D504	Construction	Armstrong McKinley Company	Pennington	Spring Creek	11/30/2007
SDR10E337	Construction	Valiant Vineyards, Inc.	Pennington	Spring Creek	06/08/2009
SDR10E626	Construction	Trailside Park Resort	Pennington	Spring Creek	02/08/2010
SDR10F115	Construction	Federal Highway Administration	Pennington	Newton Fork Creek	12/17/2010
SDR10F281	Construction	Harney Mountain LLC	Pennington	Unnamed tributary	05/31/2011
SDR10F384	Construction	Pennington County Highway Department	Pennington	Spring Creek	08/17/2011
SDR10F568	Construction	Trailside Park Resort	Pennington	Spring Creek	02/09/2012
SDR10F679	Construction	Palmer Gulch Road District	Pennington	Palmer Creek	04/23/2012
SDR10F907	Construction	RMS Lode, LLS	Pennington	Ruby Gulch, Spring Creek	10/15/2012

4.0 IMPLEMENTATION STRATEGY

Information and data regarding the water quality, wildlife, on-site wastewater, stormwater, recreation, grazing, hydrology, geology, soil, population, tourism, timber production, and past accomplishments were presented in the previous sections of this Watershed Management Plan to describe current watershed conditions. This provided the basis in determining suggested priorities, recommended alternatives, and proposed implementation practices included in this chapter. This plan is one of three planning tasks for the *Spring Creek Watershed Management and Project Implementation Plan–Segment 1* [Oswald, 2009]. The other two tasks included a *Stormwater Management Plan* [Rausch and Krajewski, 2013], and an *On-Site Wastewater Management Plan* [Krajewski, 2013]. These planning documents were completed to assist residents, landowners, and decision makers in determining actions needed to attain water quality standards on waterbodies within the Spring Creek Watershed. The purpose of this implementation strategy is to identify priority areas and recommend alternatives that could reduce fecal coliform bacteria and *E. coli* loads into Spring Creek and its tributaries to achieve goals outlined in Section 1.3.2 and reductions described in Section 1.6.1.

This strategy incorporates the goals and objectives of the South Dakota Nonpoint Source Program Management Plan and addresses the U.S. EPA's Nine Elements of Watershed-Based Plans. This strategy is not intended to identify which specific BMPs, conservation practices, or remediation actions should be included in discharge permits, ordinances, storm water pollution prevention plans, project designs, or resource conservation plans, but rather, provides an adaptive approach with suggested structural and nonstructural implementation alternatives which could reduce sources of fecal coliform bacteria and *E. coli* within the project area. Sources of available funding and technical assistance in addition to associated cost estimates for some of these alternatives are included in this section.

4.1 PRIORITY AREAS

Priority areas for implementation within the project area were identified for the following sources: (1) OWTS management; (2) stormwater management; and (3) livestock, wildlife, and domestic animal management. Priority areas are those that are major sources or significantly contribute to exceedances of fecal coliform bacteria and *E. coli* water quality standards on Spring Creek. Implementing the alternatives included in this plan would potentially reduce fecal coliform bacteria and *E. coli* and should improve the water quality throughout the Spring Creek Watershed. Each of these priority areas are described in the following sections.

4.1.1 Priority Areas for On-Site Wastewater Treatment Management

The priority areas for managing OWTS were developed by subwatershed, and ranking criteria for each subwatershed included the following items:

1. Number and percent total of OWTS
2. Number of people served by OWTS
3. Number of OWTS installed by year
4. Percent of fecal coliform bacteria production estimated during the recreation season
5. Number of monitoring sites with fecal coliform water quality criteria exceedances
6. Number of monitoring sites with *E. coli* water quality exceedances.

The OWTS priority areas by subwatershed are listed in order of priority ranking: (1) Sheridan Lake–Spring Creek, (2) Newton Fork–Spring Creek, (3) Newton Fork, and (4) Headwaters Spring Creek. The Sheridan Lake–Spring Creek and Newton Fork–Spring Creek subwatersheds accounted for approximately 80 percent of the estimated fecal coliform production from addressed structures in the project area during the recreation season. These priority areas are illustrated with the inventoried OWTS locations in Table 4-1 and Figure 4-1.

4.1.2 Priority Areas for Stormwater Management

Stormwater catchments and management alternatives were assessed and modeled in the *Spring Creek Stormwater Management Plan* [Rausch and Krajewski, 2013]. The priority areas for managing stormwater were developed by catchments, and ranking criteria for each management alternative included the following items:

- Number of acres treated
- Initial costs and life-cycle costs of alternatives
- Fecal coliform bacteria removed per season
- Life-cycle cost per fecal coliform bacteria removed.

The priority areas by catchment are listed in order of priority in Table 4-2, and priority areas are illustrated in Figure 4-2. All catchments and their respective BMP alternatives are described in detail in Rausch and Krajewski [2013]. Optimizing these alternatives eventually depends on combining financial, technical, and administrative feasibilities. Table 4-2 indicates that the initial cost to optimally treat all catchments would be $574,000, and that these alternatives would remove an estimated $101{,}000 \times 10^6$ cfu of fecal coliform bacteria per recreation season.

Table 4-1. On-Site Wastewater Treatment System Priority Area Ranking Criteria by Subwatershed Within the Spring Creek Watershed

Subwatershed	OWTS	OWTS (%)	Persons on OWTS	OWTS by Year			OWTS Installed Before 1976 Within 300 Feet of a Perennial Stream (number)	Recreation Season Fecal Coliform Production (%)	Water Quality Sites With Fecal Coliform Exceedances (number)	Water Quality Sites Sites with *E. coli* Exceedances (number)	OWTS Priority Area Ranking
				Before 1976	1976–1991	1992–2012					
Newton Fork–Spring Creek	365	39.8	803	139	71	155	85	41.4	3	6	**1**
Sheridan Lake–Spring Creek	343	37.4	755	141	61	141	83	39.1	3	3	**2**
Newton Fork	166	18.1	365	43	33	90	21	14.9	0	0	**3**
Headwaters Spring Creek	42	4.6	92	13	8	21	10	4.6	0	0	**4**
Project Area	**916**	**100**	**2,015**	**336**	**173**	**407**	**199**	**100.0**	**6**	**9**	

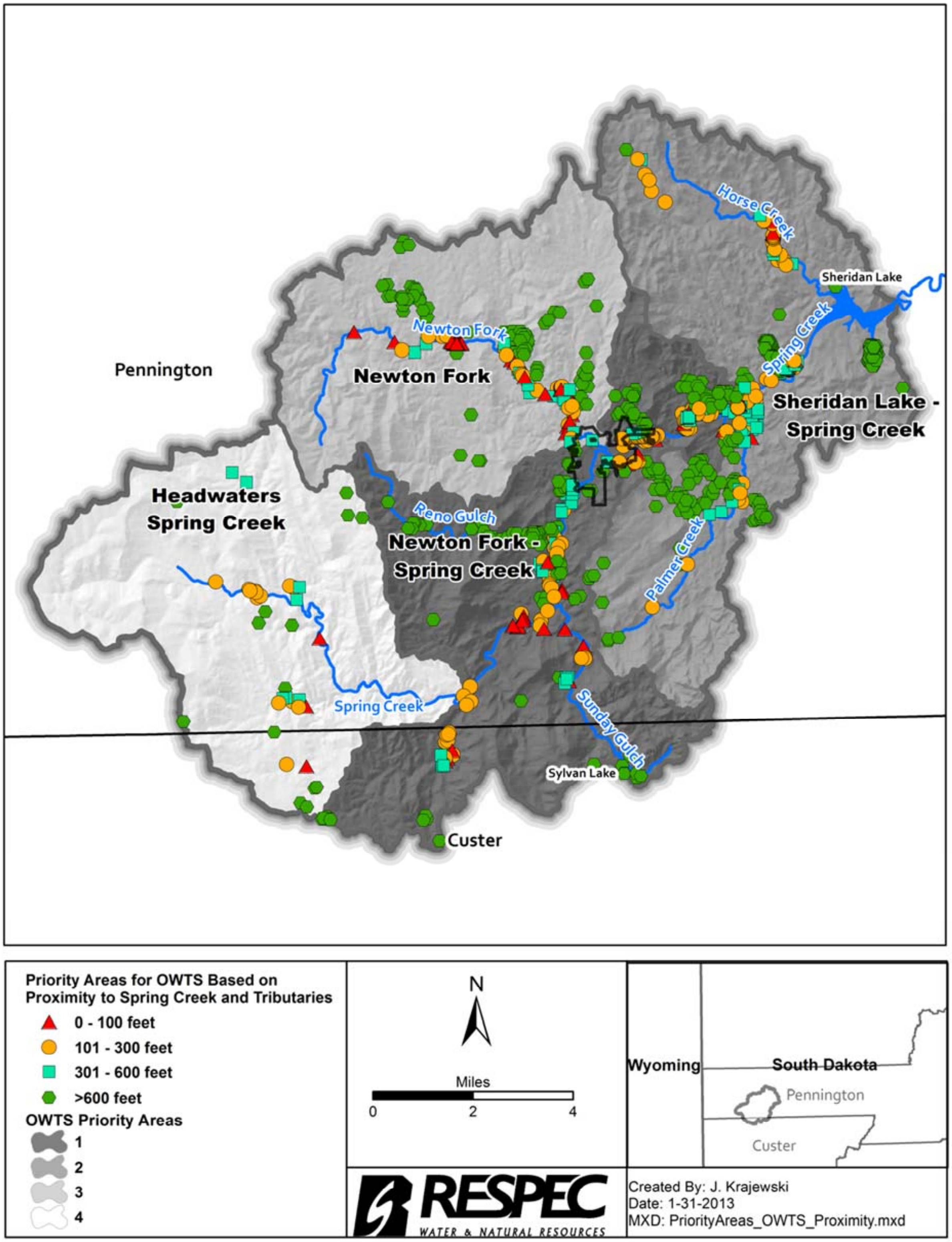

Figure 4-1. On-Site Wastewater Treatment System Priority Areas Based on Proximity to Spring Creek and Tributary Streams.

Table 4-2. Priority Ranking of Stormwater Catchments and Best Management Practice Alternatives

Priority Ranking	Stormwater Catchment	BMP Alternative	Area Treated (ac)	Initial Cost ($)	20-Year Cost ($)	Fecal Coliform Removed per Season (10^6 cfu)	20-Year Cost per Fecal Coliform Removed ($)	Advantages	Disadvantages
High	West Bishop Mountain	WBM2b	250.0	69,800	98,300	31,100	3.16	High reduction, large area, aids routing	High initial cost
High	Deerfield Road	DFR4a	20.0	8,100	12,900	2,100	6.01	Large area, low cost, visibility	Low reduction, recent work done at location
High	Bishop Mountain Drive	BMD1a	41.0	69,500	89,900	12,300	7.29	High reduction, large area, aids routing	High initial cost
High	Deerfield Road	DFR2a	44.0	157,900	197,300	20,600	9.58	High reduction, large area, visibility	High initial cost
Medium	West Bishop Mountain	WBM3a	230.0	9,200	12,600	5,500	2.28	Moderate reduction, large area, low cost	WBM2b construction makes it less important
Medium	Top O Hill	TOH1b	4.8	17,700	25,900	5,000	5.18	Moderate reduction, lower cost	Unknown feasibility
Medium	Chute Rooster Drive	CRD2a	4.1	25,800	37,500	4,100	9.14	Moderate reduction	Small area, increased maintenance interval
Medium	South Highway Catchment	SHW1c	14.0	44,200	65,300	5,800	11.27	Moderate reduction, large area, visibility	High initial cost, land value
Medium	Truck Route	TRT1b	6.8	38,900	41,600	2,800	14.95	Medium area, aids routing	Low medium reduction
Medium	North Pine Mountain	NPM2a	8.9	33,200	36,500	2,200	16.77	Medium area, high visibility	Low reduction, high cost
Low	West Forest Street	WFS1a	23.0	2,200	3,400	910	3.72	Large area, low cost	Low reduction
Low	Deerfield Road	DFR3a	7.4	1,500	2,300	560	4.11	Large area, low cost	Low reduction
Low	Bette Matkins Avenue	BMA1a	2.5	29,700	40,200	2,400	16.57	Reduces sediment problem	Low reduction, small area
Low	Deerfield Road	DFR6b	2.3	29,000	51,000	2,800	18.51	High visibility	High cost, low reduction, feasibility
Low	Chute Rooster	CHR2b	2.3	8,300	8,600	410	21.01	Reduces sediment problem	Small area, low reduction
Low	Main Street	MST2b	1.8	29,000	51,000	2,200	23.16	High visibility	High cost, low reduction, feasibility
Totals			**403.0**	**$574,000**	**$774,300**	**101,000**	**$7.67**		

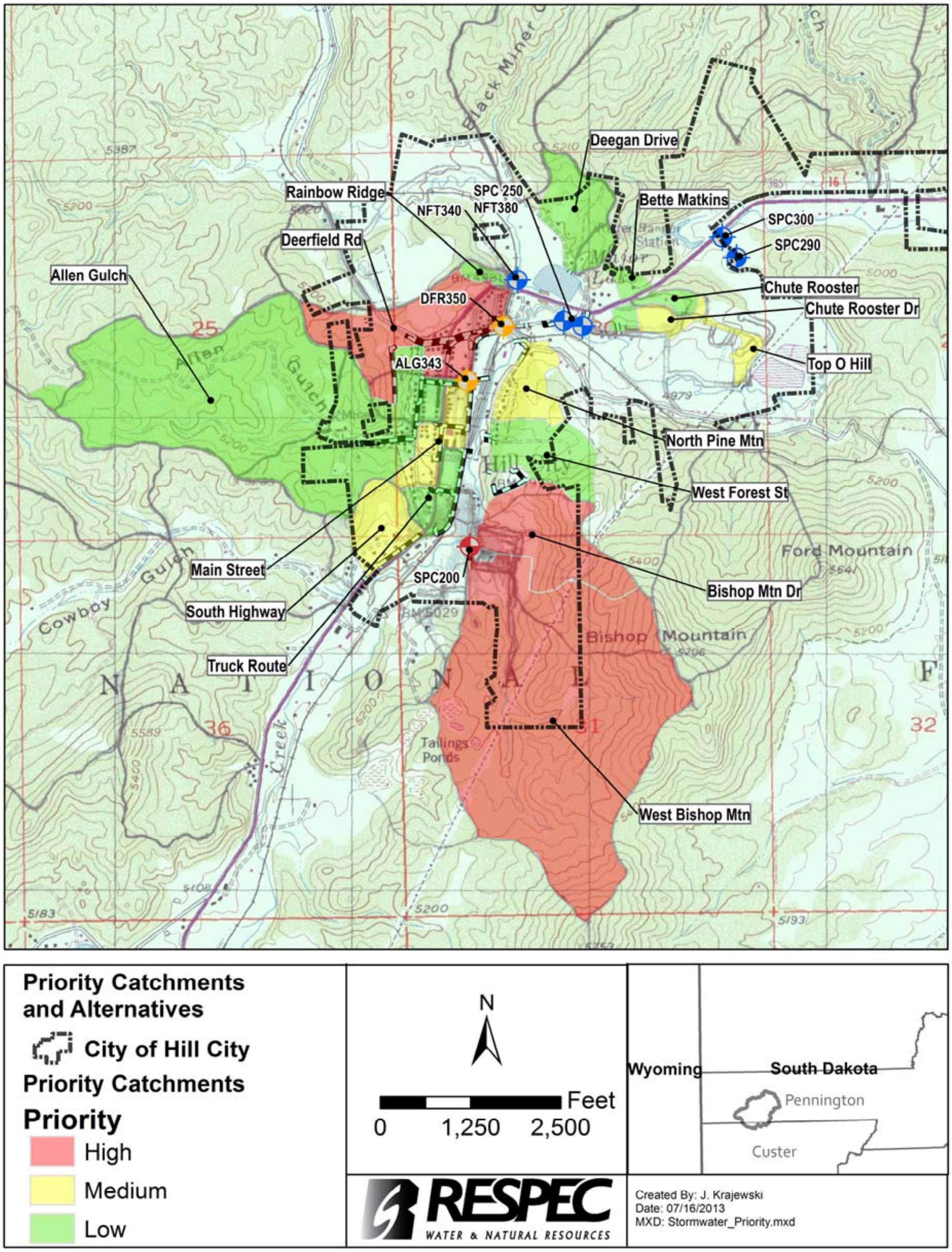

Figure 4-2. Priority Catchments for Stormwater Management in and Surrounding the City of Hill City, South Dakota.

4.1.3 Priority Areas for Livestock, Wildlife, and Domestic Animal Management

The priority areas for managing livestock and wildlife were developed by subwatershed, and ranking criteria for each subwatershed included the following items:

1. Acres of BHNF grazing allotments within project area
2. Number of livestock animal units (AUs) within the BHNF grazing allotment
3. Number of existing livestock/wildlife water development and storage facilities
4. Number of miles of Spring Creek within a subwatershed
5. Number of monitoring sites with fecal coliform water quality criteria exceedances
6. Number of monitoring sites with *E. coli* water quality exceedances.

The priority areas for livestock and wildlife by subwatershed are listed in order of priority ranking: (1) Newton Fork–Spring Creek, (2) Sheridan Lake–Spring Creek, (3) Headwaters Spring Creek, and (4) Newton Fork, which are listed in Table 4-3 and illustrated in Figure 4-3. Wildlife AUs were not included in the ranking criterion because current wildlife numbers within the project area are unknown; however, wildlife contributions should be considered when determining the merit of specific water quality improvement projects within the watershed. Livestock and wildlife were considered cooperatively in these priority areas because range and grazing plans commonly include wildlife populations and habitat in determining stocking rates, management plans, and permit conditions for grazing allotments.

An estimate of pet populations was approximated by using the number of households in the watershed, the percent of households owning a dog and cat in South Dakota, and the average number of dogs and cats owned per household as described in Section 1.4.13. By using these assumptions, approximately 453 households would have approximately 770 dogs and approximately 414 households with approximately 910 cats. Additionally, bacteria ribotyping samples on Spring Creek collected in 2004 indicated that 12.5 percent of the isolates were from domestic animals [SD DENR, 2008a]. Moreover, dogs were identified as one of the most prevalent sources of *E. coli* collected from Spring Creek in 2004 with the highest numbers of dog *E. coli* observed within Hill City, which then decreased downstream [SD DENR, 2008a].

The priority subwatersheds for domestic animals and pet waste management are suggested as the following: (1) Newton Fork–Spring Creek and (2) Sheridan Lake–Spring Creek. The Newton Fork–Spring Creek Subwatershed contains approximately 832 (58 percent) of the 1,430 addresses structures within the project area, while the Sheridan Lake–Spring Creek contains proximately 342 (24 percent) of the 1,430 addresses structures. The Newton Fork–Spring Creek Subwatershed is also the top priority for OWTS management and encompasses the city of Hill City and all of the stormwater management priority areas.

Table 4-3. Priority Ranking of Subwatersheds for Livestock and Wildlife Management

Subwatershed	Overall Ranking	Ranking Score	BHNF Allotments Acres in Watershed	BHNF Allotments Percent of Project Area	Percent of Project Area Ranking	Animal Units (AU)	Animal Units (AUs) Ranking	Number of Watering Sources	Watering Sources Ranking	Miles of Spring Creek	Spring Creek Ranking	Water Quality Sites With Fecal/*E. coli* Exceedances	Water Quality Sites Sites With *E. coli* Exceedances	Water Quality Ranking
Newton Fork–Spring Creek	1	8	20,165	21.7	3	796	2	45	2	17.4	1	9	6	1
Sheridan Lake–Spring Creek	2	24	20,854	22.5	2	443	4	60	3	5.9	3	6	3	2
Headwaters Spring Creek	3	27	22,111	23.8	1	472	3	60	3	14.0	2	0	0	3
Newton Fork	4	40	10,474	11.3	4	830	1	39	1	0.0	4	0	0	4

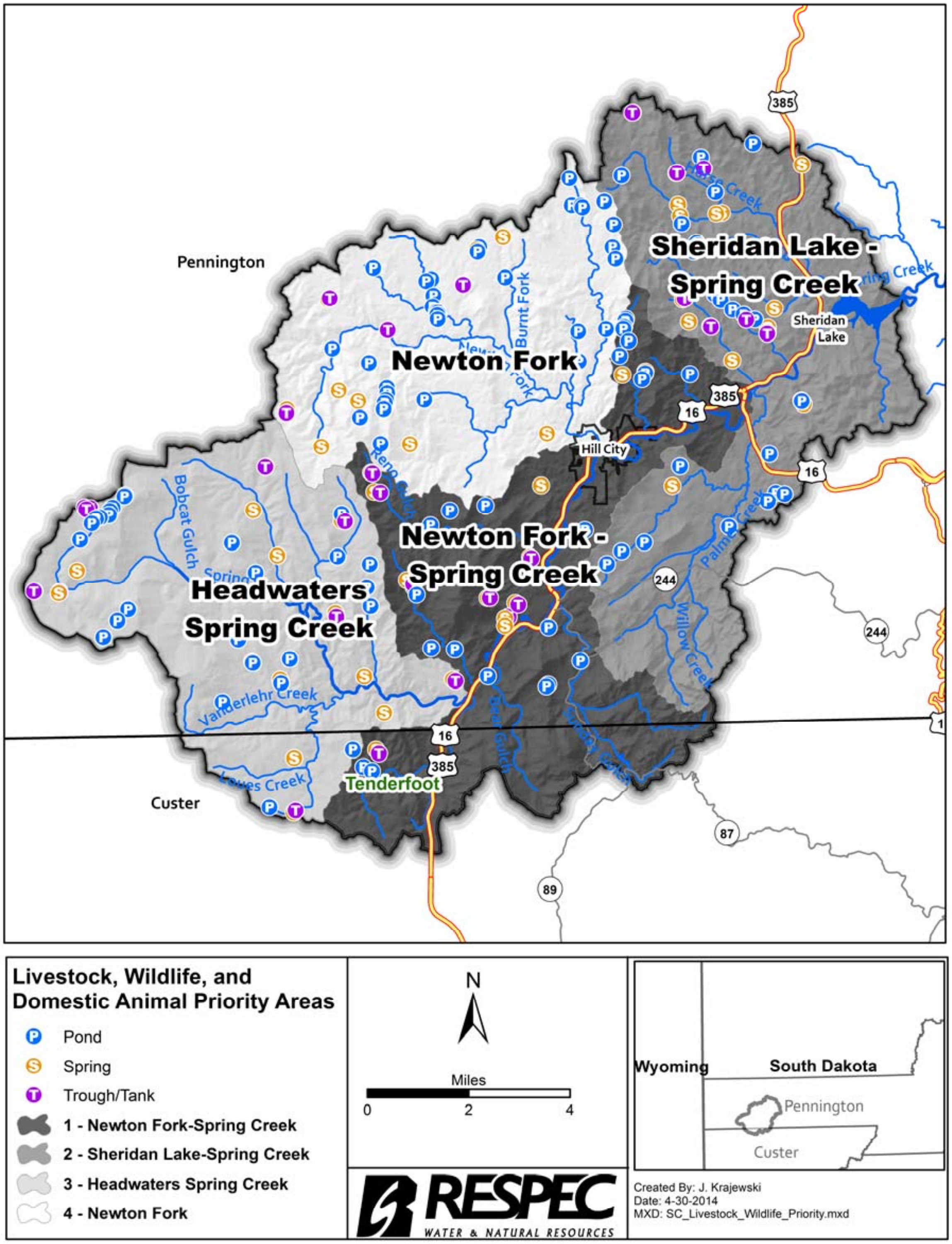

Figure 4-3. Livestock and Wildlife Priority Areas Based on Animal Units and Water Sources.

4.2 RECOMMENDED ALTERNATIVES

Recommended alternatives and implementation practices that address fecal coliform bacteria and *E. coli* sources should focus on (1) OWTS management; (2) stormwater management; and (3) livestock, wildlife, and domestic animal management. More detailed information and specific implementation alternatives for OWTS management and stormwater management can be found in the *On-Site Wastewater Management Plan*, [Krajewski, 2013] and the *Stormwater Management Plan* [Rausch and Krajewski, 2013]. These recommended alternatives could be implemented in the suggested priority areas to reduce fecal coliform bacteria and *E. coli* sources and improve the water quality in the project area. This section provides recommended structural and nonstructural implementation alternatives that are necessary to voluntarily reduce fecal coliform bacteria and *E. coli* sources. This section does not identify any site-specific BMPs, conservation practices, or remediation actions that should be included in permits, ordinances, pollution prevention plans, or conservation plans.

4.2.1 On-Site Wastewater Treatment System Management Alternatives

OWTS characteristics, system assessments, and regulations for OWTS were included in Chapter 2.0 of this plan, which provided information regarding the number, type, effectiveness, and proximity of OWTS as well as an estimate of OWTS fecal coliform bacteria production and a summary of OWTS ordinances, rules, and regulations. This information was used to develop recommended alternatives and priorities for OWTS management on four subwatersheds in the project area.

Because of the high number of OWTS within the project area, the proposed management approach includes identifying priority areas; recommending nonstructural and structural OWTS alternatives; and coordinating with residents, property owners, local certified installers and service providers, and shared jurisdictional entities (the city of Hill City, Custer County, Pennington County, and the state of South Dakota) to reduce fecal coliform bacteria contributions from OWTS and achieve TMDL reductions. Moreover, this section provides a summary of issues, problems, and concerns regarding OWTS management in the project area that were often the topics of discussion between property owners and project coordinators.

This section provides nonstructural and structural alternatives for reducing fecal coliform bacteria contribution from malfunctioning or failing OWTS within the project area. Also, this section of the plan addresses rehabilitating, siting, managing, and operating and maintaining existing OWTS within the project area and provides information on OWTS technologies for consideration. However, this section is not intended to identify which specific structural and nonstructural OWTS measures or components should be installed on a particular property or individual parcel but provides an adaptive approach with recommendations and alternatives necessary to reduce fecal coliform bacteria contribution from OWTS within the watershed. Sources of technical and financial assistance are also included in this section.

Recommended nonstructural alternatives could include activities such as (1) informing OWTS owners about proper system operation and maintenance techniques, (2) properly siting an OWTS, (3) partnering with OWTS installers to provide outreach to property owners, (4) increasing an awareness of requirements in current OWTS ordinances and regulations, and (5) partnering with residential and commercial property owners to demonstrate new and emerging OWTS technologies. Recommended structural alternatives could include rehabilitating existing OWTS, installing alternative and experimental OWTS and components, and considering a sanitary sewer system or district in priority areas within the project area. Additionally, because of the multijurisdiction that exists for OWTS management within the project area, efforts to enhance OWTS program coordination between Hill City, Custer and Pennington Counties, and the SD DENR are necessary. These recommendations are based on experience gained during this planning effort; feedback from advisory group members; and discussion with homeowners, residential, and commercial property owners in the watershed.

4.2.1.1 Proper Siting, Operation, and Maintenance of Systems

Almost 90 percent of the project area has soil ratings for absorption fields that are categorized as "very limited" (features unfavorable for OWTS), which perhaps signifies poor performance and high maintenance. Moreover, more than half (54 percent) of the parcels with addressed structures are 0.1 to 3 acres in size with almost 70 percent of the parcels less than 5 acres in size. An estimated 25 (2.7 percent) OWTS are within 100 feet of Spring Creek, and 42 (4.6 percent) OWTS are within 100 feet of a perennial tributary in the project area, as illustrated in Figure 4-1. Additionally, an estimated 180 (19.7 percent) OWTS are located within 600 feet of Spring Creek and another 154 (16.8 percent) OWTS are within 100 to 600 feet of a perennial tributary within the project area. Floodplains in portions of the project area have been mapped by FEMA, and floodplain development ordinances have been adopted by Hill City, Custer County, and Pennington County. Construction and development activities, including OWTS installation or replacement, within a floodplain or special flood hazard areas must be permitted by the floodplain manager or administrator with the city or counties within the project area.

Because of these attributes and the limitations caused by poor soil absorption ratings, depth to water or bedrock, setback requirements to property boundaries, utilities, waterbodies, and floodplain areas, procedures and requirements for locating and siting an OWTS within the project area, including site evaluations and percolation tests, are recommended to be reviewed and evaluated jointly by the state of South Dakota, Custer County, and Pennington County, and perhaps in cooperation with certified septic installers, residents, and landowners.

Operating and maintaining an OWTS can be a difficult and costly responsibility for property owners depending on several factors, including the size, type, use, installation methods, and complexity of the OWTS. However, properly operating and maintaining an OWTS can protect family and personal health, prevent plumbing backups, increase the system's lifespan, reduce replacement and repair expenses, and decrease potential failures or discharges. Properly managing an OWTS includes operating the system to ensure that it was designed to treat what enters it; maintaining the system to prevent failures by repairing or replacing damaged or leaking components; monitoring how the system functions by observing what enters it; checking components such as baffles, screens, or pumps; and looking for wet areas near pipes, tanks, drainfields, or mounds.

Recommended OWTS nonstructural alternatives include three approaches for improving proper OWTS operation and maintenance within the project area. These approaches include various levels of involvement from the property owners, certified OWTS professionals, city of Hill City, Custer County, Pennington County, and the state of South Dakota. The management alternatives include the following:

1. **Property Owner Awareness—**this alternative could include activities such as workshops, one-on-one conversations, checklists, record-keeping materials, owner self-assessments, maintenance tips, graphic displays, and newsletters that can help property owners remember or learn methods to ensure that proper operation, timely maintenance, and frequent monitoring benefits them and their OWTS by increasing system life, decreasing costs, and reducing effects on groundwater and surface water.
2. **Maintenance Agreements—**this alternative could include agreements or contracts with property owners, certified installers, service providers, or waste pumpers for to conduct timely operation and maintenance procedures on more complex OWTS installations that are used in addition to conventional systems described as alternative, advanced, and experimental; involve special components (sand/peat filters, aerobic units, and composting units); and require detailed knowledge about their operation. Holding tanks can also be addressed by an agreement that provides periodic system inspection and routine pumping schedules.
3. **Operating Permits—**this alternative could include specific permitting and inspection activities in areas where OWTS performance is a priority to protect public health and water quality. Property owners apply for an OWTS operating permit from a city, county, or management entity, such as a sanitary district, and are issued the permit once the system is inspected, pumped, and determined to meet current requirements. Operating permits can be renewed for another term if the property owner shows that the OWTS is still functioning in accordance with current ordinances, regulations, and terms and conditions of the operating permit.

In 2012, Pennington County adopted changes to Section 204-J “On-Site Wastewater Treatment Systems (Revised 03-28-12)” of their Zoning Ordinance, which included requirements that property owners must obtain an operating permit to operate and maintain the system and must have their OWTS inspected by a certified service provider [Pennington County, 2012b]. Additionally, Pennington County required agreements with property owners for approval of holding tanks stating that the tank would be pumped regularly or as needed and wastewater would be properly disposed of at an approved facility.

These alternatives, such as property owner awareness, maintenance agreements, and operating permits, have been used to a degree within the project area and it is recommended that a coordinated effort that used the awareness, agreement, and permitting alternatives be continued in higher-ranked priority areas of the watershed or for properties in close proximity to Spring Creek and its tributaries. In consideration of these alternatives, coordinating with affected residents, property owners, local certified installers, and service providers should occur to avoid problems with available manpower, equipment, and materials that could become limited and result in increased costs, installation delays, and permit approval issues.

4.2.1.2 Cooperative Outreach and Technology Demonstration

Approximately 203 state of South Dakota-certified installers are located in the project area. An estimated 20 state-certified installers are located in Hill City, 46 certified installers are in Custer County, and 137 certified installers are in Pennington County outside of Hill City. South Dakota state law requires that the SD DENR certify septic installers who are responsible for altering, repairing, constructing, and installing an OWTS and related equipment [South Dakota Legislature, 2012c]. Additionally, all service providers that perform work related to OWTS, including installers, operation and maintenance providers, and liquid waste pumpers in Pennington County, must receive certification from the county in addition to their state of South Dakota certification. An estimated 75 certified installers and 9 certified liquid waste pumpers or haulers are located in Pennington County.

OWTS installers and service providers are the first people that a property owner contacts when their system is failing or malfunctioning. Certified installers and service providers are trained, experienced, and available to provide professional services to property owners for OWTS management within the project area. Moreover, service providers within the project area have illustrated a willingness to inform residents and property owners of OWTS issues and opportunities and to correct failing and malfunctioning systems.

Another recommended OWTS nonstructural alternative could include partnering with OWTS installers to cooperatively provide outreach information and materials to property owners to increase awareness for improving proper OWTS operation and maintenance and understanding current OWTS requirements. Service providers could offer property owners more information about OWTS needs, construction, and function as well as identify common mistakes of OWTS operation and maintenance. In considering this alternative, a survey of the certified installers and service providers that inquires about the type and amount of outreach that they provide to their clients and identifies service providers' issues, concerns, and needs would be necessary. It would be essential that this approach be collaborative and cooperative as a partnership between certified installers and service providers and possibly with the city of Hill City, Custer County, Pennington County, and the state of South Dakota and is not merely a delivery method for distributing educational or regulatory materials to property owners.

Within the project area, the most common type of OWTS assessed is a conventional system, which is a septic tank and associated drain or absorption field for an addressed structure. Of the estimated 916 OWTS in the project area, approximately 27 percent are conventional systems, 5 percent are portable systems, 3 percent are holding tanks, 0.4 percent are graywater systems, and 0.3 percent are mound or at-grade systems, as described in Section 2.1.3 and illustrated in Table 2-5 and Figure 2-5. Conventional systems are the most common because these systems are a practical, cost-effective, and low-maintenance alternative for property owners; however, when confronted with unsuitable site conditions, such as elevated groundwater levels, inadequate soil percolation, or insufficient setback distances from water features, property owners have chosen to install holding tanks instead of mound systems or other alternative or advanced treatment systems and components. The increased cost of a mound, alternative, or advanced system prohibits most property owners from installing these types of systems and causes them to install holding tanks, which have no wastewater treatment capabilities and rely on periodic pumping to transport waste to an approved facility for treatment.

Another recommended OWTS nonstructural alternative could expand on an outreach partnership alternative with certified installers, service providers, and manufacturers to conduct on-the-ground demonstrations or workshops. Property owners, installers, service providers, and technicians can observe installation, function, and operation and maintenance of alternative and advanced treatment OWTS technologies such as mounds, aerobic treatment units, sand or peat filters, media or textile filters, graywater, and drip distribution. New technologies can be highlighted and discussions can be facilitated regarding system costs, maintenance, and effectiveness in priority areas within the project area. These activities could also be included in training for obtaining continuing education credits for certified installer and service providers. In considering this alternative, cost incentives would need to be incorporated to decrease the expenses for property owners for installing alternative and advanced treatment OWTS technologies such as mounds, ATUs, sand or peat filters, media or textile filters, and drip distribution.

4.2.1.3 Rehabilitation of Existing Systems

An estimated 336 OWTS that were installed before 1976 are located within the project area, as described in Section 2.1.5 and illustrated in Table 2-7 and Figure 2-7. This represents almost 37 percent of the estimated 916 OWTS in the watershed. These systems are estimated to have been installed at least 36 years ago and have reached or exceeded expected OWTS lifespans. As the age of an OWTS rises, the risk of failures and malfunctions generally increases, depending on the individual operation and maintenance history of the OWTS. Additionally, almost 60 percent (an estimated 199 of the 336 OWTS) installed before 1976, are located within 300 feet of Spring Creek and its perennial tributaries, including Horse Creek, Loues Creek, Newton Fork, Palmer Creek, Tenderfoot Creek, and Vanderlehr Creek.'

The recommended approach for rehabilitating existing OWTS is to provide cost-share incentives to landowners within the Newton Fork-Spring Creek subwatershed to improve, upgrade, or replace OWTS that are malfunctioning, were installed before 1976, or are located within 300 feet of Spring Creek or a perennial tributary. This cost-share incentive alternative was developed and modified during Segment 1 of the Spring Creek Watershed Management and

Implementation Project and reimbursed property owners for the costs of rehabilitating their OWTS within the project area.

From 2010 to 2012, 19 OWTS applications were received from property owners within the Newton Fork–Spring Creek subwatershed. Eight of those 19 OWTS projects have been completed, three are still in progress, and eight other OWTS applications were not funded or the status is unknown. This cost-share alternative could also include a coordinated effort of awareness, maintenance agreements, and operating permits. Because existing OWTS that are in compliance were grandfathered in when Pennington County adopted their ordinance changes in 2012, existing OWTS can continue to operate until they malfunction or fail. This cost-share incentive alternative is recommended so that OWTS improvement projects could be installed to possibly prevent an OWTS from failing or malfunctioning within the highest priority Newton Fork–Spring Creek subwatershed. Again, when considering this alternative, coordinating with affected residents, property owners, local certified installers, and service providers should occur to avoid problems with available manpower, equipment, and materials that could become limited and result in increased costs, installation delays, and permit approval issues.

4.2.1.4 Installation of Alternative and Advanced Systems

An estimated three mound or at-grade OWTS, one OWTS with advanced treatment components, and four graywater systems exist within the project area, as described in Section 2.1.3 and illustrated in Table 2-5 and Figure 2-5. These systems represent less than 1 percent of the estimated 916 OWTS in the watershed. In addition to the previously recommended cost-share incentives alternative, additional incentives to property owners could encourage them to convert conventional OWTS to alternative or advanced treatment systems or install advanced components (such as composting and incinerator toilets), graywater and blackwater separation, or pretreatment components (such as ATUs, sand or peat filters, and media filters) in the highest-ranked priority areas: Newton Fork–Spring Creek and Sheridan Lake–Spring Creek subwatersheds. This cost-share incentive alternative was included in Segment 1 of the project, and three applications were received for alternative or advanced OWTS but were not funded because higher-ranked applications were approved for project funding.

4.2.1.5 Consideration of a Sanitary Sewer System or District

In addition to OWTS improvements, a feasibility study for a sanitary sewer district in the higher-ranked priority area (such as the Newton Fork–Spring Creek and Sheridan Lake–Spring Creek subwatersheds) is recommended for consideration. Approximately 1,558 people are served on an estimated 708 OWTS within the Newton Fork–Spring Creek and Sheridan Lake–Spring Creek subwatersheds. A sanitary sewer district option may be a viable alternative because population, development, and OWTS densities along Spring Creek and its tributaries from State Highway 244 above the city of Hill City downstream to the Three Forks area near the junction of U.S. Highways 385 and 16 are greater than in other areas of the project area, as illustrated in Figure 2-3. This area also includes more residential, commercial, and industrial development and land-use activities, as described in Section 1.4.7 and illustrated in Figure 1-11. A feasibility study or master plan could include an assessment of the city of Hill City's existing sanitary sewer system; a consideration of zoning revisions and overlay districts; and an examination of boundaries, ownership, and funding options.

In Custer and Pennington Counties, a sanitary sewer is defined as a municipal, community, small or individual sewage disposal system of a type approved by the Health Department of the SD DENR [Custer County Planning Department, 2007; Pennington County, 2012b]. In South Dakota, sanitary districts can include any populated area outside the boundary of any municipality that is situated so the sewage of the populated area becomes, or may become, a menace to the residents of the populated area or to the residents of any municipality adjacent to the populated area. The populated area may be incorporated as a sanitary district and must contain at least 30 legal residents, including minors, or less than ten landowners within the proposed district who are also registered voters in the proposed district, as provided in Chapter 34A-5 “Sanitary District” in the South Dakota Codified Laws, South Dakota [South Dakota Legislature, 2012d].

4.2.2 Stormwater Management Alternatives

Stormwater assessments that consist of modeling catchments and subcatchments in addition to roles and responsibilities for stormwater management were included in *the Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013]. Existing stormwater catchment attributes, and stormwater runoff dynamics were identified, studied, and modeled for the subcatchments illustrated in Figure 3-1. This section of the plan includes identified priority areas; recommended nonstructural and structural stormwater alternatives; and proposed coordination with residents, property owners, the city of Hill City, Pennington County, state of South Dakota, and the USFS to reduce fecal coliform bacteria and *E. coli* contributions from stormwater. These alternatives focus on the stormwater catchments surrounding and within Hill City but are also applicable in other developed areas of the watershed. This approach focuses on the voluntarily implementing structural and nonstructural alternatives to effectively manage the quality and quantity of stormwater runoff.

Nonstructural alternatives could serve to either enhance the efficiency or reduce the required size of structural alternatives. These recommendations are not intended to identify which specific structure or practice should be included in discharge permits, ordinances, or SWPPPs, but rather provides generalized alternatives to manage stormwater and reduce fecal coliform bacteria in the project area. After the stormwater runoff dynamics within the project area were understood, selecting and sizing different alternatives for the stormwater management was possible. Structural alternatives are designed to trap and detain runoff to settle or filter out pollutants, which prevents them from entering waterbodies.

4.2.2.1 Nonstructural Alternatives

To increase the effectiveness of the structural alternatives, nonstructural measures could be used in conjunction with the recommended structural measure alternatives. These nonstructural alternatives could reduce pollutants and runoff volume as well as inform and encourage participation from residents and landowners within the project area. The stormwater nonstructural alternatives focus on a voluntary approach aimed at increasing knowledge and fostering partnerships among residents, landowners, developers, businesses, and agencies to minimize impacts and improve water quality in Spring Creek and its tributaries. Recommended nonstructural alternatives could include increasing awareness about stormwater runoff, identifying stormwater drains, developing partnerships, using good housekeeping measures, and preventing or controlling stormwater runoff.

Public outreach is recommended as a priority nonstructural measure that could focus on activities that encourage the public's voluntary participation in minimizing stormwater runoff into Spring Creek and its tributaries by informing residents, property owners, homeowners, developers, contractors, businesses, and agencies regarding the impacts of stormwater runoff within the project area. Outreach to the general public and local community should include information regarding stormwater issues, permit requirements, seminars and trainings, management practices, and effects on water quality. This approach should be implemented within the project area as part of this SWMP, and potential activities include the following:

- Develop and distribute education materials regarding the effects of stormwater runoff
- Update and maintain web pages regarding stormwater for the city of Hill City, Custer County, and Pennington County
- Inform the residents and property owners about the potential impacts of animal waste and the need to clean up and properly dispose of, or recycle, animal waste
- Initiate storm drain labeling and marking projects in cooperation with Adopt-a-Highway and other community groups and volunteer activities
- Coordinate with Pennington County regarding their SWMP outreach activities within the project area
- Demonstrate postconstruction control methods and permanent stormwater projects.

Coordinating with local, state, and federal agencies; civic organizations; and other groups is necessary to combine resources and provide outreach within the project area, understand current local and state requirements, identify potential problems, and determine preventative measures for reducing stormwater runoff. An example of this coordinated effort is perhaps a stormwater seminar or demonstration project, which could include the city of Hill City, Custer and Pennington Counties, Custer and Pennington conservation districts, the Pennington County Cooperative Extension Service, the WDWDD, South Dakota State University (SDSU) Extension's West River Ag Center, the SD DENR, the SDDOT, the NRCS, and the USFS with participation from civic and community organizations. These organizations could include, but certainly are not limited to, the Hill City Area Chamber of Commerce, the Black Hills Home Builders Association, the Black Hills Forest Resource Association, the Black Hills Council of Local Governments, the Rural Community Assistance Corporation, and the South Dakota Storm Water Outreach Alliance. The Storm Water Outreach Alliance is a consortium of urban public works departments in South Dakota and provides outreach resources regarding stormwater pollution prevention.

Pollution prevention and good housekeeping can be an adaptable nonstructural approach that focuses on preventing or reducing pollutant runoff from municipal, county, state, and federal operations and facilities within the project area. This recommendation is necessary because areas exist, including city, county, state, and federal facilities, where pollution prevention measures and techniques could be expanded on, and stormwater quality within the project area would improve. The current facility, routine operation and maintenance, spill prevention, and SWPPPs should be reviewed and additional measures should be identified that specifically address fecal coliform bacteria sources and reduce stormwater runoff as well as, but not limited to, the following recommended activities:

- Review facility, spill prevention, and pollution prevention plans that include routine operations, such as cleaning pavement surfaces and proper material storage, conducted to prevent contaminants from leaving the property
- Proper disposal of material collected during sweeping operations
- Evaluate current erosion and sediment control measures on city, county, state, and federal maintenance facility sites and identify additional measures to be performed
- Develop schedules and inspection procedures for structural and nonstructural stormwater controls to reduce pollutants discharged from parking lots, maintenance areas, storage areas, roofs, drainage systems, and material stockpiles
- Evaluate current staff training proficiency for addressing erosion control, stormwater pollution prevention, and stormwater quality
- Provide training opportunities for city, county, state, and federal personnel that promote awareness of pollution prevention methods, new technologies, proper SWPPP review, and water quality improvement methods
- Identify site-specific measures such as trash disposal, sanitary wastes, recycling, and proper material handling to prevent the discharge of these materials to receiving waters
- Develop equipment and vehicle sanitary or washing practices that could be used to prevent pollutants from entering stormwater drainage systems
- Develop spill prevention and control plans, including methods to reduce spills, contain and clean up spills, dispose of contaminated spill material, and train personnel responsible for spill prevention and control.

4.2.2.2 Structural Alternatives

During the development of the *Stormwater Management Plan for the Spring Creek Watershed* prepared by Rausch and Krajewski [2013], a literature review was conducted to determine the effectiveness of different alternatives and their applicability to the watershed.

Clary et al. [2008] conducted a study of BMPs' ability to reduce bacteria based on data published in the International Stormwater BMP Database. Their research indicated that the best BMPs for bacteria reduction include wet ponds and different forms of filtration or infiltration. Infiltration BMPs may act to eliminate the pollutant load in the WQCV entirely; however, these BMPs are susceptible to degradation by sedimentation. Dry ponds and detention vegetated swales are very effective at removing not only large sediment particles, but suspended solids as well. The BMP alternatives in the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013] were assembled with the idea that combinations or "trains" of sediment and bacteria BMPs are ideal. Detention pretreatment is most critical in catchments with high potential for sediment runoff.

Stand-alone dry ponds and detention swales should be sized for a 24-hour release WQCV or less to limit the thermal impact on the creek from these BMPs. Detention swale implies using notched check dams or similar controls spaced along the swale to detain flow. Dry ponds may be used as pretreatment for wet ponds and infiltration basins to reduce sediment load.

Implementing wet ponds may require groundwater accessibility and studying possible groundwater contamination. The NRCS Web Soil Survey reports all soils within the project areas to be in the hydrologic soil group B: suitable for infiltration BMPs [NRCS, 2012b]; however, any specific site should be studied to confirm soil suitability and to determine the depth to the bedrock. Infiltration BMPs also depend on adequate elevation above the water table to ensure proper filtration of contaminants [Muthukrishnan et al., 2004].

Implementing BMPs that promote the infiltration of stormwater will positively contribute to elevated groundwater and stream base flow levels. As with wet ponds, possible groundwater contamination should be considered in the site-specific planning and design of any proposed project. The feasibility of most alternatives described in the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013] depends on exact elevations of existing elements (storm sewer pipe inverts, junction box inverts, street surfaces, and ground surfaces). All alternatives depend on the absence or relocation of existing underground utilities. Many sites will depend on cooperation between governmental agencies and private landowners.

4.2.2.3 Cost Estimation

The stormwater BMP guide produced by Field et al. [2006] was used extensively for BMP planning and cost estimation in the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013]. Another available tool for BMP cost estimation is the BMP-REALCOST spreadsheet developed by the Urban Drainage and Flood Control District (UDFCD) in Colorado. Both references use equations developed from actual cost data and are generally based on BMP size. Cost estimations should also include land acquisition, feasibility studies, design, permitting, contingencies, and erosion control. Maintenance costs should also be estimated and considered when selecting a BMP.

4.2.2.4 Fecal Coliform Load Reductions

The *Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Spring Creek, Pennington County, South Dakota*, reported a total seasonal fecal coliform load of 1.68×10^{13} cfu [SD DENR, 2008a]. The TMDL findings show that 13.7 percent of this load is from urban areas and 7.9 percent is from wildlife. These loads will typically represent those treated by stormwater BMPs in urban areas. The *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013] details load calculations.

The International Stormwater BMP Database [Geosyntec and Wright Water Engineers, Inc., 2012] provides fecal coliform reduction performance for different BMPs. In the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013], average and median reduction values were calculated by using data from storms with paired inlet and outlet event mean concentration (EMC) values and used the values illustrated in Table 4-4. These values represent efficiency of load reduction for a single WQCV event. The WQCV is designed to treat approximately 85 percent of storms, so seasonal load reductions may be interpreted as 85 percent of the single event efficiency.

Table 4-4. Pollutant Reduction Efficiencies for Different Types of Best Management Practices

BMP Type	Fecal Coliform Bacteria Reduction				TSS Reduction		
	Events Sampled	Mean (%)	Median (%)	Applied (%)	Events Sampled	Mean (%)	Median (%)
Wet Pond	73	80	92	**80**	582	77	81
Dry pond	62	41	38	**40**	216	67	63
Swale	33	41	21	**30**	100	53	51

Although TSS reduction efficiencies were calculated for each BMP, they were not used for BMP optimization in the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013]; however, the TSS reduction efficiencies for each BMP show that implementation will have a positive impact on TSS load. Based on the TSS and phosphorus correlation findings of Schmitz [2011], the phosphorus load should be reduced as well.

Infiltration basins and infiltration trenches are assumed to capture and infiltrate the entire WQCV, which results in a 100 percent reduction of the WQCV load and a subsequent 85 percent reduction of the seasonal load. Reduction efficiencies for additional BMPs may be found in the International Stormwater BMP Database [Geosyntec and Wright Water Engineers, Inc., 2012]

4.2.3 Livestock, Wildlife, and Domestic Animal Management Alternatives

Livestock, wildlife, and domestic animal information and data was included in Sections 1.4.13 through 1.4.15 of this plan. In addition to the OWTS and stormwater management alternatives described in Sections 4.2.1 and 4.2.2, focus on conservation practices and BMPs that address fecal coliform bacteria and *E. coli* sources such as livestock, wildlife, and domestic animals on residential, agricultural, and recreational lands should continue. Implementation activities should include livestock/wildlife water facilities, prescribed/managed grazing, access control, domestic animal and pet waste management, and riparian/wetland restoration and enhancement. The NRCS Conservation Practice Physical Effects (CPPE) for South Dakota was used to identify applicable practices and their potential to improve water quality degradation from excess pathogens and to make recommendations for continued implementation activities in the following sections [NRCS, 2013a].

4.2.3.1 Livestock Grazing

Over 76,000 acres of grazing lands are located on Ponderosa pine, Aspen, and grass vegetative cover types in the project area. Livestock in the project area are predominantly cattle on USFS grazing allotments. Other livestock include horses, poultry, and goats. Livestock contribute bacteria loads directly by defecating in the stream and indirectly by defecating on forestlands and grasslands that can be washed off during precipitation events. In 2004, bacteria ribotyping samples collected on Spring Creek and Palmer Gulch Creek indicated that livestock contributed 47.0 percent of the fecal coliform bacteria contributions [SD DENR, 2008a]. Modeling results from the TMDL suggested that 37.9 percent of the fecal coliform bacteria load is from livestock defecation in streams [SD DENR, 2008a].

Off-stream livestock and wildlife water developments could decrease the amount of time that livestock or wildlife spend in or near streams, and thus potentially reduce defecation and improve water quality. A summary of these recommended livestock grazing practices are provided in Table 4-5. Applicable practices are not limited to those in the table, and many of those listed may require supporting practices to be most effective. The USFS Mystic Range Project has implemented some of these practices on approximately 8 of the 14 BHNF grazing allotments within the project area. Approximately 118 livestock and wildlife watering facilities exist on the BHNF grazing allotments within the project area. Implementation efforts that focused on reducing fecal coliform bacteria and *E. coli* contributions from livestock and wildlife should continue to emphasize installing conservation practices that improve forest and grazing land health, enhance livestock and wildlife distribution, and increase livestock and wildlife water availability.

4.2.3.2 Wildlife

Wildlife within the project area are a source of fecal coliform bacteria and *E. coli*. Similar to livestock and domestic animals, wildlife species contribute bacteria loads directly by defecating while drinking, wading, or swimming in the stream and indirectly by defecating on lands that are washed off during precipitation events. Water-harvesting catchments and guzzlers are artificial catchments that provide sources of water in remote areas for wildlife. These catchment facilities rely entirely on precipitation and could be considered in areas where wildlife water is needed and other options are unavailable. The practices recommended for reducing negative impacts from wildlife are illustrated in Table 4-6. Applicable practices are not limited to those in the table, and many of those listed may require supporting practices to be most effective.

Table 4-5. Recommended Livestock Grazing Practices on Grazed Forest, Range, and Pasture Lands Within the Watershed

Recommended Conservation Practice (NRCS Practice Code)	CPPE Water Quality Degradation Excess Pathogens Potential Effect
Vegetated Treatment Area (635)	Substantial Improvement
Constructed Wetland (656)	Moderate to Substantial Improvement
Filter Strip (393)	Moderate Improvement
Riparian Forest Buffer (391)	Moderate Improvement
Riparian Herbaceous Cover (390)	Moderate Improvement
Fence (382)	Slight to Moderate Improvement
Heavy Use Area Protection (561)	Slight to Moderate Improvement
Sediment Basin (350)	Slight to Moderate Improvement
Waste Storage Facility (313)	Slight to Moderate Improvement
Watering Facility (614)	Slight Improvement
Access Control (472)	Slight Improvement
Diversion (362)	Slight Improvement
Forest Stand Improvement (666)	Slight Improvement
Grazing Land Mechanical Treatment (548)	Slight Improvement
Prescribed Grazing (528)	Slight Improvement
Range Planting (550)	Slight Improvement
Spring Development (574)	Slight Improvement
Streambank and Shoreline Protection (580)	Slight Improvement
Tree/Shrub Establishment (612)	Slight Improvement

4.2.3.3 Domestic Animal and Pet Waste

Domestic animals and pet wastes are a contributor to bacteria loading in the project area. In 2004, bacteria ribotyping samples on Spring Creek indicated that 12.5 percent of the isolates were from domestic animals [SD DENR, 2008a]. Pet wastes are deposited on yards, lawns, and parks or along sidewalks, trails, or streams. Bacteria loading from domestic animals and pet waste can be reduced by encouraging residents and pet owners to remove waste from parks, lawns, and properties and properly dispose of the pet waste. These practices can prevent domestic animal and pet wastes from entering the street, gutter, storm drain, and eventually the stream.

Table 4-6. Recommended Wildlife Water/Cover/Shelter Practices on Grazed Forest, Range, Natural Areas, and Pasture Lands Within the Watershed

Recommended Conservation Practice (NRCS Practice Code)	CPPE Water Quality Degradation-Excess Pathogens Potential Effect
Watering Facility (614)	Substantial Improvement
Upland Wildlife Habitat Management (645)	Substantial Improvement
Pond (378)	Moderate to Substantial Improvement
Spring Development (574)	Moderate to Substantial Improvement
Conservation Cover (327)	Moderate to Substantial Improvement
Constructed Wetland (656)	Moderate Improvement
Forest Stand Improvement (666)	Moderate Improvement
Tree/Shrub Establishment (612)	Moderate Improvement
Wetland Creation (658)	Slight to Moderate Improvement
Wetland Enhancement (659)	Slight to Moderate Improvement
Wetland Wildlife Habitat Management (644)	Slight to Moderate Improvement
Riparian Herbaceous Cover (390)	Slight to Moderate Improvement
Water and Sediment Control Basin (638)	Slight to Moderate Improvement
Critical Area Planting (342)	Slight to Moderate Improvement
Filter Strip (393)	Slight to Moderate Improvement
Herbaceous Weed Control (315)	Slight to Moderate Improvement
Prescribed Grazing (528)	Slight to Moderate Improvement
Range Planting (550)	Slight to Moderate Improvement
Streambank and Shoreline Protection (580)	Slight to Moderate Improvement
Riparian Forest Buffer (391)	Slight Improvement
Access Control (472)	Slight Improvement
Grade Stabilization Structure (410)	Slight Improvement

A pet waste management program could increase public awareness and proper waste disposal by posting signs or billboards and installing pet waste stations or receptacles with pet waste collection bags near frequently used parks, trails, and public use areas. Suitable siting and proper maintenance of pet waste stations or receptacles is essential because these stations tend to collect pet wastes effectively and could become a nuisance or perhaps a concentrated source of bacteria. Other pet waste management alternatives include promoting private or public pet waste collection services for homeowners, employing radio and newspaper advertisements to inform pet owners, and establishing exercise areas or “dog parks.”

4.2.3.4 Riparian and Wetland

A total of 167 miles of streams with 67 miles of perennial and 100 miles of intermittent streams are located in the project area. Spring Creek begins in the southwestern portion of the watershed and flows northeast for approximately 28 miles where it enters Sheridan Lake. Approximately 125 acres of emergent wetlands, forested wetlands, and pond/riverine wetlands are located within the project area. Riparian/wetland restoration and enhancement could potentially reduce fecal coliform bacteria and *E. coli* by increasing the amount and diversity of vegetation along Spring Creek and its tributaries and increasing the number and function of wetlands surrounding creeks, ponds, and reservoirs within the watershed.

Riparian/wetland restoration and enhancement alternatives could also serve to increase the assimilative or loading capacity of a waterbody, such as Spring Creek, by improving the waterbody’s physical, chemical, and biological attributes and functions that could buffer the fecal coliform bacteria, *E. coli*, suspended sediment, temperature, and nutrients that the waterbody receives. Projects could be designed to improve hydrologic function and assimilative capacity through stream restoration, riparian enhancement, channel stabilization, geomorphic function, and wetland development, which could potentially increase flows, filter pollutants, deposit sediment, dilute concentrations, increase organic matter, and sequester pathogens. These functions and features, specifically the stream channel, floodplain, and riparian/wetland areas, are often interconnected and dependent on site-specific characteristics such as geology, soils, geomorphology, topography, vegetation, precipitation, climate, and disturbances. Table 4-7 shows the practices recommended for improving hydrologic function and assimilative capacity in the watershed. Applicable practices are not limited to those in the table, and some of those listed may require supporting practices to be most effective.

4.3 SCHEDULE AND MILESTONES

An approach of identifying priority areas, recommending alternatives, proposing implementation practices, describing milestones, and monitoring effectiveness is necessary to achieve the project goals and eventually reduce fecal coliform bacteria and *E. coli* loads. Achieving reductions and meeting load allocations as outlined within the TMDL depends on a number of factors. The factors include, but are certainly not limited to, voluntary participation, cooperative efforts, available technical and financial assistance, and the effectiveness of projects and practices intended to reduce fecal coliform bacteria and *E. coli* within the watershed.

To attain the project goal of bringing Spring Creek into compliance for fecal coliform bacteria and *E. coli* by implementing the recommended BMPs by 2021, a 10-year time frame with 5-year and 10-year descriptions of milestones were proposed to attain water quality standards. A summary of the recommended alternatives, potential milestones, and associated costs are provided in Table 4-8. Applicable alternatives are not limited to those in the table, and many of those listed may require supporting practices to be most effective. Reductions from nonpoint-source fecal coliform bacteria and *E. coli* loadings will most likely require a considerable amount of technical and financial assistance for conservation practice, OWTS rehabilitation, and stormwater management through on-the-ground projects, in cooperation with willing landowners and residents and local, state, and federal agencies.

Table 4-7. Recommended Riparian/Wetland Practices Within the Watershed

Recommended Conservation Practice (NRCS Practice Code)	CPPE Water Quality Degradation Excess Pathogens Potential Effect
Pond (378)	Moderate to Substantial Improvement
Constructed Wetland (656)	Moderate Improvement
Tree/Shrub Establishment (612)	Moderate Improvement
Wetland Creation (658)	Slight to Moderate Improvement
Wetland Enhancement (659)	Slight to Moderate Improvement
Wetland Wildlife Habitat Management (644)	Slight to Moderate Improvement
Riparian Herbaceous Cover (390)	Slight to Moderate Improvement
Critical Area Planting (342)	Slight to Moderate Improvement
Filter Strip (393)	Slight to Moderate Improvement
Herbaceous Weed Control (315)	Slight to Moderate Improvement
Streambank and Shoreline Protection (580)	Slight to Moderate Improvement
Riparian Forest Buffer (391)	Slight Improvement
Access Control (472)	Slight Improvement
Grade Stabilization Structure (410)	Slight Improvement

The cost estimates for the OWTS, livestock grazing, wildlife, domestic animal and pet waste, and riparian/wetland recommended alternatives and BMP costs were primarily based on the *Spring Creek Watershed Project – 2012 BMP Cost List and Cost Share Rates* [Pennington County, 2012c]. Many of these BMP costs were determined by using the conservation practice costs contained in the NRCS FY2013 Practice Payment Schedule for EQIP/WHIP [NRCS, 2013b]. Also, cost-share, in-kind, labor, and equipment rates were obtained from the U.S. Department of Labor, Independent Sector, and South Dakota Conservation Commission and were used to determine estimated costs [Independent Sector, 2013; South Dakota Department of Agriculture, 2013; U.S. Department of Labor, 2013a and 2013b]. Cost estimates for the stormwater management alternatives are described in the *Stormwater Management Plan for the Spring Creek Watershed* [Rausch and Krajewski, 2013].

Table 4-8. Spring Creek Watershed Implementation Schedule, Milestones, and Costs (Page 1 of 3)

Category	Recommended Alternative or Implementation Activity	Description of Measurable Milestone	Milestones		Estimated Costs	
			0–5 Years	0–10 Years	0–5 Years	0–10 Years
OWTS	Review OWTS locating and siting requirements jointly by city, county, and state agencies in cooperation with septic installers, residents, and landowners	Number of plans reviewed	2	3	TBD	TBD
	Partner with septic installers to provide outreach to property owners for OWTS operation and maintenance requirements	Number of people contacted	900	900	TBD	TBD
	Use cost-share incentives to upgrade or replace malfunctioning OWTS or an OWTS installed before 1976, or located in the highest-ranked priority areas	Number of systems upgraded	15	20	TBD	TBD
	Use incentives for property owners to convert conventional OWTS to alternative or advanced systems in the highest-ranked priority areas	Number of systems converted	2	4	TBD	TBD
	Conduct feasibility studies for a sanitary sewer extension or a sanitary sewer district in high priority areas	Number of areas studied	1	2	TBD	TBD
Stormwater	Develop and distribute media messages regarding the effects of stormwater runoff	Number of people contacted	1,800	1,800	TBD	TBD
	Update and maintain stormwater information on city and county websites	Number of people contacted	1,800	1,800	TBD	TBD
	Inform the residents and property owners regarding the impacts of animal waste and the need to properly dispose of waste	Number of people contacted	1,800	1,800	TBD	TBD
	Initiate pet waste cleanup efforts in high priority areas and catchments	Number of areas cleaned up	2	10	$2,000	$10,000
	Initiate storm drain marking projects in cooperation with Adopt-a-Highway and other community/volunteer groups	Number of drains marked	50	100	TBD	TBD
	Coordinate with Pennington County regarding their SWMP outreach activities	Number of activities	2	4	TBD	TBD
	Educate residents and property owners on the benefits of rainwater detainment/harvesting and implement rain barrel projects	Number of projects implemented	10	25	$15,000	$37,500
	Demonstrate postconstruction control methods and permanent stormwater projects in the high priority catchments	Number of demonstrations held and/or projects installed	5	10	TBD	TBD

Table 4-8. Spring Creek Watershed Implementation Schedule, Milestones, and Costs (Page 2 of 3)

Category	Recommended Alternative or Implementation Activity	Description of Measurable Milestone	Milestones		Estimated Costs	
			0–5 Years	0–10 Years	0–5 Years	0–10 Years
Livestock, Wildlife, Domestic Animals, Riparian/Wetland	Inform residents and landowners of recommended priority practices	Number of people contacted	1,800	1,800	TBD	TBD
	Upland Wildlife Habitat Management (645)	Number of acres	81	323	$972	$3,876
	Vegetated Treatment Area (635)	Number installed	2	7	$8,266	$28,931
	Watering Facility (614)	Number installed	5	20	$42,850	$171,400
	Conservation Cover (327)	Number of acres	1	4	$3,333	$13,332
	Constructed Wetland (656)	Number of acres	0.25	1	$6,250	$25,000
	Pond (378)	Number installed	1	4	$4,000	$16,000
	Spring Development (574)	Number developed	1	3	$3,500	$10,500
	Filter Strip (393)	Number of acres	6	23	$456	$1,748
	Forest Stand Improvement (666)	Number of acres	23	92	$6,141	$24,564
	Riparian Forest Buffer (391)	Number of acres	2	6	$14,000	$42,000
	Riparian Herbaceous Cover (390)	Number of acres	7	29	$560	$2,320
	Tree/Shrub Establishment (612)	Number of projects	2	7	$5,840	$20,440
	Critical Area Planting (342)	Number of acres	1	5	$60	$300
	Fence (382)	Number of feet	11,300	45,200	$28,250	$113,000
	Heavy Use Area Protection (561)	Number installed	5	20	$2,600	$10,400
	Herbaceous Weed Control (315)	Number of acres	15	58	$1,050	$4,060
	Prescribed Grazing (528)	Number of projects	2	7	$4,800	$16,800
	Range Planting (550)	Number of acres	8	32	$912	$3,648
	Sediment Basin (350)	Number installed	2	7	$960	$3,360
	Streambank and Shoreline Protection (580)	Number of feet	830	3,320	$49,800	$199,200
	Waste Storage Facility (313)	Number installed	2	7	$6,400	$22,400
	Water and Sediment Control Basin (638)	Number installed	2	7	$12,000	$42,000
	Wetland Creation (658)	Number of acres	1	2	$3,700	$7,400
	Wetland Enhancement (659)	Number of acres	2	7	$720	$2,520
	Wetland Wildlife Habitat Management (644)	Number of acres	4	17	$340	$1,445
	Access Control (472)	Number of acres	15	58	$1,500	$5,800
	Diversion (362)	Number installed	2	7	$600	$2,100
	Grade Stabilization Structure (410)	Number installed	3	10	$28,800	$96,000
	Grazing Land Mechanical Treatment (548)	Number of acres	81	323	$1,701	$6,783

Table 4-8. Spring Creek Watershed Implementation Schedule, Milestones, and Costs (Page 3 of 3)

Category	Recommended Alternative or Implementation Activity	Description of Measurable Milestone	Milestones		Estimated Costs	
			First 5 Years	Last 5 Years	First 5 Years	Last 5 Years
Monitoring	Spring Creek water quality sampling and discharge measurement	Number of sites	16	7	$258,000	$105,000
	Tributary water quality sampling and discharge measurement	Number of sites	11	3	$102,000	$45,000
	Stormwater catchment water quality sampling and discharge measurement	Number of sites	2	2	$8,000	$40,000
	Monitor implemented project and/or practice effectiveness	Number of projects/practices	2	4	$32,000	$60,000

4.4 SOURCES OF TECHNICAL AND FINANCIAL ASSISTANCE

Technical and financial assistance sources that are available to implement the recommended alternatives and practices include private residents, property owners, companies, and organizations, in addition to local, state, and federal agencies. Some of these organizations and agencies also provide financial assistance. Private contributions, including in-kind and cash expenditures, are vital to accomplish watershed implementation. Agencies and organizations with technical and financial programs that could potentially assist are listed in Table 4-9.

Local coordination is essential to develop viable approaches that could fund proposed projects and achieve water quality improvements. Voluntary cooperation between residents, landowners, organizations, and agencies is necessary in implementing the recommended alternatives in the identified priority areas within the watershed. People interested in voluntarily installing conservation practices and recommended alternatives should be informed of the opportunities and incentives available for installing improvement project and practices.

Funding for potential watershed and conservation and implementation projects within the project area is provided primarily from the SD DENR, NRCS, USFS, BHNF, and the SD GF&P. Funds to implement watershed water quality improvements can be obtained through the SD DENR, which administers three major funding programs (the Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Nonpoint Source program) that provide low interest loans and grants for projects that protect and improve water quality in South Dakota.

Numerous Farmbill programs are available from NRCS to provide financial and technical assistance to eligible landowners, agriculture producers, and watershed stakeholders to implement conservation practices. Also, the Black Hills Resource Advisory Committee (RAC) funds projects to enhance forest ecosystems or restore and improve land health and water quality on the BHNF and other adjacent lands in Custer, Lawrence, and Pennington Counties through funding available from the Secure Rural Schools and Community Self-Determination Act. Additional funding and technical assistance sources include, but are certainly not limited to, Pennington and Custer Counties, Pennington Conservation District, Custer Conservation District, WDWDD, South Dakota Association of Conservation Districts (SDACD), South Dakota Conservation Commission, South Dakota Department of Agriculture (SDDA), and SDSM&T. More information can be found regarding other sources by visiting the *Catalog of Federal Funding Sources for Watershed Protection*, which is a searchable database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of watershed projects (*http://www.epa.gov/watershedfunding*).

Table 4-9. Sources of Technical and Financial Assistance in the Watershed

Agency or Organization	Website
City of Hill City	*www.hillcitysd.com/*
Custer County	*www.custercountysd.com/*
Pennington County	*www.pennco.org/*
Pennington Conservation District	*www.sdconservation.org/Districts/*
Custer Conservation District	*www.custercountysd.com/conservation-district/*
West Dakota Water Development District	*www.eastdakota.org/*
SDSU—Extension Resources Service	*www.sdstate.edu/sdces/store/index.cfm*
SDACD	*www.sdconservation.org/*
SD DENR	*http:// denr.sd.gov/*
South Dakota Game, Fish and Parks	*http:// gfp.sd.gov/*
SDDA	*http:// sdda.sd.gov/*
SDSU—Water Resources Institute	*www.sdstate.edu/abe/wri/*
South Dakota State Engineer's Office	*www.state.sd.us/boa/ose/*
South Dakota Water Management Board	*http:// denr.sd.gov/des/wr/wmb.aspx*
SDDOT	*www.sddot.com/*
South Dakota Office of Public Lands	*www.sdpubliclands.com/*
U.S. Army Corps of Engineers	*www.usace.army.mil*
NRCS	*www.nrcs.usda.gov*
Farm Service Agency	*www.fsa.usda.gov*
Rural Development	*www.rurdev.usda.gov*
Black Hills Resource Advisory Council	*www.fs.usda.gov/main/blackhills/workingtogether/ advisorycommittees*
USFS BHNF	*www.fs.usda.gov/main/blackhills/*
U.S. EPA	*www.epa.gov*
U.S. Fish and Wildlife Service	*www.fws.gov*
U.S. Geological Survey	*www.usgs.gov*
Black Hills Forest Resource Association	*www.bhfra.org/*
Rocky Mountain Elk Foundation Black Hills Chapter	*www.rmef.org/SouthDakota/BlackHills.aspx*
Black Hills Parks & Forests Association	*www.blackhillsparks.org/*
Ducks Unlimited	*www.ducks.org/south-dakota*
South Dakota Stockgrowers Association	*www.southdakotastockgrowers.org/*
South Dakota Cattlemen's Association	*www.sdcattlemen.org/*
South Dakota Association of Rural Water Systems	*www.sdarws.com*
National Forest Foundation	*www.nationalforests.org/*
National Fish and Wildlife Foundation	*www.nfwf.org*

4.5 INFORMATION, EDUCATION, AND OUTREACH

Conservation districts; nongovernmental organizations; and local, state, and federal government agencies have created several effective information, education, and outreach products and programs that have reached thousands of residents, landowners, and stakeholders during resource planning and public scoping efforts. During Segments 1 and 2 of the Spring Creek Watershed Management and Implementation Project, Pennington County developed several mailings, fact sheets, brochures, and website pages to inform residents and property owners about the project. Pennington County and the SD DENR have used parcel owner databases to create mailing lists to contact residents and property owners within the project area about project activities during Segments 1 and 2 of the Spring Creek Watershed Management and Implementation Project. As part of an adaptive implementation approach, education and outreach activities could survey targeted audience members to obtain information regarding delivery method effectiveness that helps develop and improve future efforts. Coordinated outreach should continue to increase awareness about the fecal coliform bacteria and *E. coli* problems and solutions and available technical and financial assistance for recommended alternatives and practices in priority areas within the watershed.

4.6 CRITERIA FOR WATERSHED MANAGEMENT PLAN GOAL ACHIEVEMENT

The criteria to determine if TMDL goals are being achieved in the Spring Creek Watershed is the primary contact recreation numeric criterion for fecal coliform bacteria and *E. coli* impairment in support of assigned beneficial uses. The state of South Dakota has assigned all streams with the beneficial uses of fish and wildlife propagation, recreation, stock watering, and

commerce and industry [South Dakota Legislature, 2012a]. In addition, Spring Creek was assigned coldwater permanent fish life propagation (above Sheridan Lake), immersion recreation, and limited-contact recreation in the project area. Additional beneficial uses for Sheridan Lake and Sylvan Lake include coldwater permanent fish life propagation, immersion recreation, and limited-contact recreation [South Dakota Legislature, 2012a]. Water quality standards in support of assigned beneficial uses have also been adopted by the state of South Dakota and include criteria that apply to streams and lakes based on these assigned uses [South Dakota Legislature, 2012a].

The state of South Dakota's water quality criteria for immersion recreation waters require that (1) no sample exceeds 400 cfu/100 mL and (2) during a 30-day period, the geometric mean of a minimum of five samples collected during separate 24-hour periods must not exceed 200 cfu/100 mL. Also, *E. coli* water quality criteria for immersion recreation waters state that (1) no sample exceeds 235 cfu/100 mL and (2) during a 30-day period, the geometric mean of a minimum of five samples collected during separate 24-hour periods must not exceed 126 cfu/100 mL. Both criteria are applicable from May 1 to September 30 [South Dakota Legislature, 2012a].

The project goal is to bring Spring Creek into compliance for fecal coliform bacteria and *E. coli* by implementing the recommended BMPs by 2021. The fecal coliform bacteria and *E. coli* load reductions required by the TMDL cannot be expected to be achieved within the scope of this watershed implementation plan under historical funding amounts; however, with proper planning and implementation effort, there is reasonable assurance that significant concentration reductions may be achieved with the availability of adequate technical and financial assistance.

4.7 MONITORING PROJECT EFFECTIVENESS

Before, during, and after implementing BMPs, monitoring is necessary to ensure attainment of the TMDLs are attained. During Segments 1 and 2 of the Spring Creek Watershed Management and Implementation Project, Pennington County, in partnership with several other project partners, developed and implemented water quality monitoring on Spring Creek and its tributaries from 2010 through 2013. Currently, Pennington County and the USFS are monitoring nine sites on Spring Creek and Palmer Gulch within the project area.

The purpose of the monitoring was to collect baseline information and to estimate the effectiveness of implementation activities targeted to reduce bacteria loads or transport within the project area. Additional monitoring and evaluation efforts should be targeted toward the priority areas identified in Section 4.1 of the plan. Future monitoring should continue to include synoptic discharge measurements at existing water quality sampling locations. Continuous-stage recorders could be installed at key locations within the watershed and stage-discharge relationships developed to convert continuous stage to continuous flow. Synoptic and continuous flow data will increase accuracy in future load calculations and evaluation of BMPs and implementation practices. While implementing this plan, the locations of monitoring sites should be continually assessed and updated by the Spring Creek Task Force and Pennington County to determine implementation effectiveness.

4.8 MODELING

Future monitoring, including water quality sampling and BMP effectiveness monitoring, should be used to enhance and update the models developed during Segments 1 and 2 of the Spring Creek Watershed Management and Implementation Project. As implementation projects are installed, models could be updated to better reflect conditions that result from completed projects and used to account for load reductions, land-use changes, and identifying priority areas. Updates to the model are recommended to be performed every 5 years to ensure proper refinement and accuracy of the models.

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