BELLE FOURCHE RIVER WATERSHED MANAGEMENT AND PROJECT IMPLEMENTATION PLAN SEGMENT 7 WATERSHED PROJECT FINAL REPORT SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM

TOPICAL REPORT RSI-2736

PREPARED FOR
Belle Fourche River Watershed Partnership
1837 5th Avenue South
Belle Fourche, South Dakota 57717

SEPTEMBER 2017

RESPEC

BELLE FOURCHE RIVER WATERSHED MANAGEMENT AND PROJECT IMPLEMENTATION PLAN SEGMENT 7 WATERSHED PROJECT FINAL REPORT SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM

TOPICAL REPORT RSI-2736

PREPARED BY

Matt Stoltenberg
Jared Oswald
Erin Walter

RESPEC
3824 Jet Drive
Rapid City, South Dakota 57703

PREPARED FOR

Belle Fourche River Watershed Partnership
1837 5th Avenue South
Belle Fourche, South Dakota 57717

SEPTEMBER 2017

Project Number 3124

EXECUTIVE SUMMARY

Project Title:	Belle Fourche River Watershed Management and Project Implementation Plan Segment 7
Grant Number(s):	C9-99818515-0, C9-99818513-0, C9-99818516-0
Project Start Date:	July 15, 2015
Project Completion Date:	July 31, 2017
Funding:	
Total EPA 319 Grant Budget:	$1,211,500
Total Matching Funds Budget:	$1,506,500
Total Nonmatching Funds Budget:	$847,400
Total Budget:	**$3,565,400**
Budget Revisions:	
June, 2013	
319 Award	$793,000
June, 2014	
319 Award	$400,000
March 2017 Amendment	$18, 500
Total Expenditures of EPA Funds:	$1,211,500
Total 319 Matching Funds Accrued:	$1,158,587
Total Nonmatching Funds Accrued:	$1,151,284
Total Expenditures:	**$3,521,371**

The Belle Fourche River Watershed Management and Project Implementation Plan Segment 7 was sponsored by the Belle Fourche River Watershed Partnership (BFRWP) with support from agricultural organizations, federal and state agencies, and local governments. This project continued implementing the best management practices (BMPs) that were identified in the Total Maximum Daily Load (TMDL) report for the Belle Fourche River. This project segment had the following objectives:

- Continue implementing BMPs in the watershed to reduce total suspended solids (TSS) to 19 milligrams per liter (mg/L) below the Belle Fourche Reservoir and 11 mg/L above the Belle Fourche Reservoir
- Continue implementing BMPs to reduce E. coli in the Belle Fourche River
- Continue providing public education and outreach to stakeholders within the Belle Fourche River Watershed
- Continue tracking the progress made toward reaching the goals of the TMDL to ensure that BMPs are effective and that the proper BMPs are implemented.

Several activities were completed to improve irrigation efficiencies after water was delivered to irrigated fields in the Belle Fourche River Watershed. A total of 17 center-pivot sprinkler systems on 1,200 acres were installed to replace existing surface-irrigated fields. Thirteen farmers participated in an irrigation scheduling project to optimize irrigation application on an estimated 1,300 acres.

Grazing/riparian areas were improved in the watershed, and 18 producers participated in range/riparian improvement projects during this segment. These projects include eight water development projects, two water development and riparian fencing projects, and eight cross-fencing projects that impacted over 2,055 riparian acres in the watershed. In addition to 319 projects, projects funded in the watershed by the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) positively affected approximately 40,000 acres that included improvement on approximately 1,000 riparian acres.

Approximately 25 public education and outreach events were completed during this project segment, including public meetings, informational booths, website maintenance, radio sound bites, rainfall simulator demonstrations, and watershed tours. Outreach and education efforts reached at least 10,000 people. A soil-quality demonstration trailer was purchased by the BFRWP in 2009 to demonstrate the effects of erosion on soils and how they relate to TSS. The trailer was used at several events that were sponsored by the BFRWP. The BFRWP hosted seven meetings to provide updates on project work and progress being made. The BFRWP website continues to be updated with events and project status (*www.bellefourchewatershed.org*). Outreach activities have helped to increase participation and support for the BFRWP and also gave the BFRWP several contacts for BMP installation. Several informative sound bites were broadcasted on local radio to increase public awareness of water quality issues and to promote project involvement.

Preliminary estimates based on BMP installation indicate that TSS was reduced by 34 mg/L, or 4,799 tons per year, in this segment. The amount brings the cumulative TSS load reduction to 173,477 tons per year toward the goal of 176,588 tons per year as identified in the TMDL. Currently, the project is in the ninth year of implementation. In addition to TSS, the installed BMPs are estimated to reduce *E. coli* by 62 most probable number (mpn), nitrogen by 4,145 pounds per year, and phosphorus by 2,303 pounds per year.

ACKNOWLEDGEMENTS

The BFRWP would like to thank those who were involved with this segment of implementing practices recommended by from the Belle Fourche River Watershed TMDL. The efforts of all those involved from the following organizations are greatly appreciated and have been essential to the success of this project:

- Belle Fourche Irrigation District
- Bureau of Land Management
- Butte County Conservation District
- Elk Creek Conservation District
- Individual ranchers, farmers, and landowners within the watershed
- Lawrence County
- Lawrence County Conservation District
- Natural Resources Conservation Service
- South Dakota Association of Conservation Districts
- South Dakota Conservation Commission
- South Dakota Department of Agriculture
- South Dakota Department of Environment and Natural Resources
- South Dakota Game Fish and Parks
- South Dakota Grassland Coalition
- South Dakota School of Mines & Technology
- South Dakota State University
- US Army Corp of Engineers
- US Bureau of Reclamation
- US Environmental Protection Agency)
- US Fish and Wildlife Service
- US Geological Survey
- Wyoming Department of Environmental Quality.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

1.0 INTRODUCTION

The Belle Fourche River is a natural stream that drains parts of Butte, Lawrence, and Meade Counties in South Dakota. The headwaters are located in Wyoming. The river flows into the Cheyenne River in southern Meade County and ultimately into the Missouri River. The watershed is shown in Figure 1-1. The Belle Fourche River Watershed encompasses approximately 2,100,000 acres (3,300 square miles) in South Dakota and includes Hydrologic Units 10120201, 10120202, and 10120203. The city of Spearfish with a population of 10,718 is the largest municipality located in the South Dakota portion of the watershed. Other South Dakota communities in the watershed include Deadwood (population of 1,380), Lead (3,124), Sturgis (6,644), Belle Fourche (5,658), Fruitdale (64), Nisland (232), and Newell (603).

Land in the watershed is used primarily for grazing with some cropland and a few urban areas. Wheat, alfalfa, native and tame grasses, and hay are the main crops, although corn is grown in the Belle Fourche Irrigation District (BFID). Gold mining (while reduced in scope from the past) and silviculture occur in the Black Hills portion of the watershed. Approximately 15 percent of the watershed is federally owned; 11 percent of the watershed is managed by the US Forest Service (USFS) and 4 percent is managed by the Bureau of Land Management (BLM), which is illustrated in Figure 1-1.

The Belle Fourche River from the Wyoming border to the mouth at the Cheyenne River is identified as impaired in the 1998 and 2002 *South Dakota 303(d) Waterbody Lists* and the 2004, 2006, 2008, 2010, 2012, 2014, and 2016 *Integrated Report for Surface Water Quality Assessment* because of elevated total suspended solids (TSS) concentrations. Except for in 2008 and 2010 when certain segments met the TSS standard, all other segments of the Belle Fourche River from Fruitdale to the mouth were impaired for TSS from 1998–2016. The Total Maximum Daily Load (TMDL) assessment included the full suite of water quality parameters in the mainstem Belle Fourche River and tributaries but only occurred in 2001–2002. Most of the tributaries only have data from 2002. A summary of the five impaired segments of the Belle Fourche River Watershed and Horse Creek in the 2016 Integrated Report (IR) is provided in Table 1-1, which also lists the impaired beneficial use, impairment parameter, water quality criteria, and possible source. The impaired segments are shown on Figure 1-2. The Belle Fourche River is monitored quarterly at South Dakota Department of Environment and Natural Resources' (SD DENR's) five historic water quality monitoring (WQM) stations, of which three are currently active. Other tributaries, such as Whitewood Creek, have also experienced TSS problems.

Horse Creek was listed in the 1998 impaired waterbody list for total dissolved solids (TDS), but this was later determined to be a listing error. The Horse Creek listing was corrected to conductivity during 2002 and listed for conductivity or specific conductance in 2006, 2008, and 2010. Conductivity measurements stopped in 2012. In the 2016 IR, Horse Creek was listed for TSS and *E. coli.* Horse Creek is currently being monitored for pH and turbidity with periodic TSS and *E coli* grab samples.

The Belle Fourche River from the Wyoming border to the Redwater River was first listed for pathogens in the *2002 South Dakota Report to Congress 305(b) Water Quality Assessment* and continued to be listed for fecal coliform and then *E. coli* in successive IRs (2004, 2006, 2008, 2010, 2014, and 2016). The Redwater River failed to support its Immersion Recreation beneficial use because of elevated levels

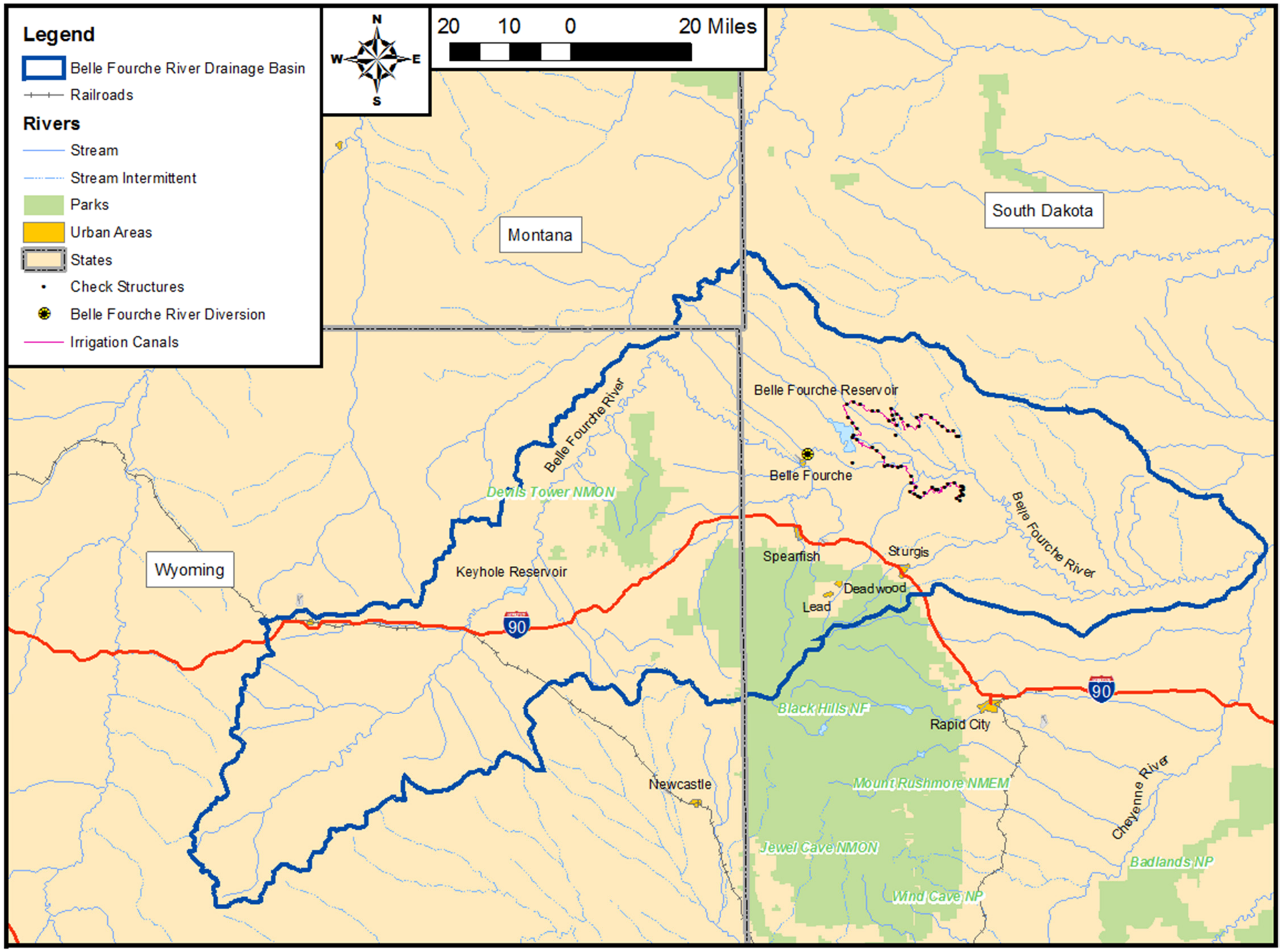

Figure 1-1. Belle Fourche River Watershed.

Table 1-1. Summary of Belle Fourche River Exceedance Water Quality Data From the 2016 Integrated Report

Stream	Stream Reach	Beneficial Use	Impairment Parameter	Water Quality Criteria	Source
Belle Fourche River	Wyoming Border to Redwater River, South Dakota	Immersion Recreation	Fecal Coliform (per/100 mL)	200[a]/400[b]	Wildlife, Livestock, Urban Runoff
		Immersion Recreation	*E. coli*	126[a]/235[b]	Wildlife, Livestock, Urban Runoff
		Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	Irrigated Crop Production
Belle Fourche River	Redwater River to Whitewood Creek	Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	N/A[c]
Belle Fourche River	Whitewood Creek to Willow Creek	Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	N/A
Belle Fourche River	Whitewood Creek to Willow Creek	Immersion Recreation	*E. coli*	126[a]/235[b]	N/A
Belle Fourche River	Willow Creek to Alkali Creek	Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	N/A
Belle Fourche River	Alkali Creek to Mouth	Immersion Recreation	Fecal Coliform (per/100 mL)	200[a]/400[b]	Livestock
		Immersion Recreation	*E. coli*	126[a]/235[b]	Livestock
		Limited Contact Recreation	Fecal Coliform (per/100 mL)	1,000[a]/2,000[b]	Livestock
		Limited Contact Recreation	*E. coli*	630[a]/1,178[b]	Livestock
		Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	N/A
Horse Creek	Indian Creek to mouth	Limited Contact Recreation	*E. coli*	126[a]/235[b]	N/A
Horse Creek	Indian Creek to mouth	Warm-Water Semipermanent Fish Life	TSS (mg/L)	90[a]/158[b]	N/A

mL = milliliters.
mg/L = milligrams per liter.
(a) 30-day average.
(b) Daily maximum.
(c) N/A = Not available.

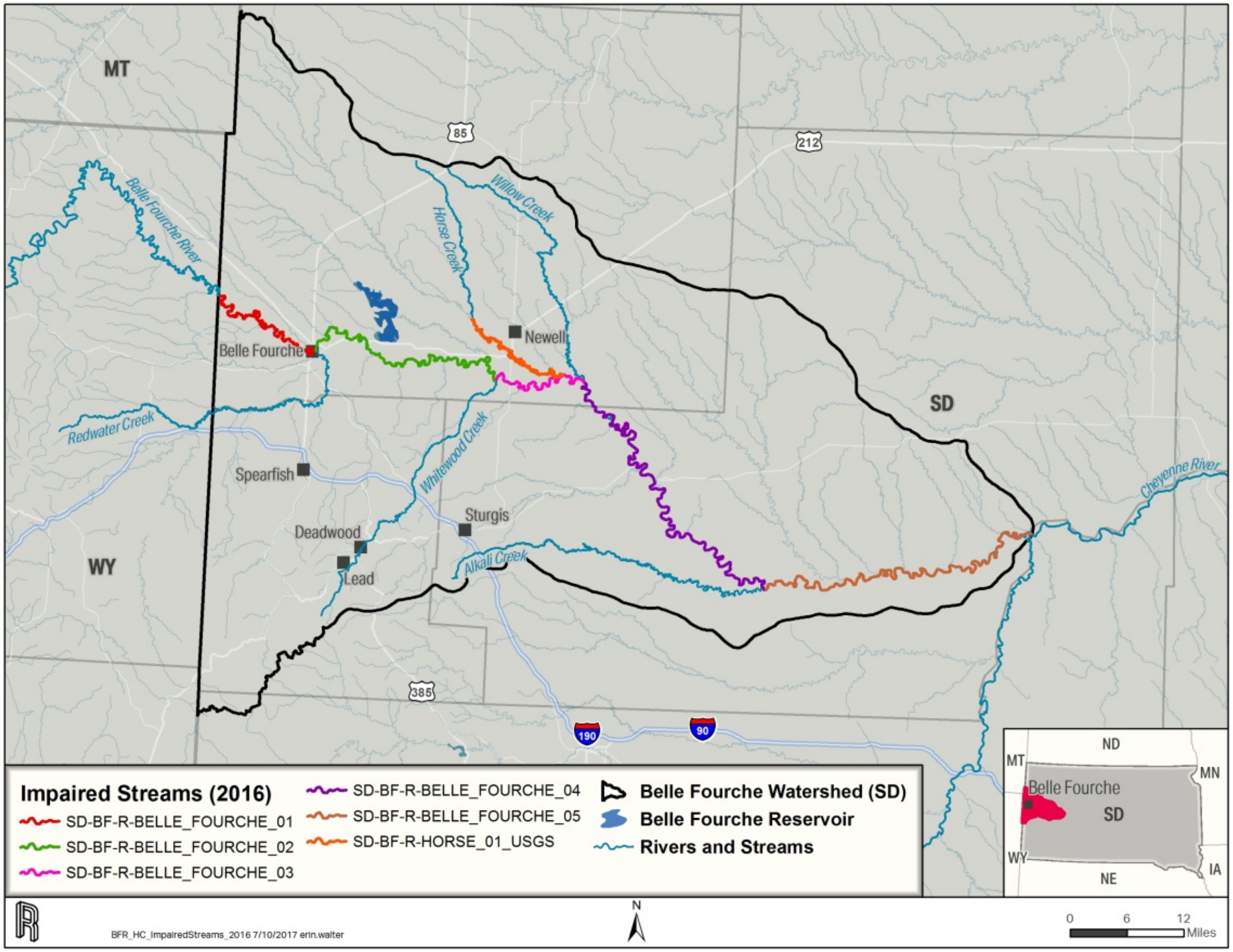

Figure 1-2. Belle Fourche River Impaired Stream Segments.

of bacteria. Belle Fourche River Segment 5, from Alkali Creek to the mouth, has been listed for bacteria from 2010–2016 and has an approved *E. coli* TMDL. Belle Fourche Segment 3 from Whitewood to Willow Creek has been listed for *E coli* in the 2016 Integrated Report. Other tributaries (e.g., Deadwood Creek, Whitewood Creek and West Strawberry Creek) have also experienced bacteria impairment. Temperature has been an impairment in Bear Butte Creek, Redwater Creek, Whitewood Creek and West Strawberry Creek. Specific conductance has been an issue in Willow Creek; PH has been an impairment in Spearfish Creek, Whitewood Creek, and West Strawberry Creek; and cadmium, copper, and zinc have impaired West Strawberry Creek.

The Belle Fourche River Watershed Partnership (BFRWP) completed a water quality assessment project that led to developing a TSS TMDL for the Belle Fourche River and Horse Creek. The project period extended from April 2001 through 2003. Six TMDLs were approved by the US Environmental Protection Agency (EPA) for the Belle Fourche River and Horse Creek in 2005. Based on the results of the watershed study, the main sources of TSS were determined to be rangeland erosion, irrigation return flows, free-cattle access to streams, riparian degradation, natural geologic processes, hydraulic alteration by irrigation, and reduced stream miles. The *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan* [Hoyer, 2005] that was developed to implement the TMDL includes recommendations for reducing TSS concentrations by using practices that include irrigation water management, riparian rehabilitation, and grazing management. As part of the Segment 4 implementation project, the fecal coliform TMDL has been developed for Whitewood Creek.

During the winter of 2004, the BFRWP applied for and received a Clean Water Act Section 319 Grant to begin implementing the Best Management Practices (BMPs) recommended in the TMDLs for the Belle Fourche River. Currently, the BFRWP is in its 11th year of implementing BMPs in the watershed and has been funded through fiscal year 2017 with the Segment 7 proposal. The project is supported by agricultural organizations, federal and state agencies, local governments, South Dakota State University (SDSU), and the South Dakota School of Mines & Technology (SDSM&T).

Funding for the project included support from local ranchers and farmers, the BFRWP, SD DENR, US Fish and Wildlife Service (USFWS), Lawrence County, BFID, Wyoming Department of Environmental Quality (WDEQ), Natural Resources Conservation Service (NRCS), Bureau of Reclamation, US Geological Survey (USGS), and the Clean Water Act Section 319 Grant. Products of the first implementation project segment were the *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan* [Hoyer, 2005] and the *Belle Fourche Irrigation District Water Conservation Plan* [Rolland and Hoyer, 2005]. These plans outline BMP installation activities to be completed in this project for a 10-year time frame, and associated TSS and unused water savings are presented for each action planned. The BMPs recommended by the TMDLs and the 10-year plan installed during this project segment include replacing open irrigation ditches with pipeline, lining open irrigation ditches, installing pipelines to deliver water from the BFID system to the fields, installing irrigation sprinkler systems within the BFID, scheduling irrigation events, and grazing management.

2.0 PROJECT GOALS AND OBJECTIVES

The goal of the Belle Fourche River Watershed Management Project is to bring the Belle Fourche River and Horse Creek into compliance with water quality standards within 10 years. To accomplish this goal, a 55 and 41 percent reduction of TSS load will be required for the Belle Fourche River and Horse Creek, respectively.

In this project segment, the concentration reduction goal is 30 mg/L. To accomplish this goal, this project segment had the following three objectives:

1. Implement BMPs Recommended to Reduce TSS
2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, and Future Grants Writing
3. Complete Essential Water Quality Monitoring and TMDL Development.

Progress toward reaching the goals of the TMDL will continue to be tracked to ensure that the BMPs are effective and that the proper BMPs are being implemented.

2.1 PLANNED AND ACTUAL MILESTONES, PRODUCTS, AND COMPLETION DATES

Objective 1. Implement BMPs Recommended to Reduce TSS. This objective consisted of two tasks: (1) improving irrigation water management and (2) implementing riparian vegetation improvements and improved cropping systems. The products of this objective included installing 17 sprinkler irrigation systems to replace existing flood irrigation on 1,200 acres; scheduling irrigation on 1,300 acres; implementing rangeland projects that benefit 2,055 riparian acres; and improve cropping systems on approximately 300 acres. BMP implementation is discussed further in Chapter 3.0.

Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, and Future Grants Writing. Approximately 25 outreach activities were conducted and involved approximately 10,000 participants. Additionally two Grant Tracking and Reporting System (GRTS) reports and this final report were written. These activities are further discussed in Chapter 4.0 of this report.

Objective 3. Complete Essential Water Quality Monitoring and TMDL Development. Water quality samples were collected by the USGS at real-time stream gaging sites and the SD DENR at several WQM sites in the watershed. A detailed statistical analysis is included in Chapter 5.0 of this report.

Table 2-1 lists the project objectives along with their products, planned milestone completion dates, and actual milestone completion dates. All BMPs were completed by the July 2017 deadline and final reporting was completed by July 2017.

Table 2-1. Planned Versus Actual Milestone Completion Dates

BFRWP Implementation	Planned Completion	Actual Completion
Objective 1. Implement BMPs Recommended to Reduce TSS		
Product 1. Improve Irrigation Delivery and Application	July 2017	July 2017
Product 2. Complete and Install Riparian Area BMPs	July 2017	July 2017
Objective 2. Conduct Public Education and Outreach		
Product 3. Public Outreach, Report Writing, Federal Audit	July 2017	July 2017
Objective 3. Complete Essential Water Quality Monitoring		
Product 4. Water Quality Monitoring	July 2017	July 2017
Product 5. Whitewood Creek Temperature TMDL	July 2017	July 2017

2.2 EVALUATION OF GOAL ATTAINMENT

Project success was evaluated by comparing project outputs and outcomes with the planned milestones. Sediment reduction goals were met for this segment, and BMP accomplishments were close to the goals outlined in the project implementation plan. Some goals were not completely met and others were higher than expected, which resulted in sediment reductions higher than expected. Further explanations of these changes are shown in Section 3.1 of this report. The following milestones were obtained:

/ Implemented several recommended BMPs within the *Phase I Watershed Assessment Final Report and TMDL* [Hoyer and Larson, 2004]

/ Obtained reductions, estimated as a result of BMP installation, of 34 mg/L (4,539 tons per year)

/ Completed approximately 25 successful education and outreach activities, which led to greater public participation in the project, completion of annual GRTS reports and this final report, and two required federal audits.

This project successfully implemented BMPs to reduce sediments. Although the type of BMP implementation may have changed from the outlined goals, overall progress toward sediment reduction was made. BMPs were implemented and are estimated to reduce TSS in the Belle Fourche River by approximately 4,799 tons per year. Table 2-2 shows pollutant reductions that were achieved by each implemented BMP. Reductions are recorded in both milligrams per liter and tons per year. The mg/L units were derived from the original HSPF model used for the TMDL. Sediment reductions reported in tons per year and nitrogen and phosphorous in pounds per year were derived from combining Spreadsheet Tool for Pollutant Load (STEPL) and literature values for load reductions when STEPL was not applicable.

Table 2-2. Pollutant Reduction Achieved by Each Best Management Practice Implemented

Best Management Practice	Modeled Sediment Reductions[a] (mg/L)	StepL/Book Value Sediment Reductions (tons/year)	StepL/Book Value Nitrogen (lbs/yr)	StepL/Book Value Phosphorous (lbs/yr)
17 Sprinkler Irrigation Systems	28	3,400	1,785	1,530
Irrigation Scheduling	N/A	260	105	90
Managed Grazing	6	917	1441	382
Improved Cropping	N/A	222	814	301
Totals	34	4,799	4,145	2,303

(a) Based on the HSPF model in the TMDL.

3.0 BEST MANAGEMENT PRACTICES

Installing the recommended BMPs in the Belle Fourche River TMDL continued during this project segment and included funding from local ranchers and farmers, the BFID, USFWS, and NRCS along with the EPA's 319 program. The following BMPs were installed:

- Seventeen irrigation sprinkler systems to replace flood irrigation on 1,200 acres
- Thirteen producers to complete irrigation scheduling on approximately 1,170 acres
- Eight water development projects, two water development and riparian deferment projects, and eight pasture cross-fencing projects that involved 18 producers and improved 2,055 riparian acres
- Environmental Quality Incentives Program (EQIP) projects in the watershed positively affected 40,000 acres that included improvement on 1,000 riparian acres
- Improved cropping systems on over 300 acres of cropland.

Table 3-1 provides a status of the BMP implementation planned and implemented to date. Table 3-2 shows BMP implementation for Segment 7 and identifies funding sources as 319 or other.

Table 3-1. Best Management Practices Implemented

Best Management Practice	Planned This Segment	Installed This Segment	Installed to Date
Sprinkler Irrigation Systems	21 on 1,640 acres	17 on 1,200 acres	114
Irrigation Scheduling	20 producers on 1,000 acres	13 producers on 1,170 acres	
Managed Riparian Grazing (Acres)	3,000	2,055	34,393
Improved Cropping Practices	200	300	300
Complete Essential Water Quality	1	1	N/A
Information and Education Events	20	25	N/A

Table 3-2. Best Management Practices Implemented With Funding Sources Identified

Best Management Practice	Installed This Segment	319 ($)	Other ($)	Total ($)
Sprinkler Irrigation Systems	17 on 1,200 acres	617,407 (38%)	1,023,358 (62%)	1,640,765
Irrigation Scheduling	13 producers on 1,170 acres	35,000 (100%)	0	35,000
Managed Riparian Grazing (Acres)	2,055	180,043 (15%)	992,513 (85%)	1,172,556
Improved Cropping Practices	300	10,000 (100%)	0	10,000
Complete Essential Water Quality	1	30,000 (9%)	294,000 (91%)	324,000
Information and Education Events	25	12,728 (100%)	0	12,728
Total		$885,178 (28%)	$2,309,871 (72%)	$3,195,049

3.1 REDUCING NONUSED IRRIGATION WATER AND IMPROVING EFFICIENCY

3.1.1 ON-FARM IRRIGATION IMPROVEMENTS

Seventeen center-pivot sprinkler systems were installed to replace existing surface irrigation on 1,200 acres during this segment. The goal for this segment was converting 21 sprinkler systems on 1,640 acres. Although abundant interest exists locally to convert flood irrigation systems to sprinklers, EQIP funding has been reduced across the entire state of South Dakota for all practices. This led to less irrigated acres being converted than estimated for this segment. Converting from surface or flood irrigation to sprinkler irrigation reduces wastewater, which reduces sediments that reach waterways and act as a drain for the BFID. Figure 3-1 shows a photograph of a flood-irrigated field demonstrating inefficient water use that leads to an increased sediment load in the Belle Fourche River. Figure 3-2 shows an improved center-pivot irrigation system that greatly reduces runoff of excess water, which was partially funded by the project. The general locations of producer-irrigation BMPs that were implemented during and before Segment 7 are shown in Figure 3-3.

Figure 3-1. Flood-Irrigated Field Demonstrating Inefficient Water Use That Leads to Sediment Runoff.

Figure 3-4 illustrates 201 center-pivot sprinkler systems that have been installed in the Belle Fourche River Watershed. The BFRWP has had an active role in funding 114 of these pivots. Other pivots have been funded independently by NRCS or by individual producers. These 201 pivots cover approximately 20,072 acres. Approximately 17,000 acres that have suitable soils for sprinkler irrigation remain in the BFID. In Figure 3-4, green represents the implemented acres; yellow represents untreated acres with desirable soils; and untreated, undesirable soils are represented in pink. Realistically, of the remaining 17,000 acres with desirable soils, only about one-half of the acres would be suitable or economically feasible to implement center-pivot sprinkler systems because of the size and shape of the fields.

Implementation efforts would reach nearly 60 percent of the total potential conversion from flood irrigation to sprinklers irrigation.

Figure 3-2. Center-Pivot Irrigation System Installed in the Belle Fourche River Watershed.

3.1.2 IRRIGATION SCHEDULING

Sprinkler irrigation greatly reduces excess runoff, improves water efficiencies, and reduces sediments in waterways. Proper timing of irrigation events is imperative to maximize these benefits. The BFRWP has recognized this and has received funding in the past from an NRCS Conservation Innovation Grant (CIG) to work with producers in scheduling timely irrigation events. This CIG expired in 2010, and although local participating producers had gained knowledge from the project, technical assistance was needed to continue adopting this technology. During this funding segment, technical service was provided to 13 irrigators on approximately 1,170 acres. The participating farmers were provided sensors and a datalogger to record soil moisture and technical assistance from project staff to schedule timely irrigation events. Figure 3-5 shows an example of a soil-moisture graph that was provided to the producer. The two lines represent the two soil-moisture sensors at different rooting depths. The number on the left represents moisture where 0 is saturated and 200 is dry. As the moisture of the sensors reach different zones of soil saturation (represented by the colored bars), recommendations can be made for irrigation application. This practice greatly increased water efficiencies and reduced excess runoff.

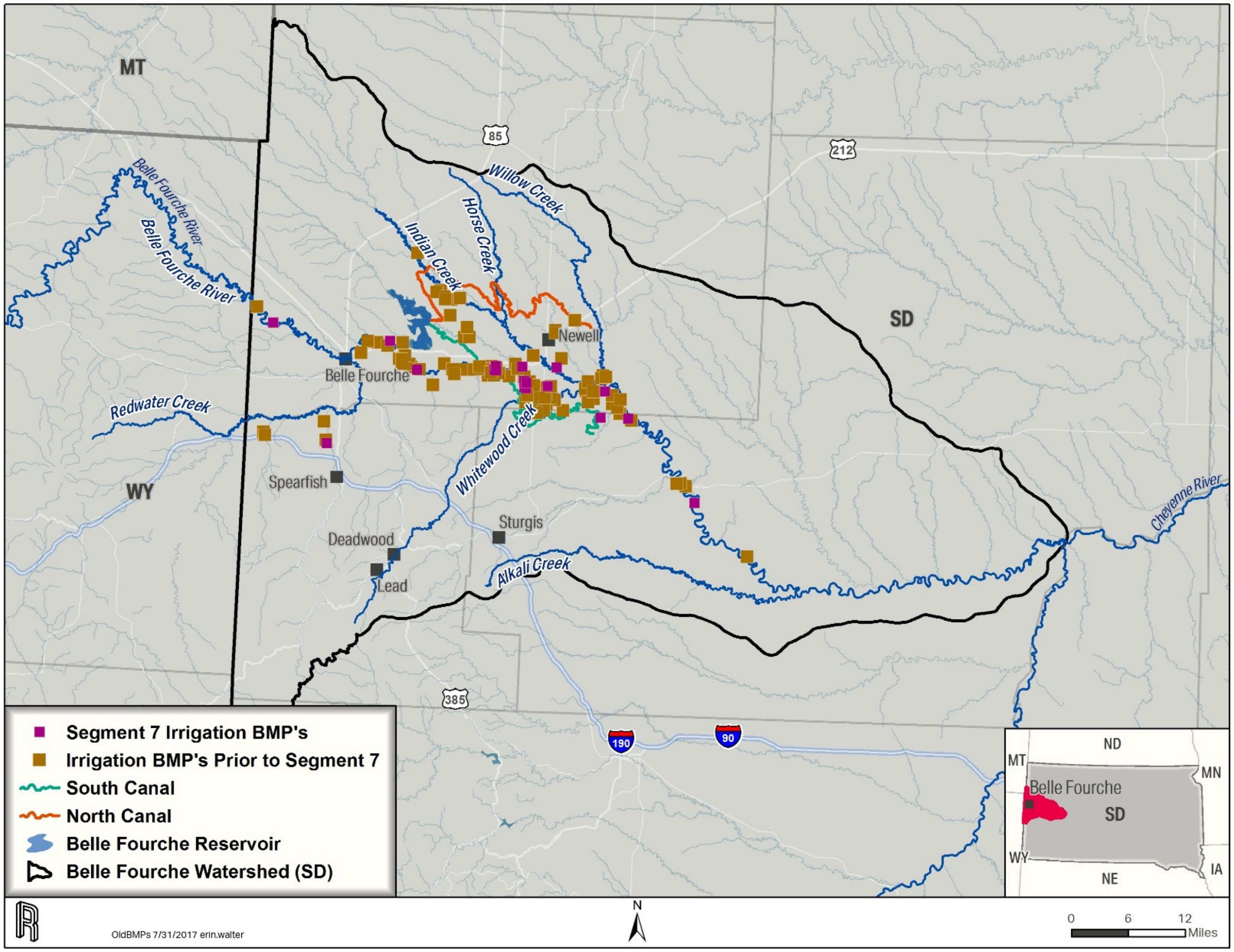

Figure 3-3. General Location of Producer-Irrigation Best Management Practices During Segment 7 and Before Segment 7.

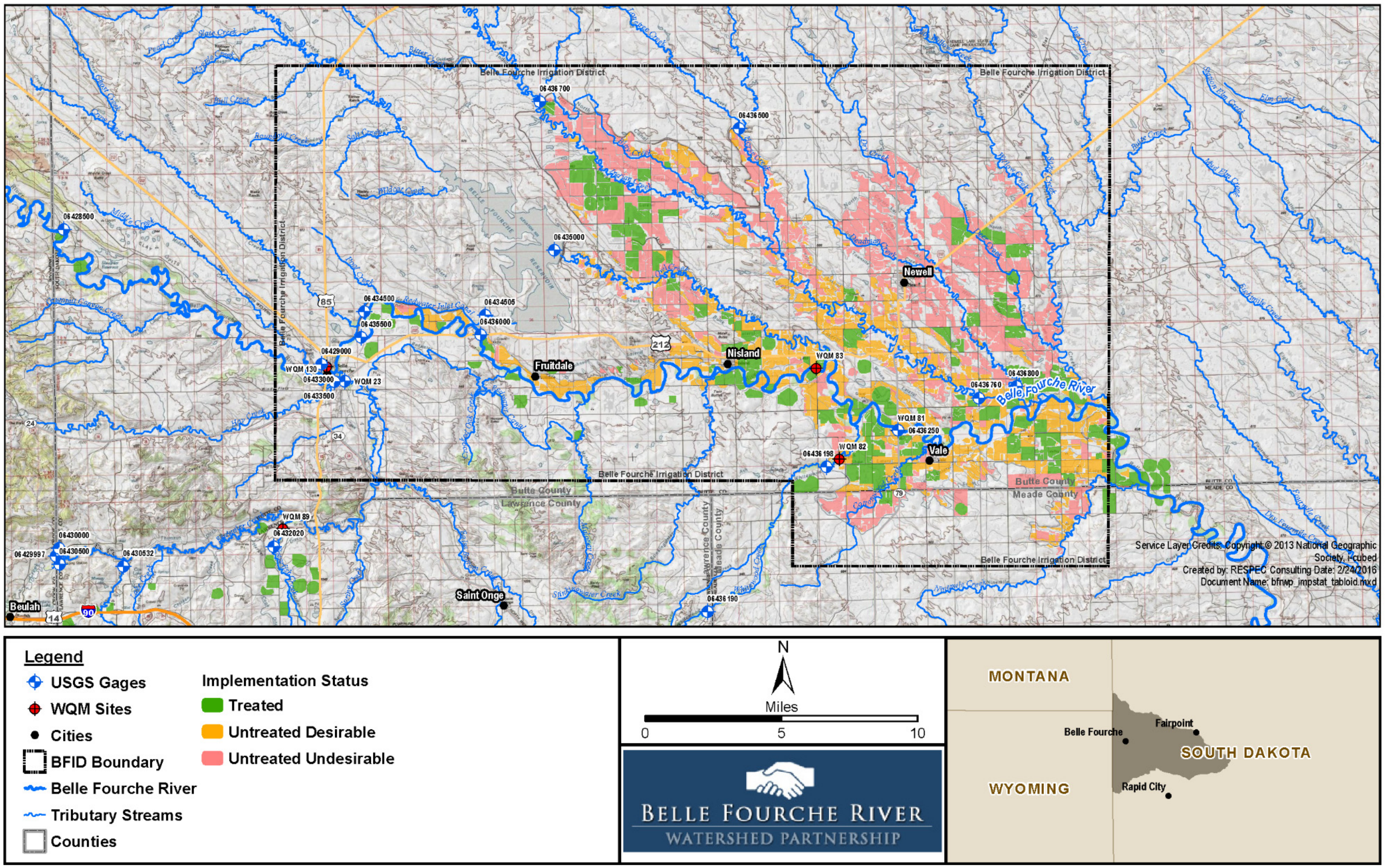

Figure 3-4. Locations of the 201 Center-Pivot Sprinkler Systems That Were Installed in the Belle Fourche River Watershed.

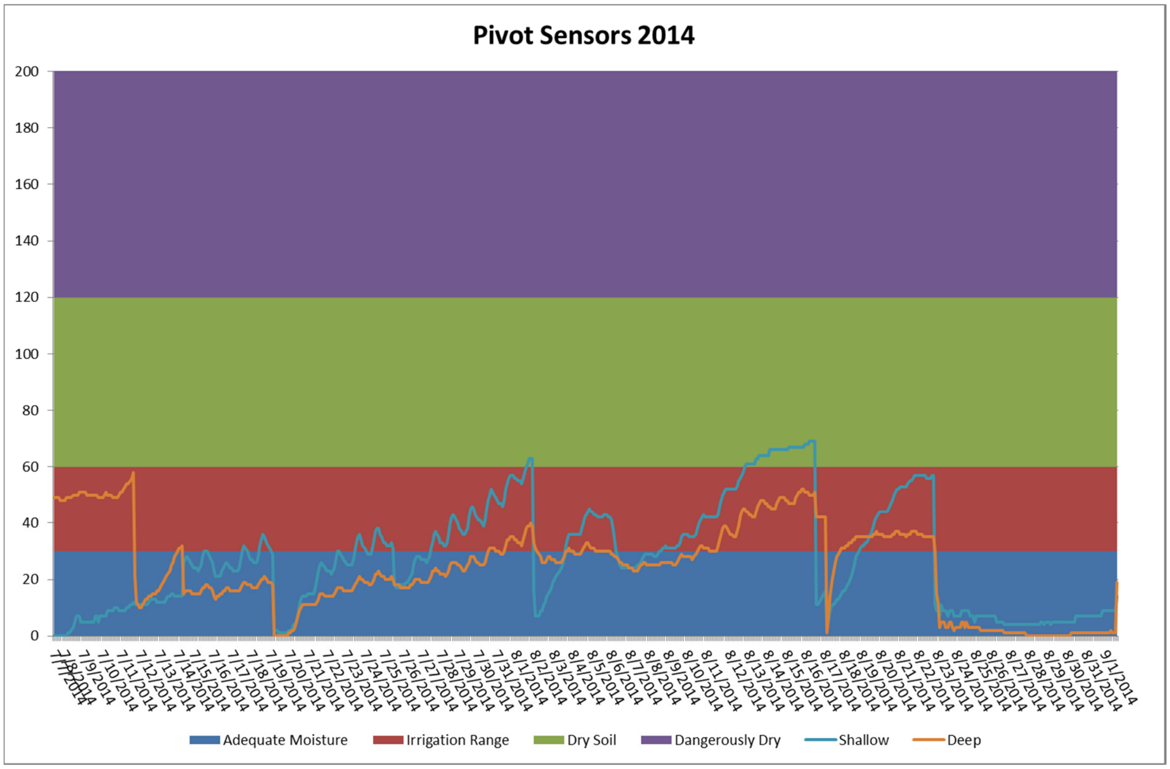

Figure 3-5. Soil Moisture Graph Provided to Producer to Improve Irrigation Water Management.

3.2 RANGE RIPARIAN IMPROVEMENTS

Improved grazing distribution maintains or improves the integrity of the riparian corridor of the watershed. Healthy riparian areas are integral to trapping sediment from rangeland runoff and reducing TSS entering the Belle Fourche River. After installing riparian/grazing BMPs, riparian areas improved within the watershed. Eighteen producers participated in range/riparian improvement projects during this segment. These projects include eight water development projects, two water development and riparian deferment projects, and eight cross-fencing projects that impacted over 2,055 riparian acres in the watershed; however, the goal of 3,000 acres was not met. The estimate of 3,000 acres in the proposal may have been too ambitious, and estimating NRCS involvement and specifically measuring riparian acres that have improved are very challenging. The NRCS' tracking system takes in a broader measure of conservation efforts that are not specific to riparian. The location of the riparian vegetation improvement projects funded with Segment 7 funds and projects funded before Segment 7 is illustrated in Figure 3-6. Figure 3-7 shows a livestock water tank outside of a livestock deffered stream, and Figure 3-8 is a photograph buried pipe being installed for livestock water development.

Outside of grazing projects, the BFRWP teamed with the Belle Fourche Weed Management group to provide funds for native plant rehabilitation along the Belle Fourche River after the controlling the locally noxious plant phragmites. This streambank stabilization project is an ongoing effort that has received funds from the Wild Turkey Federation, the South Dakota Conservation Commission, local county governments, and other private entities. Watershed staff helped the group obtain alternative funding sources to fund the rehabilitation efforts. This project is currently in its seventh and final year of restoring native vegetation on the Belle Fourche River on over 750 acres.

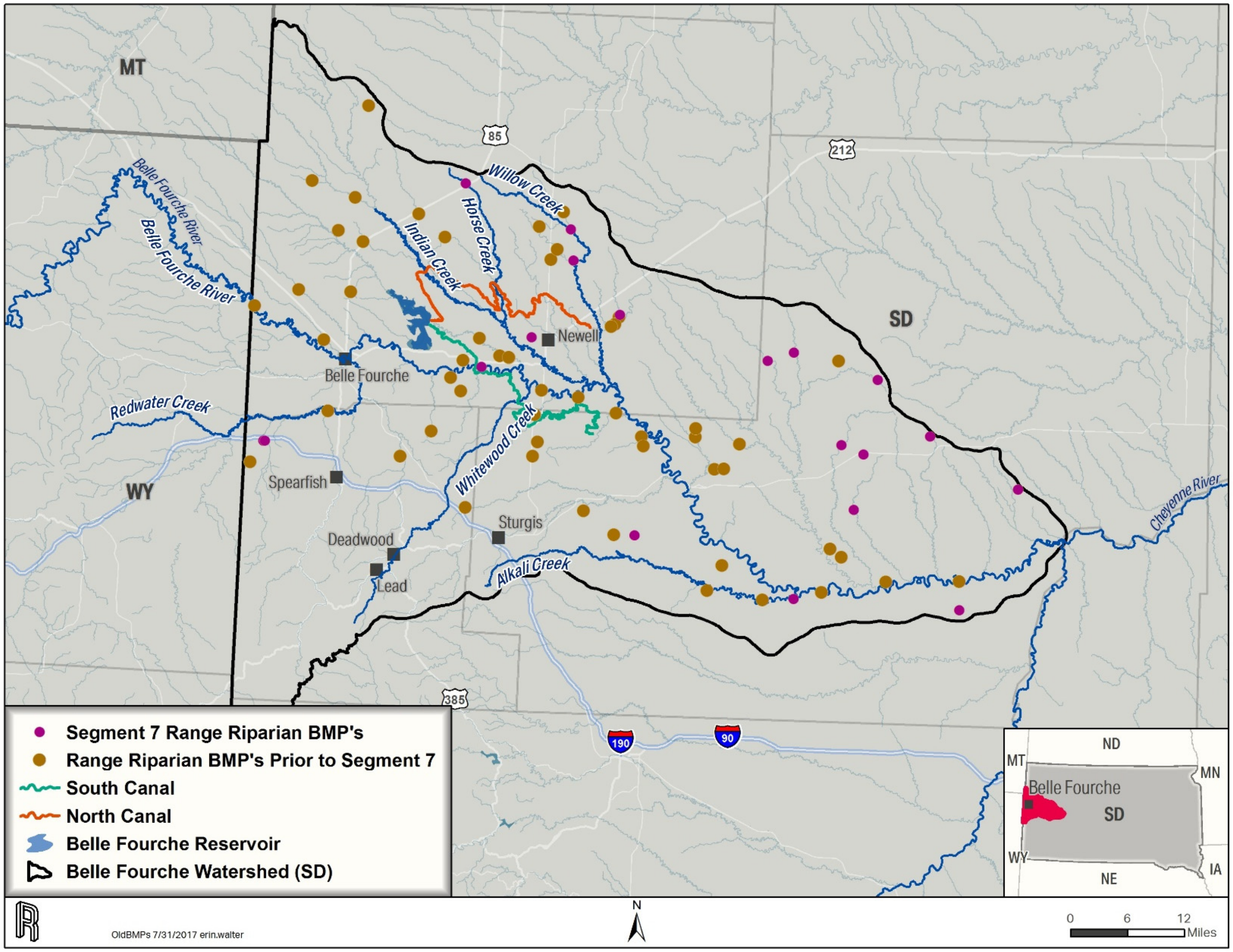

Figure 3-6. General Location of Producer-Range Riparian Best Management Practices During and Before Segment 7.

Figure 3-7. Riparian Exclusion Site on a Ranch Where Grazing Plans and Water Development Were Used to Improve the Range and Riparian Health.

Figure 3-8. Livestock Water Pipeline Installation.

In addition to 319 projects, the NRCS EQIP-funded projects in the watershed positively affected 40,000 acres that included improvement on 1,000 riparian acres.

3.2.1 IMPROVED CROPPING PRACTICES

The BFRWP funded four cover-crop demonstration sites that provided a stipend to the willing participants and demonstrated cover-crop and no-till farming practices on approximately 300 acres. In the fall of 2016, the BFRWP partnered with SDSU, NRCS, and the South Dakota Soil Health Coalition to conduct a field day that showcased these sites. The event was well attended by local producers and producers from outside of the watershed. The event provided an excellent platform to transfer knowledge. In addition to this field day, the BFRWP cosponsored two soil health workshops in Belle Fourche to further promote trends toward improved cropping practices in the watershed. Figure 3-9 shows the location of the cover crop demonstration sites.

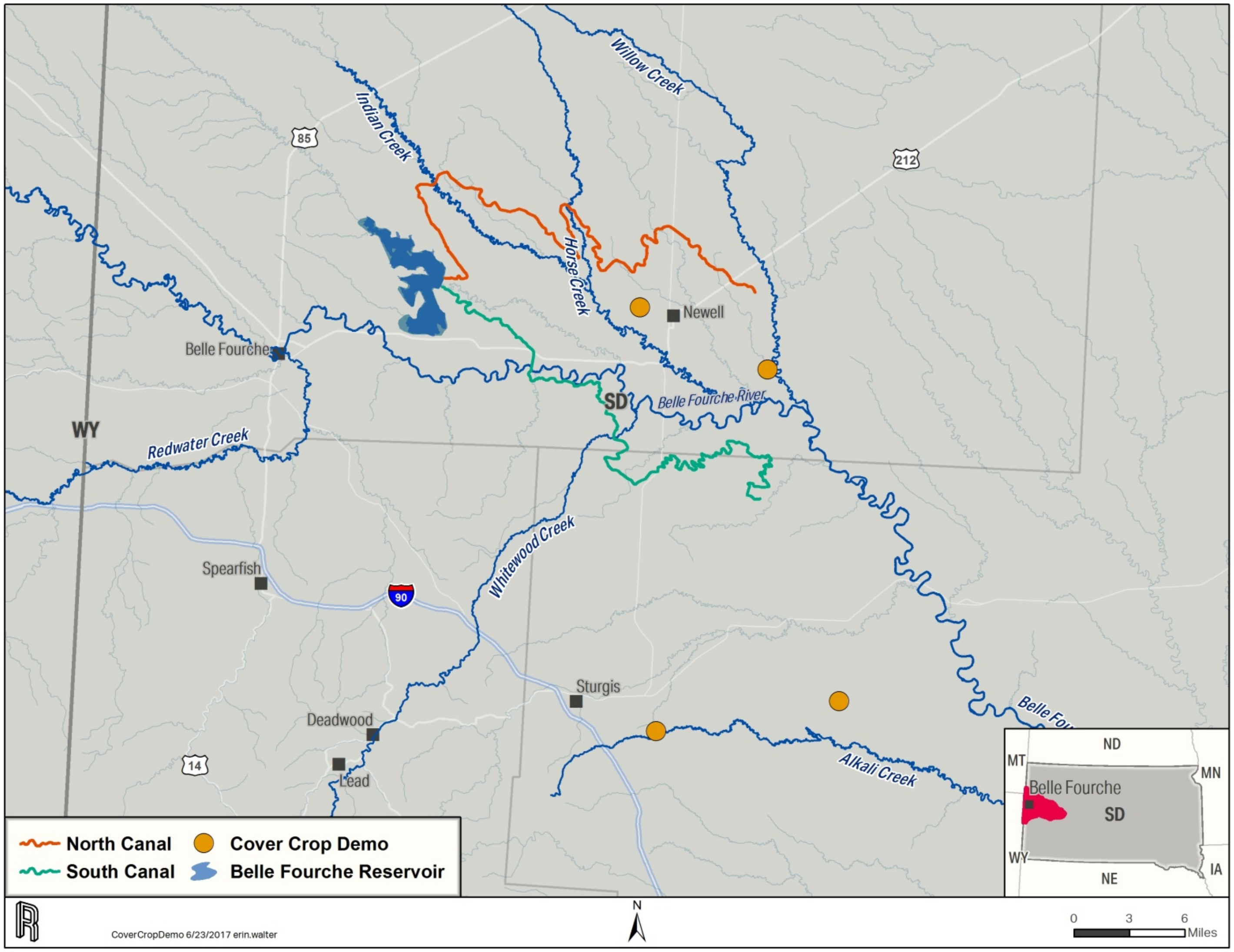

Figure 3-9. Location of Improved Cropping Practice Demonstration Sites.

4.0 SUMMARY OF PUBLIC PARTICIPATION AND OUTREACH

Approximately 25 public education and outreach events were completed during this project segment in the form of public meetings, informational booths, website maintenance, radio sound bites, rainfall simulator demonstrations, and watershed tours. A summary of the events are listed in Table 4-1. Outreach and education efforts reached an estimated 10,000 people. A soil-quality demonstration trailer was purchased by the BFRWP in 2009 to demonstrate the effects of erosion on soils and how they relate to TSS. The trailer was used at several events sponsored by the BFRWP. The BFRWP hosted six meetings to provide updates on project work and progress. The BFRWP website continues to be updated with events and project status (*www.bellefourchewatershed.org*). Outreach activities have helped to increase participation and support for the BFRWP and also gave the BFRWP several contacts for BMP installation. Several informative sound bites were broadcasted on the local radio to increase public awareness of water quality issues and to promote project involvement.

Table 4-1. Summary of Public Outreach and Education During Segment 7

Type of Education and Outreach	Date	Number of Participants
BFRWP Meetings (6 Meetings)	July 1, 2015–July 31, 2017	90
Society for Range Management Range Tour and Rainfall Simulator Demonstration	2015, 2016, 2017	90
Vale Ag Show, Booth	2016, 2017	450
South Dakota Association of Conservation Districts Tour	2016	50
Board of Water and Natural Resources Tour	2016	50
No-Till/Cover-Crop Tour Demonstration Site Tour	2016	70
Ranchers Roundup, Union Center, Booth	2015, 2016	400
South Dakota Adult and Youth Range Camp	2016, 2017	150
Cover-Crop Information Day With SDSU	2017	50
South Dakota Leopold Award Sponsorship	2015, 2016	NA
Butte County Range and Soil Health Tour	2017	50
Meade County Range and Soil Health Tour	2017	50
Informational Radio Sound Bites	2016, 2017	7,000
Website	2015–2017	1,500

The BFRWP sponsored or cosponsored eight tours in the watershed during Segment 7. These tours included local producers; state and federal agency staff; local, state, and federal government officials; and the public. Partners in these tours included the Butte, Lawrence, and Elk Creek Conservation Districts; the South Dakota Association of Conservation Districts; SDSU Cooperative Extension; South Dakota Society for Range Management; NRCS; and Bureau of Reclamation. These tours showcased projects that were sponsored by the BFRWP that included irrigation demonstrations in the BFID, rangeland demonstrations on ranches in the watershed, and an improved cropping system demonstration site tour. These outreach activities helped increase participation and support for the BFRWP and also gave the BFRWP several contacts for BMP installation.

RESPEC

The South Dakota Association of Conservation Districts annual meeting tour of the Belle Fourche River Watershed that demonstrates accomplishments is illustrated in Figure 4-1. Figure 4-2 shows one of the tours that demonstrated no-till and cover-crop practices that are being adopted in the watershed.

Figure 4-1. South Dakota Association of Conservation Districts Annual Meeting Tour of the Belle Fourche River Watershed Demonstrating Best Management Practices Accomplishments.

Figure 4-2. Soil Health Tour Demonstrating the Benefits of No-Till and Cover Crops in Improving Soil Health and Water Quality Grazing Management Tour in the Watershed.

5.0 MONITORING RESULTS

The following sections outline and summarize all applicable, pertinent and relevant water quality data within the Belle Fourche River Watershed in South Dakota.

5.1 IMPAIRED WATERBODIES AND US ENVIRONMENTAL PROTECTION AGENCY APPROVED TOTAL MAXIMUM DAILY LOADS

The Belle Fourche River Basin in South Dakota contains 13 impaired streams, as shown in Figure 5-1. These waterbodies are listed as nonsupportive of their assigned beneficial uses and are specified in the South Dakota's 2016 Integrated Report [SD DENR, 2016]. Five of the listed impairments are located on the Belle Fourche River, while the remaining eight impaired stream reaches are located on tributaries to the Belle Fourche River. A summary of the current impaired waterbodies within the project area, the number of years impaired, the impairments, TMDL status, and their respective water quality criteria threshold values is provided in Table 5-1.

5.2 DISCHARGE ANALYSIS

Flow in the Belle Fourche River can be significantly impacted by meteorological events and periods of wet and dry climatic conditions as observed through the seasons in the watershed. Discharge rates observed in the Belle Fourche River are influenced not only by seasonal climatic conditions and storm events, but they also heavily depend on irrigation activities in the BFID.

The typical irrigation season in the BFID begins in May and lasts until the end of September. Historical observations have shown that the region receives very little precipitation during the late irrigation season; therefore, increases in observed discharge in the Belle Fourche River during seasonally dry periods can be attributed to losses or waste in the irrigation system's transport and delivery infrastructure. Discharge data from USGS gages along the Belle Fourche River were analyzed for their entire period of record. Data collected by RESPEC on Horse Creek during the monitoring seasons for 2012–2016 and Indian Creek during the 2016 monitoring season were also analyzed.

5.2.1 BELLE FOURCHE RIVER DISCHARGE ANALYSIS

Currently, four operating USGS gaging stations are located on the Belle Fourche River, within the South Dakota portion of the Belle Fourche River Watershed. Discharge data were obtained from each site for their entire period of record for this analysis. Table 5-2 provides an overview of available data from each USGS streamflow gaging station, and the site locations are shown in Figure 5-2.

Historical monthly mean discharge rates were computed for the four USGS gaging stations on the Belle Fourche River and are depicted in Figure 5-3. As illustrated in this plot, the elevated monthly average discharge rates occur from March through June with flows tapering off during the fall and winter months. Elevated flows from March through June are a product of seasonal precipitation patterns and corresponding runoff events. From July through September, flow rates decrease because of the decreased precipitation, but the rates are also influenced by activities that were performed by the BFID throughout the irrigation season.

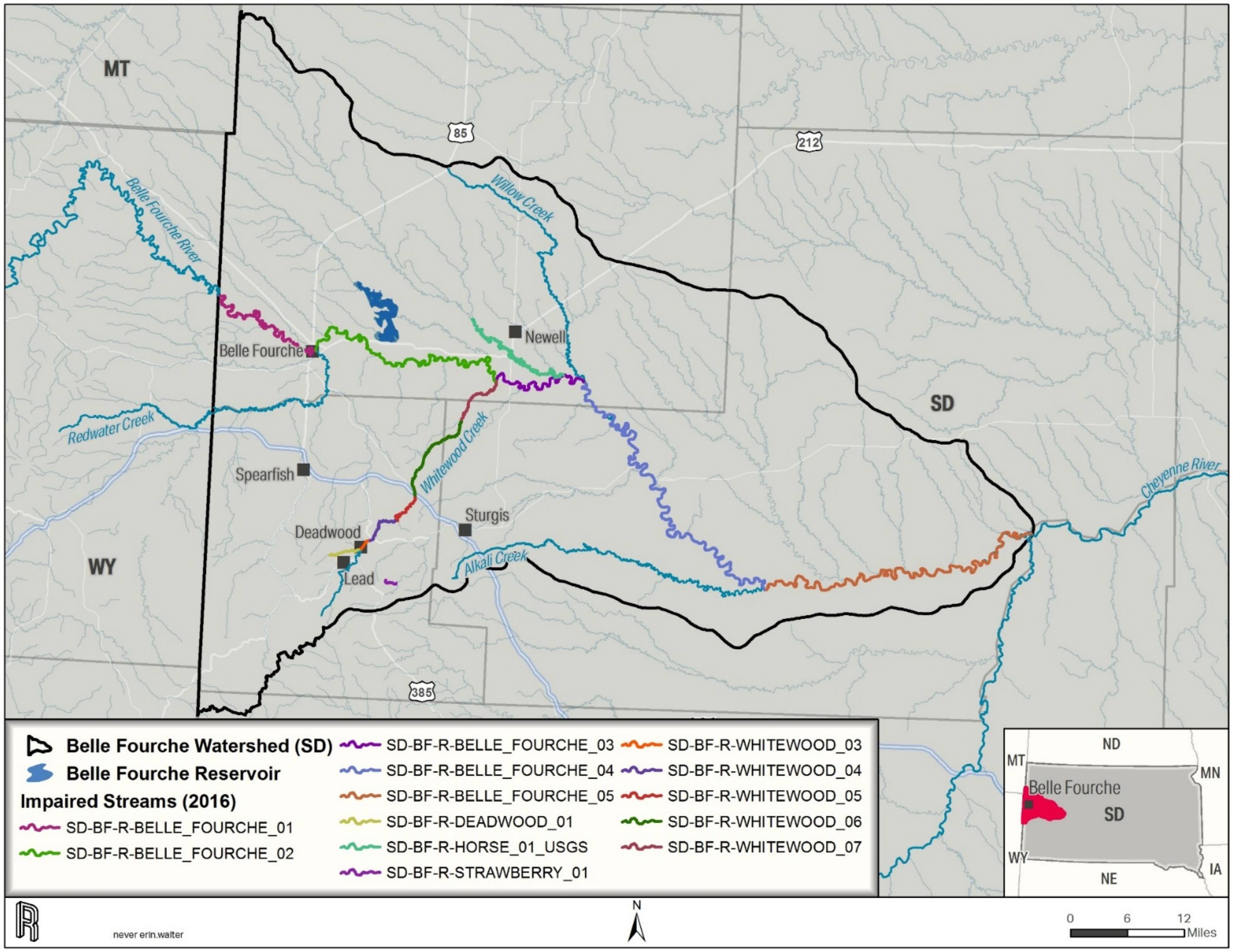

Figure 5-1. Impaired Waterbodies in the Belle Fourche River Watershed in South Dakota.

Table 5-1. 303(d)-Listed Impaired Waterbodies in the Lower Belle Fourche River Watershed in South Dakota (Page 1 of 2)

Waterbody Name/ Description	Assessment Unit I.D.	Years Listed	Impaired Beneficial Use(s)	303(d) Listing Parameter	EPA Category[a]	Water Quality Criteria Threshold Values (Bacteria Criteria Apply From May 1 Through September 30)
Belle Fourche River (Wyoming Border to Redwater River, South Dakota)	SD-BF-R-BELLE_FOURCHE_01	2016 2014 2012 2010 2008 2006 2004	Immersion Recreation	*E. coli* Fecal Coliform Bacteria	5*	*E. coli*: Daily maximum of ≤ 235 most probable number per 100 milliliters (mpn/100 mL) and a geometric mean of at least five samples over a 30-day period ≤ 126 mpn/100 mL. Fecal Coliform: Daily maximum of ≤ 400 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 200 mpn/100 mL.
		2016	Limited Contact Recreation	*E. coli*		Daily maximum of ≤ 1,178 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 630 mpn/100 mL.
		2016 2014 2012 2010 2008 2006 2004	Warm-Water Permanent Fish Life	TSS		Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Belle Fourche River (Redwater River to Whitewood Creek)	SD-BF-R-BELLE_FOURCHE_02	2016 2014 2012 2006 2004	Warm-Water Permanent Fish Life	TSS	4A*	Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Belle Fourche River (Whitewood Creek to Willow Creek)	SD-BF-R-BELLE_FOURCHE_03	2016	Immersion Recreation	*E. coli*	5*	Daily maximum of ≤ 235 most probable number per 100 milliliters (mpn/100 mL) and a geometric mean of at least five samples over a 30-day period ≤ 126 mpn/100 mL.
		2016 2014 2012 2010 2006 2004	Warm-Water Permanent Fish Life	TSS		Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Belle Fourche River (Willow Creek to Alkali Creek)	SD-BF-R-BELLE_FOURCHE_04	2016 2014 2012 2010 2006 2004	Warm-Water Permanent Fish Life	TSS	4A*	Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Belle Fourche River (Alkali Creek to Mouth)	SD-BF-R-BELLE_FOURCHE_05	2016 2014 2012 2010	Immersion Recreation	*E. coli* Fecal Coliform Bacteria	4A*	*E. coli*: Daily maximum of ≤ 235 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 126 mpn/100 mL. Fecal Coliform: Daily maximum of ≤ 400 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 200 mpn/100 mL.
			Limited Contact Recreation	*E. coli* Fecal Coliform Bacteria		*E coli*: Maximum daily concentration of ≤ 1,178 mpn/100 mL and a geometric mean of at least five samples over a 30-day period of ≤ 630 mpn/100 mL. Fecal Coliform: Maximum daily concentration of ≤ 2,000 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 1,000 mpn/100 mL.
		2016 2014 2012 2010 2006 2004	Warm-Water Permanent Fish Life	TSS	4A*	Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.

Table 5-1. 303(d)-Listed Impaired Waterbodies in the Lower Belle Fourche River Watershed in South Dakota (Page 2 of 2)

Waterbody Name/ Description	Assessment Unit I.D.	Years Listed	Impaired Beneficial Use(s)	303(d) Listing Parameter	EPA Category[(a)]	Water Quality Criteria Threshold Values (Bacteria Criteria Apply From May 1 Through September 30)
Deadwood Creek (Rutabaga Gulch to Whitewood Creek)	SD-BF-R-DEADWOOD_01	2016 2014	Immersion Recreation	*E. coli*	5	*E. coli*: Daily maximum of ≤ 235 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 126 mpn/100 mL. Fecal Coliform: Daily maximum of ≤ 400 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 200 mpn/100 mL.
Horse Creek (Indian Creek to mouth)	Sd-bf-r-horse_01_usgs	2016	Limited Contact Recreation	*E. coli*	5*	Daily maximum of ≤ 1,178 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 630 mpn/100 mL.
		2016	Warm-Water Semipermanent Fish Life	TSS		Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Strawberry Creek (Bear Butte Creek to S5, T4N, R4E)	SD-BF-R-STRAWBERRY_01	2016 2014 2012 2010 2008 2006 2004	Fish/Wildlife Propagation. Recreation Stock Waters	Cadmium	4A*	Cadmium: Maximum concentration of < (1.136672 – [(ln(hardness) × 0.041838] × exp[1.128 × (ln(hardness)] – 3.828) in mg/L.
Whitewood Creek (Deadwood Creek to Spruce Gulch)	SD-BF-R-WHITEWOOD_03	2016 2014 2012 2010 2008 2006 2004	Immersion Recreation	*E. coli* Fecal Coliform Bacteria	4A*	*E. coli*: Daily maximum of ≤ 235 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 126 mpn/100 mL. Fecal Coliform: Daily maximum of ≤ 400 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 200 mpn/100 mL.
Whitewood Creek (Spruce Gulch to Sandy Creek)	SD-BF-R-WHITEWOOD_04	2016 2014 2012 2006	Immersion Recreation	*E. coli* Fecal Coliform Bacteria	5	*E. coli*: Daily maximum of ≤ 235 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 126 mpn/100 mL. Fecal Coliform: Daily maximum of ≤ 400 mpn/100 mL and a geometric mean of at least five samples over a 30-day period ≤ 200 mpn/100 mL.
Whitewood Creek (Sandy Creek to I-90)	SD-BF-R-WHITEWOOD_05	2016 2014 2012 2010 2008 2006	Cold-Water Marginal Fish Life	pH	5	6.5–9.0 Standard Unit (SU)
Whitewood Creek (I-90 to Crow Creek)	SD-BF-R-WHITEWOOD_06	2016 2014	Limited Contact Recreation	*E. coli*	5	Maximum daily concentration of ≤ 1,178 mpn/100 mL and a geometric mean of at least five samples over a 30-day period of ≤ 630 mpn/100 mL.
		2016 2014 2012 2010 2008	Warm-Water Permanent Fish	pH		6.5–9.0 SU
Whitewood Creek (Crow Creek to Mouth)	SD-BF-R-WHITEWOOD_07	2016	Limited Contact Recreation	*E. coli*	5	Maximum daily concentration of ≤ 1,178 mpn/100 mL and a geometric mean of at least five samples over a 30-day period of ≤ 630 mpn/100 mL.
		2016 2014 2012 2010	Warm-Water Permanent Fish Life	TSS		Maximum daily concentration of ≤ 158 mg/L and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.

(a) EPA Category: (1) All uses met, (2) Some uses met but insufficient data to determine support of other uses, (3) Insufficient data, (4A) Water impaired but has an approved TMDL, (5) Water impaired/requires a TMDL.
* = Waterbody has an EPA-approved TMDL. The EPA category data are shown as reported in the *2016 South Dakota Integrated Report for Surface Water Quality Assessment*.

Table 5-2. US Geological Survey Gaging Stations on the Belle Fourche River in South Dakota

USGS Gaging Station	Period of Record	Period of Record Average Discharge (cfs)	Range of Discharge (cfs)
Belle Fourche River at WY-SD State Line (06428500)	12/01/1946–09/30/2016	92.8	0.0–5,510
Belle Fourche River Near Fruitdale, SD (06436000)	11/01/1945–09/30/2016	105.4	0.0–11,100
Belle Fourche River Near Sturgis, SD (06437000)	11/01/1945–09/30/2016	303.4	0.0–29,700
Belle Fourche River Near Elm Springs, SD (06438000)	08/01/1928–09/30/2016	396.8	0.0–40,800

cfs = cubic feet per second

Historical monthly average flow in the Belle Fourche River at the state line (USGS 06428500) was compiled as a time series to understand historical flow cycles, upstream from the irrigation district, and compared to flow in the Belle Fourche River near Elm Springs (USGS 06437000), the most downstream gage in the Lower Belle Fourche River Watershed. Figure 5-4 illustrates both time series over a 50-year period (1966–2016). Both time series indicate that the watershed has experienced cycles of wet and dry periods, with more recent years showing a larger variance between dry and wet periods.

5.2.2 HORSE CREEK DISCHARGE ANALYSIS

Real-time discharge data on Horse Creek above Vale, South Dakota (06436760), was collected by the USGS from October 1980 until September 2012, when the USGS discontinued its operation. Since 2012, RESPEC has collected discharge and water quality data at the same location from May through September each year. Horse Creek is dominated by irrigation return flows during dry summer periods, because it delivers excess runoff from individual fields and the BFID delivery system back to the Belle Fourche River. Since 2006, BMPs and on-farm improvements have been implemented within the BFID delivery system to reduce the volume of sediment-laden return flows that impact Horse Creek, and ultimately, the Belle Fourche River. Previous segments of the BFRWP have analyzed the effectiveness of such BMPs from 2006 to 2014 and compared the results to a time period before its implementation (1995–2005). This report will extend the analysis from 2014 and include the previous two monitoring seasons and analyze data through 2016. Figure 5-5 is a map that shows Horse Creek in relation to the BFID delivery system, irrigated fields, and the location of the discharge monitoring station on Horse Creek.

Median flow rates were analyzed and compared to precipitation because these flow rates best represent base flows within Horse Creek instead of the flow rates that were influenced by rainfall/runoff processes. Precipitation data that were analyzed were collected from the Parameter-Elevation Regressions on Independent Slopes model (PRISM) dataset from 1995–2016. PRISM is a 4 kilometer (km) ×4 km dataset that provides daily precipitation totals, which are computed by a combination of point data and radar measurement estimates, interpolated by a climate-elevation regression for each Digital Elevation Model (DEM). Daily gridded precipitation data were averaged over the Horse Creek Watershed before computing monthly totals and averages.

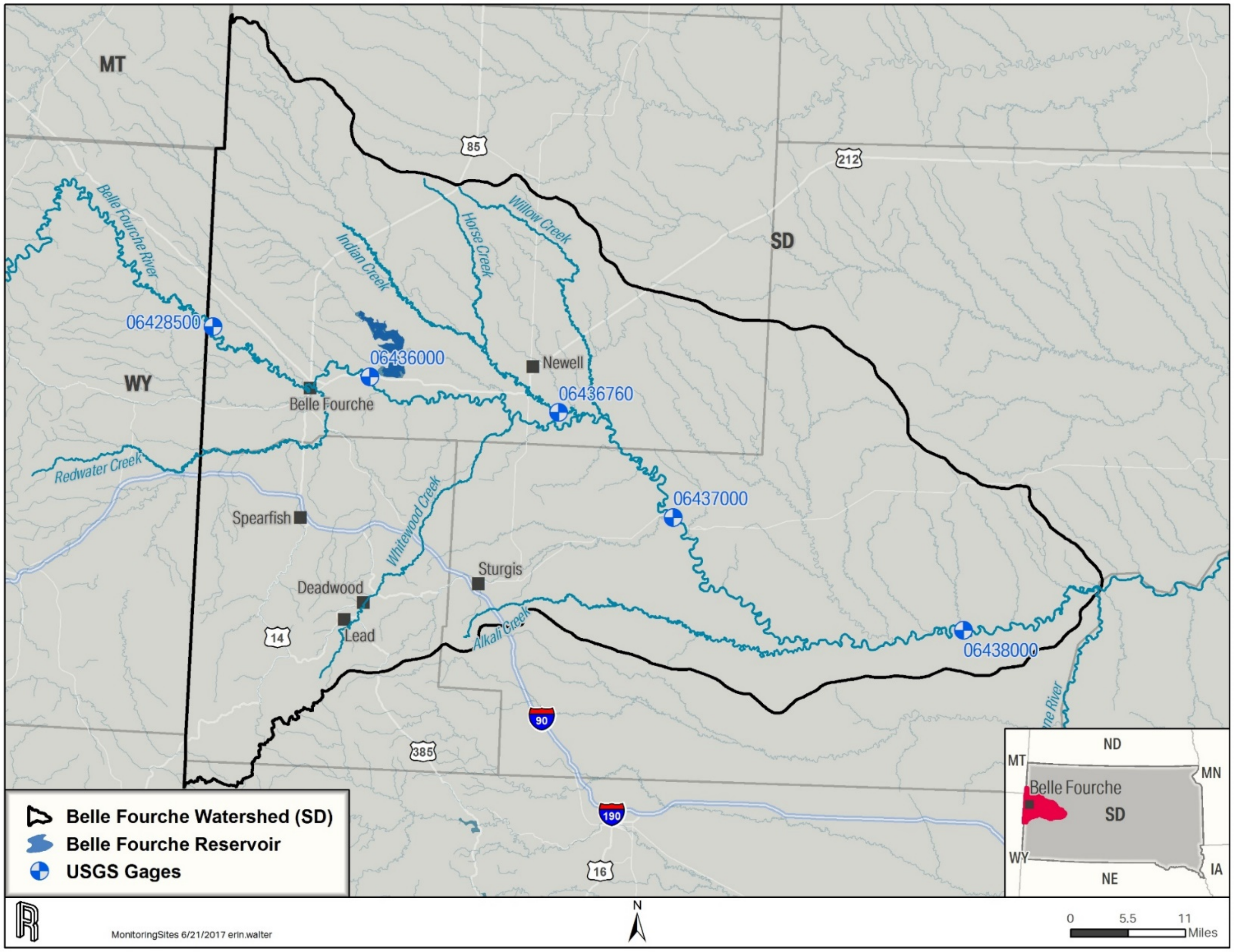

Figure 5-2. US Geological Survey Discharge Gages on the Belle Fourche River.

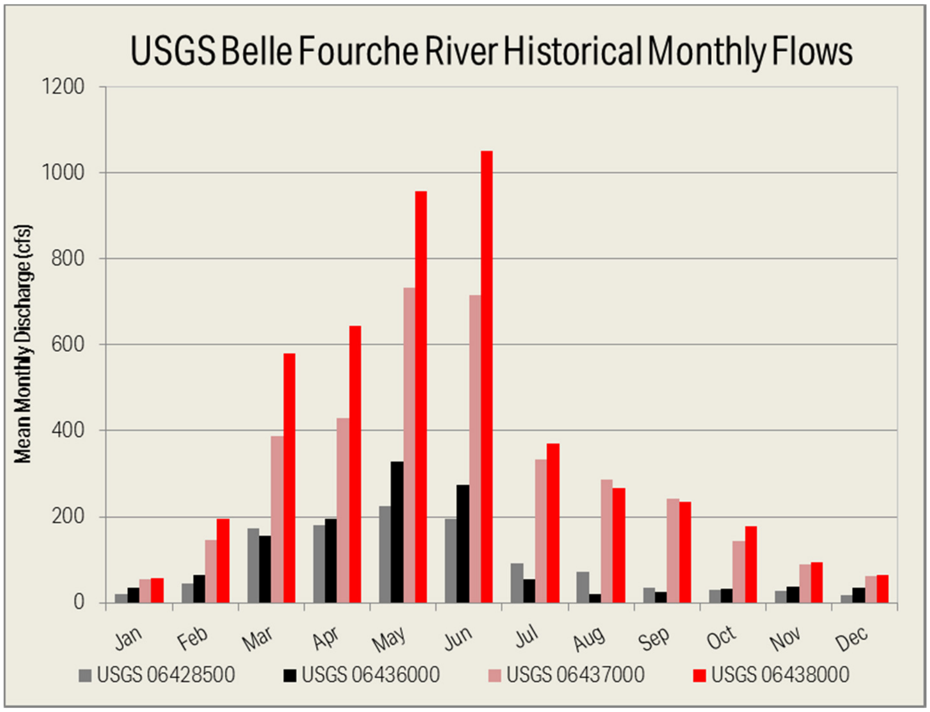

Figure 5-3. Average Historical Monthly Flows on the Belle Fourche River at US Geological Survey Gaging Locations Within the Lower Belle Fourche River Watershed in South Dakota.

The influence on flows in Horse Creek from wastewater in the BFID delivery system and field applications is evident when observing monthly median discharge rates for Horse Creek and averaged monthly precipitation totals from 1995 to 2016, as illustrated in Figure 5-6. Median discharge rates in the months of June through September remain elevated, while monthly precipitation totals for the period trend downward from 3.43 inches in May to 1.13 inches in September. This relationship illustrates the impact of the BFID's delivery system on Horse Creek.

The typical irrigation season in the BFID begins in May and lasts until the end of September. Figure 5-6 shows that the median flow on Horse Creek increases from 17.2 cubic feet per second (cfs) in May to 59.9 cfs by June. Median flow hovers near 40 cfs throughout September, while precipitation steadily decreases to an average monthly total of 1.13 inches in September. Because this region receives less precipitation during the late irrigation season, much of the elevated discharge rates observed in Horse Creek can be attributed to inefficiencies or waste in the irrigation system's transport and delivery on individual fields.

Although median flow rates adequately present a means of understanding season impacts from irrigation returns on flows in Horse Creek, they are not adequate on their own for comparing the pre- and post-BMP implementation periods because of precipitation influences. To reduce bias in the comparison, monthly median flow rates that are specific to each period were normalized by their respective monthly average PRISM precipitation values. This normalization results in arbitrary units of cfs/inch, where the higher the value, the more likely that median flow rates are influenced by irrigation return flows. Table 5-3 compares these values for the typical irrigation season of May through September between the pre-BMP (1995–2005) and post-BMP (2006–2016) periods.

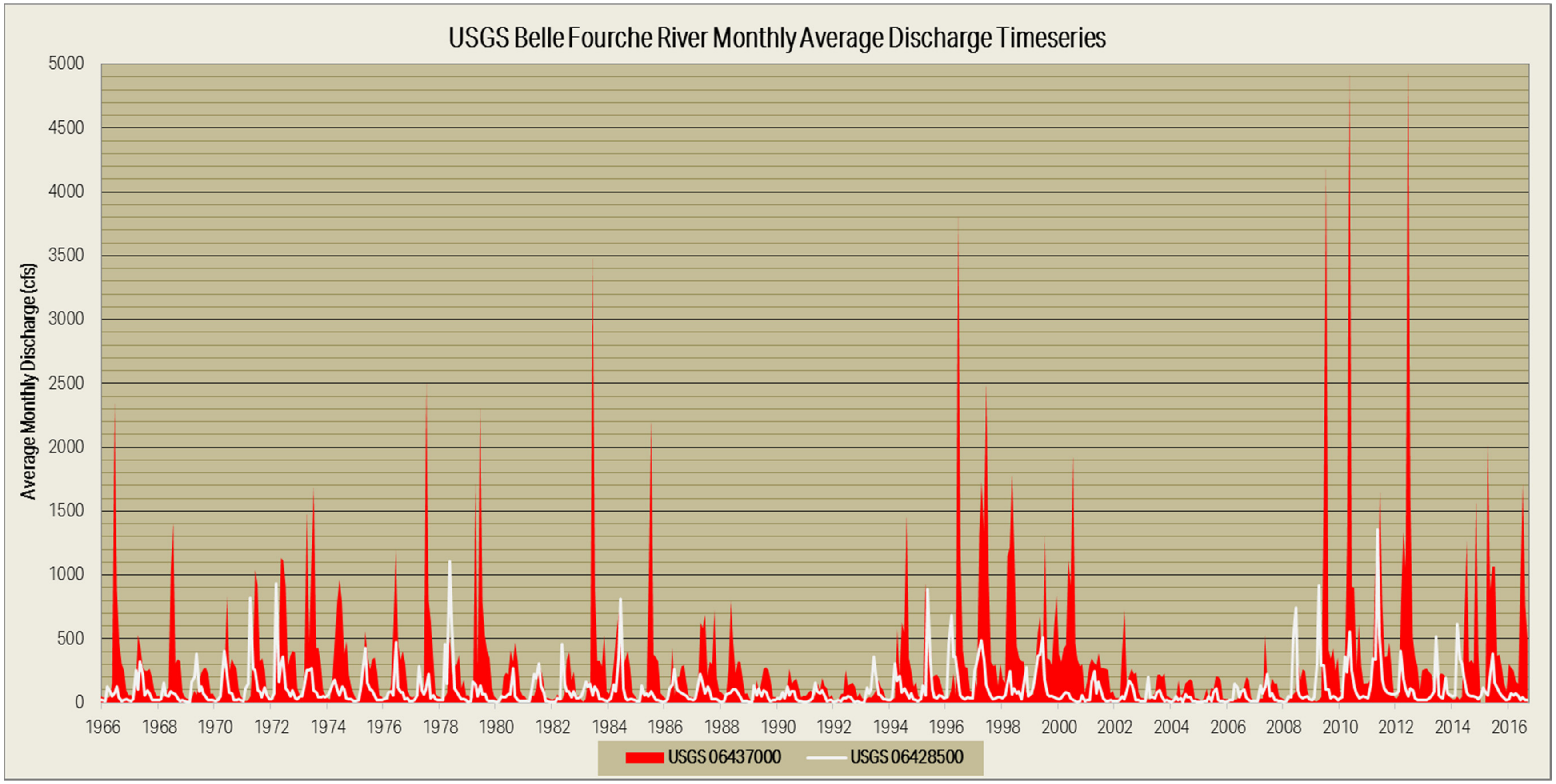

Figure 5-4. Monthly Average Flow for the Belle Fourche River at State Line (USGS 06428500) (White Lines) and at Elm Springs (USGS 06437000) (Red Lines).

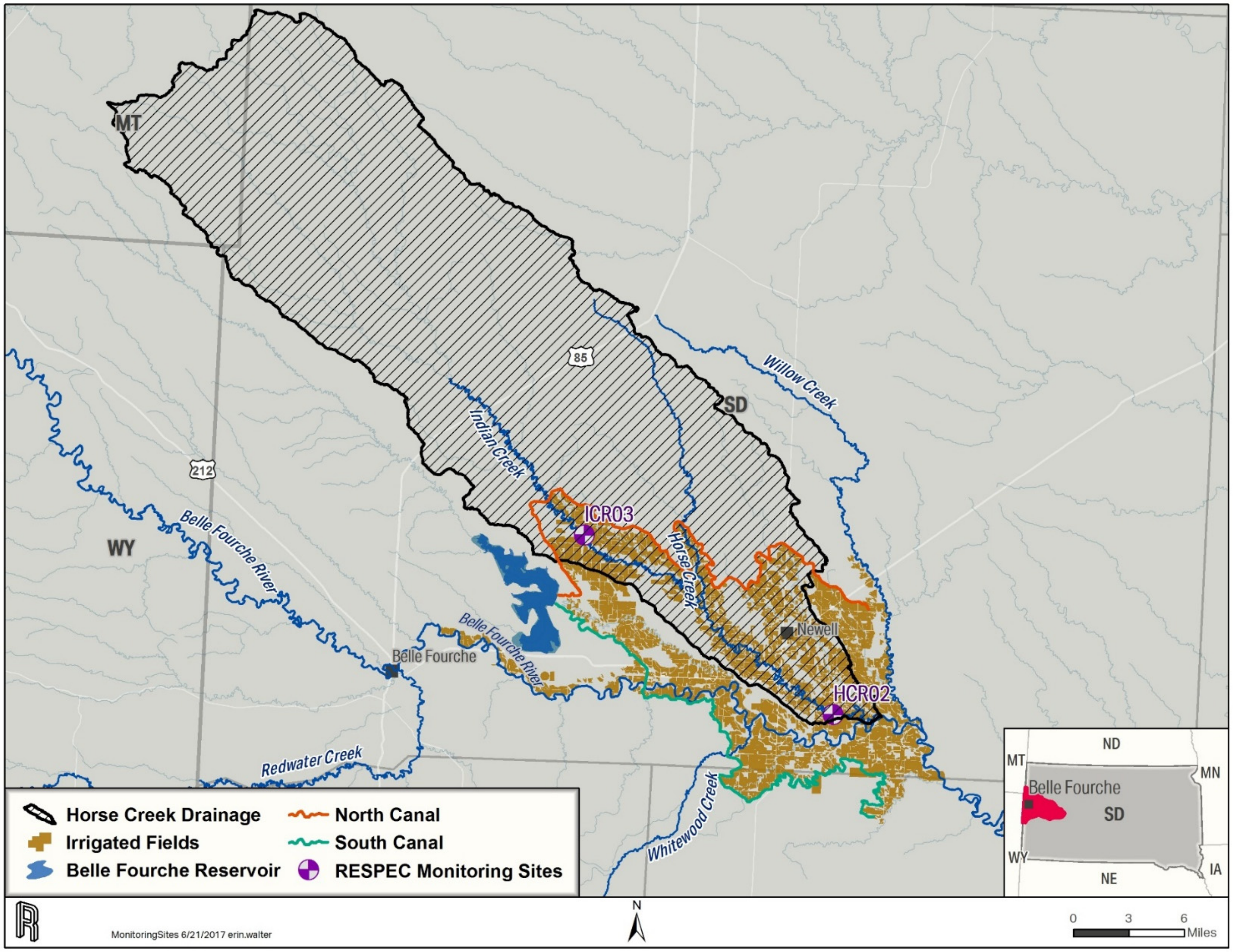

Figure 5-5. Location of Horse Creek in Relation to Irrigation Fields and Main Delivery System Within the Belle Fourche Irrigation District.

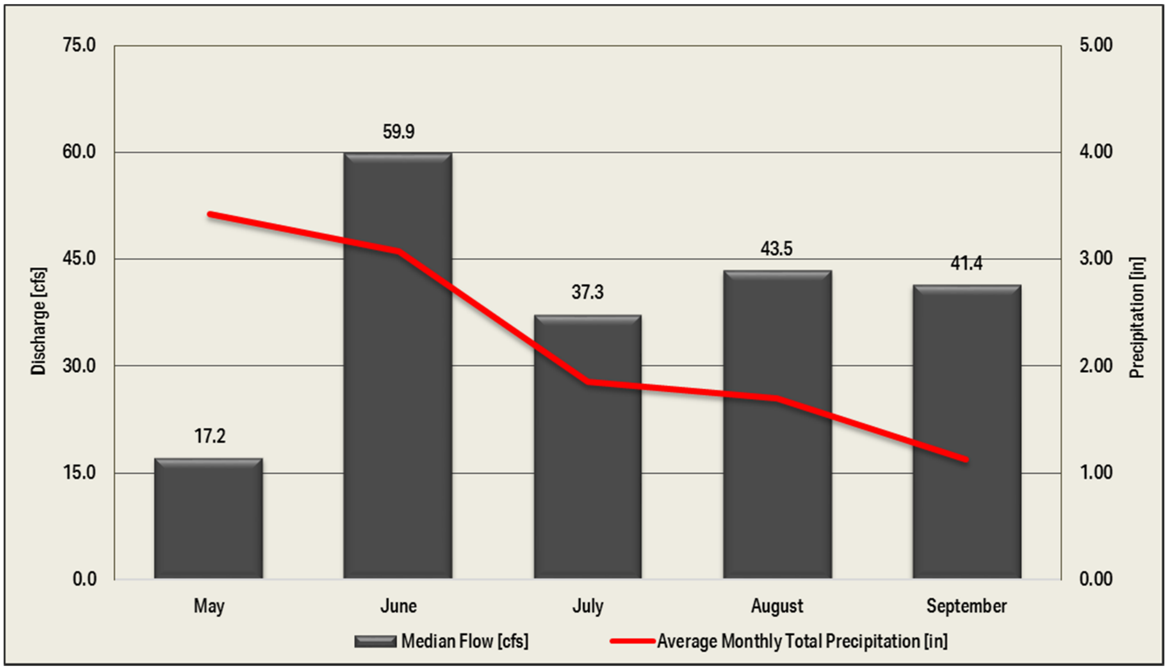

Figure 5-6. Historical Median Discharge on Horse Creek and Average Precipitation Over Horse Creek Watershed, South Dakota.

Table 5-3. Comparison of Monthly Median Flows, Average Precipitation, and Flow per Precipitation for Pre- and Post-Best Management Practices Implementation Periods

	Period	May	June	July	August	September
Median Flow (cfs)	Pre-BMP	18	29.5	40.0	39.0	40.0
	Post-BMP	17.2	61.0	37.2	43.6	41.7
Average Monthly Total Precipitation (in)	Pre-BMP	2.96	2.97	1.98	1.19	1.07
	Post-BMP	3.89	3.18	1.73	2.20	1.18
Flow per Precipitation (cfs/in)	Pre-BMP	6.07	9.93	20.25	32.88	37.33
	Post-BMP	4.42	19.18	21.56	19.83	35.32
Percent Reduction		27%	–93%	–6%	40%	5%

Table 5-3 and Figure 5-7 show that monthly median flow rates normalized by monthly average precipitation increased from pre-BMP to post-BMP implementation in the months of June and July. This may be explained in typical management of the delivery system during those months of the irrigation season.

During June and into early July, demand for irrigation water is often low because of increased precipitation and adequate soil moisture throughout the irrigation district. However, even with low demand, the delivery system must be flowing to carry even the smallest water orders to their respective fields and prepare for increases in irrigation water demand. When the delivery system is carrying water for small water orders, not all water is delivered to fields but instead must be released through wasteways that lead to natural drainages, such as Horse Creek.

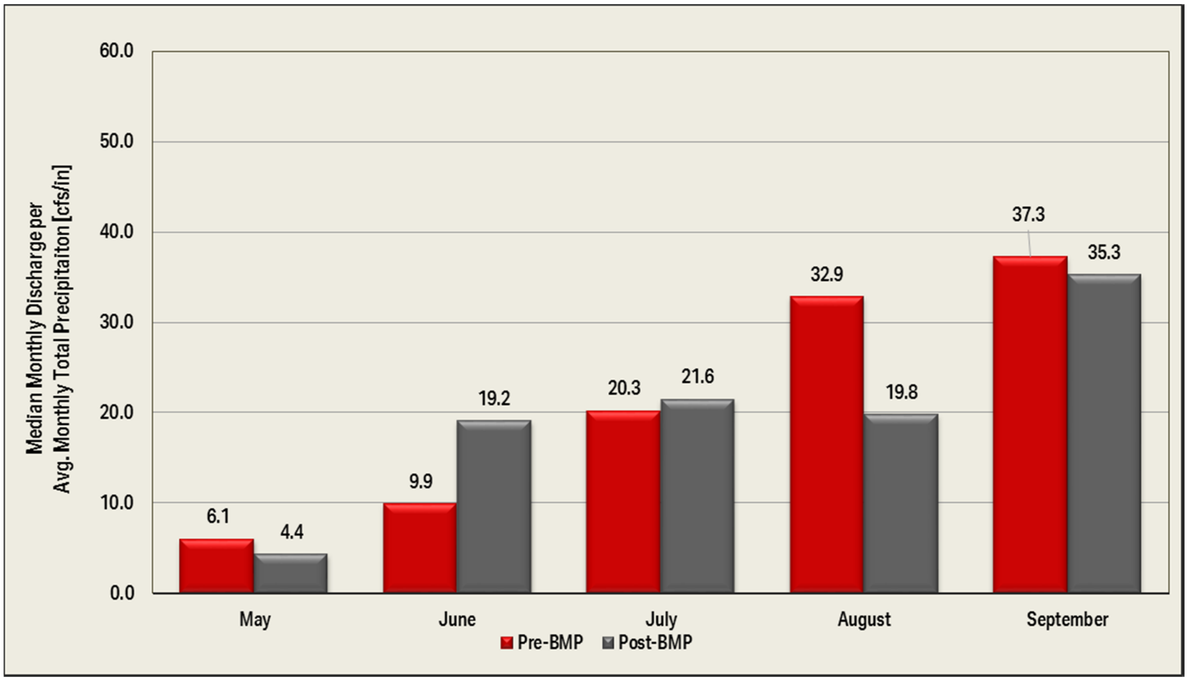

Figure 5-7. Comparison of the Median Flow Rate per Average Precipitation by Month for the Pre- and Post-Best Management Practices Implementation Periods.

Excess water in the delivery system during the spring and early summer months can also be caused by water-level management in the Belle Fourche Reservoir. When inflows to the reservoir exceed the amount that is needed to maintain preferred water levels, water must be released through the irrigation delivery system because it is the only controlled outlet for the reservoir. The resultant excess water in the delivery system must be wasted to natural drainages.

Because of the variable requirements for managing the delivery system and reservoir in June and July, the months of August and September are much more indicative of irrigation efficiency. Irrigation deliveries in August and September are seldom impacted by reservoir management needs and are regularly the most demanding for irrigation application to fields. Comparing pre-BMP to post-BMP implementation periods for August and September indicate improvements to the flow/precipitation metric of 40 percent and 5 percent, respectively. Thus, BMP implementation within the BFID delivery system and on-farm applications over the last 11 years has made progress toward the goal of reducing return flows impacting Horse Creek, especially during the peak irrigation season.

The current BMPs in the BFID include using automated gate controls and flow monitoring, replacing open ditches with pipeline, lining open canals and laterals, replacing flood irrigation techniques with sprinkler irrigation, and irrigation scheduling for BFID operators. Along with implementing physical BMPs, public meetings and project tours have helped extend public outreach and awareness throughout the watershed.

In addition, the 2016 monitoring season added a new site on Indian Creek, ICR03, located in the northern tip of the BFID, upstream from the confluence with Horse Creek, as illustrated in Figure 5-5. This site was added for the 2016 monitoring season to analyze the discharge and quality of water before entering the irrigation district. Direct flow measurements and staff gage readings were collected biweekly from May through September. These data were applied a site specific rating curve for estimating continuous discharge. Figure 5-8 overlays daily average discharge from ICR03 and HCR02

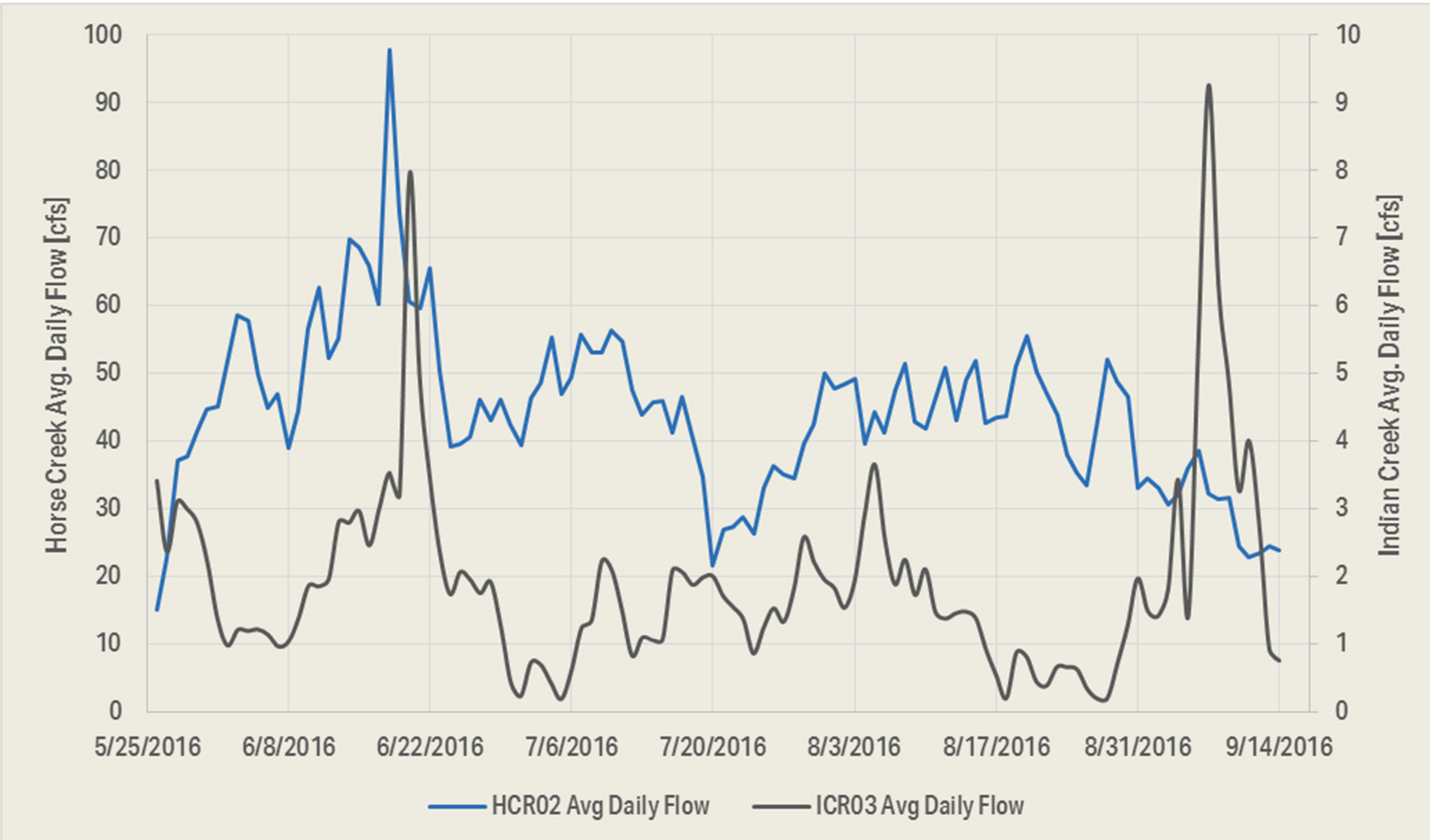

Figure 5-8. Daily Average Discharge at HCR02 (Blue) and ICR03 (Gray) for the 2016 Monitoring Season.

from May 26 through September 14, 2016. In general, flow trends at HCR02 follow ICR03. Flow measurements collected from ICR03 had little variability during the 2016 monitoring season, and with only one season of data to build a rating curve, estimates for high flow rates have limited accuracy and needed additional validation during storms and other high flow events.

5.3 WATER QUALITY ANALYSES

To evaluate the effectiveness of current BMP implementation plans, statistical analyses were performed on historic data at four sites located along the Belle Fourche River in the Lower Belle Fourche River Watershed in South Dakota. Monitoring was also conducted on the Horse Creek site (HCR02), and a new site was established along Indian Creek (ICR03) in May 2016. Indian Creek and Horse Creek are both key tributaries to the Belle Fourche River. All of the monitoring site locations are illustrated in Figure 5-9.

Water quality samples have historically been collected on the Belle Fourche River to evaluate concentrations of *E. coli*, fecal coliform, and TSS since January 1995. However, two sites (460130 [Belle Fourche River in Belle Fourche] and 460683 [Belle Fourche River near Vale]) were discontinued in 2015. The USGS initiated monitoring at HCR02 for specific conductivity in May 2004, which continued through October 2011. RESPEC began monitoring at the same location in May 2012 and collected biweekly grab samples analyzed for *E. coli* and TSS throughout the recreation season (May 1 through September 30). Additionally, RESPEC added ICR03 in May 2016 to compare water quality results upstream from the irrigation district.

Historical data were grouped into two categories for analysis: pre-BMP and post-BMP implementation. Pre-BMP implementation data refer to data that were collected from 1995 to 2005, before rigorous BMP implementation began, while post-BMP implementation data refer to data that were collected from 2006 to 2016. HCR02 has a period of record dating back to 2004, which only includes 2 years of data during the pre-BMP implementation period, while ICR03 only has 1 year on record. Pre- versus post-BMP water quality conditions were, therefore, not analyzed for Horse Creek or Indian Creek.

5.3.1 BELLE FOURCHE RIVER

5.3.1.1 *E. COLI* WATER QUALITY DATA

Statistics generated for *E. coli* bacteria sampling data collected from the five SD DENR water quality monitoring sites on the Belle Fourche River during the recreation season (May 1 through September 30) are provided in Table 5-4. The sites are listed from upstream to downstream in the table and locations shown in Figure 5-9. *E. coli* data collection was not initiated at these sites until 2009; therefore, no pre-BMP data are available for comparing for *E. coli* reduction. Note that BMP implementation to date focused on TSS reductions rather than bacteria, although many of the practices will have a positive impact on the loadings for both constituents.

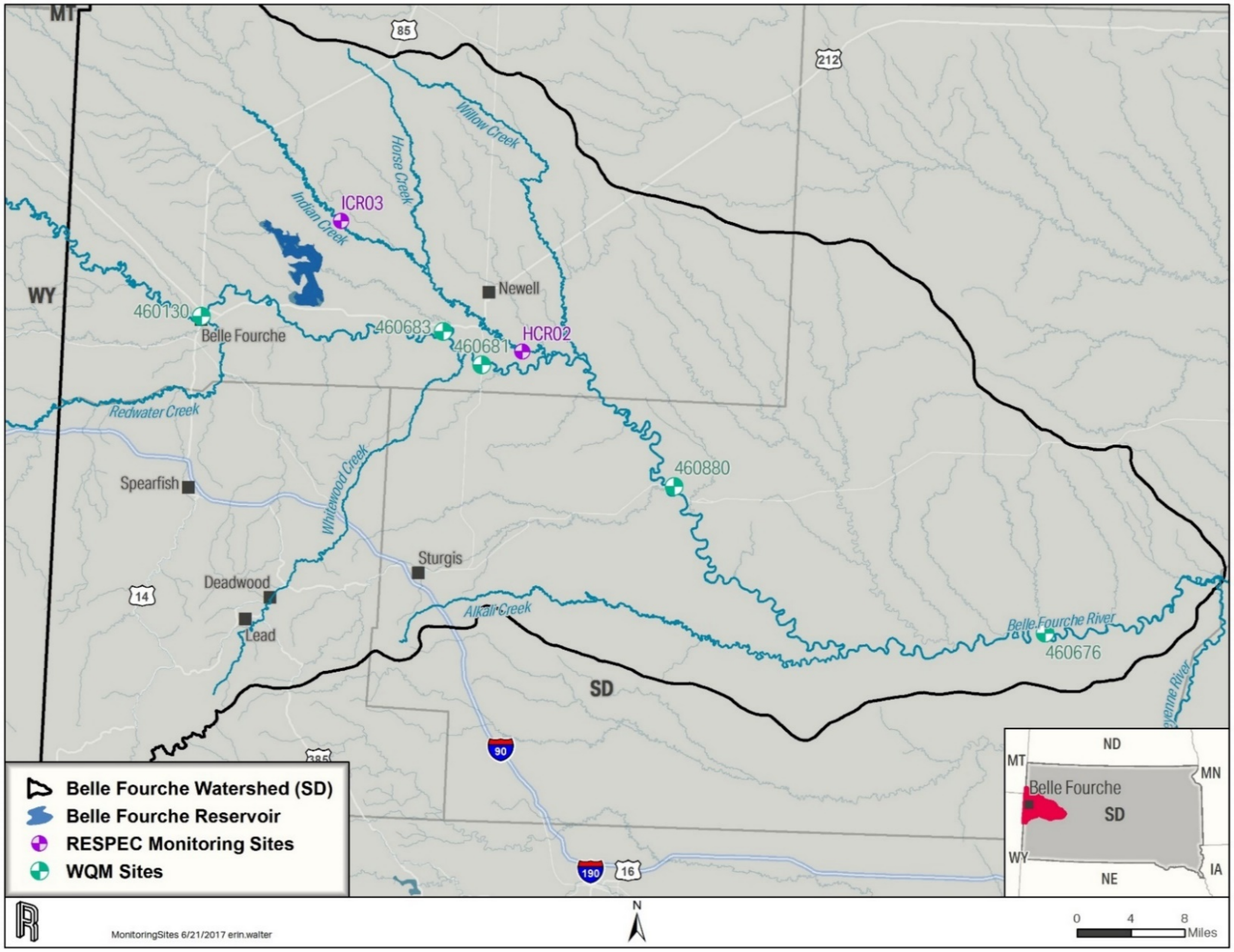

Figure 5-9. Locations of the Five South Dakota Department of Environment and Natural Resources Quality Water Quality Monitoring Sites and the RESPEC Monitoring Sites Located on Horse Creek (HCR02) and Indian Creek (ICR03).

Table 5-4. *E. coli* Statistics for the South Dakota Department and Natural Resources Water Quality Monitoring Sites on the Belle Fourche River

Site	Period of Record	Mean (mpn/100 mL)	Median (mpn/100 mL)	Total Samples	Number of Samples Exceeding Criterion	Percent Exceedance (%)
Belle Fourche River in Belle Fourche (460130)	05/05/2009–06/11/2015	389	66	33	7	21
Belle Fourche River Near Vale (460683)	05/05/2009–05/14/2015	153	37	14	1	7
Belle Fourche River Near Vale (460681)	05/05/2009–08/16/2016	243	74	16	4	25
Belle Fourche River Near Volunteer (460880)	05/05/2009–08/16/2016	599	33	17	2	12
Belle Fourche River Northwest of Elm Springs (460676)	05/05/2009–07/07/2016	304	37	40	6	15

Data collected during the recreation season (May 1 through September 30) from each monitoring site from 2009 to 2016 were used to calculate the percent exceedance of the single-sample *E. coli* bacteria criterion of 235 mpn/100 mL. The Immersion Recreation criterion for *E. coli* of 235 mpn/100 mL applies at all five sites. Sites 460130 (upstream) and 460676 (downstream) exceeded the *E. coli* standard at rates of 21 and 15 percent, respectively. Fecal Coliform Water Quality Data.

5.3.1.2 FECAL COLIFORM WATER QUALITY DATA

Fecal coliform bacteria sampling data collected from the five SD DENR water quality sites on the Belle Fourche River during the recreation season (May 1 through September 30) were statistically analyzed for pre-BMP (1995–2005) and post-BMP (2006–2014) conditions and are provided in Table 5-5. Fecal coliform data were not available after September 2014. The collected data were used to calculate the percent exceedance of the single-sample fecal coliform bacteria criterion of 400 mpn/100 mL for Immersion Recreation, which is applicable at all five locations. Sites 460130 and 460676 exceeded the fecal coliform standard during the post-BMP period at rates of 20 and 12 percent, respectively.

Median fecal coliform concentrations were reduced at every site (except at 460676) after BMP implementations began in 2005 (post-BMP). The largest reduction in median concentration from the pre-BMP to post-BMP condition was observed at Site 460681.

Site 460676 has a large increase in mean fecal coliform concentration. This large increase is primarily caused by a single elevated result in July 2009 of 130,000 mpn/100 mL. The next highest value was 5,400 mpn/100 mL. Ignoring the one outlier would result in post-BMP fecal coliform mean and median concentrations at Site 460676 of 477 mpn/100 mL and 94 mpn/100 mL, respectively. In the remaining four sites, the percent exceedance of the standard has been reduced.

5.3.1.3 TOTAL SUSPENDED SOLIDS WATER QUALITY DATA

TSS sampling data that were collected from the five SD DENR water quality sites on the Belle Fourche River were statistically analyzed for pre-BMP (1995–2005) and post-BMP (2006–2016) conditions, which is provided in Table 5-6. Collected data were used to calculate the percent of samples that exceed the daily maximum value of 158 mg/L, which is applicable to those waters with an assigned Warm-Water Permanent Fish Life beneficial use. All five sites are subject to this standard.

Table 5-5. Fecal Coliform Statistics for South Dakota Department of Environment and Natural Resources Water Quality Monitoring Sites on the Belle Fourche River

Site	BMP Status	Period of Record	Mean (mpn/100 mL)	Median (mpn/100 mL)	Total Samples	Number of Samples Exceeding Criterion	Percent Exceedance (%)
Belle Fourche River in Belle Fourche (460130)	Pre-BMP	04/29/1999–11/17/2005	478	160	19	5	26
	Post-BMP	01/09/2006–06/11/2015	506	150	46	9	20
Belle Fourche River Near Vale (460683)	Pre-BMP	01/04/1995–10/27/2005	128	65	13	1	8
	Post-BMP	01/09/2006–5/14/2014	58	58	14	0	0
Belle Fourche River Near Vale (460681)	Pre-BMP	01/04/1995–10/27/2005	385	225	12	2	17
	Post-BMP	01/09/2006–8/16/2016	156	82	15	1	7
Belle Fourche River Near Volunteer (460880)	Pre-BMP	02/22/1995–10/27/2005	1,038	49	16	2	13
	Post-BMP	01/09/2006–8/16/2016	81	38	15	0	0
Belle Fourche River Northwest of Elm Springs (460676)	Pre-BMP	02/09/1999–12/14/2005	148	92	34	3	9
	Post-BMP	01/17/2006–09/06/2016	3,355	100	45	6	13

Table 5-6. Total Suspended Solids Statistics for South Dakota Department of Environment and Natural Resources Water Quality Monitoring Sites on the Belle Fourche River

Site	BMP Status	Period of Record	Mean (mg/L)	Median (mg/L)	Total Samples	Number of Samples Exceeding Criterion	Percent Exceedance (%)
Belle Fourche River in Belle Fourche (460130)	Pre-BMP	04/29/1999–11/17/2005	198	7	47	6	13
	Post-BMP	01/09/2006–06/11/2015	273	25	110	33	30
Belle Fourche River Near Vale (460683)	Pre-BMP	01/04/1995–10/27/2005	85	31	44	4	9
	Post-BMP	01/09/2006–05/14/2015	69	18	37	5	14
Belle Fourche River Near Vale (460681)	Pre-BMP	01/04/1995–10/27/2005	76	18	44	4	9
	Post-BMP	01/09/2006–08/16/2016	98	26	43	7	16
Belle Fourche River Near Volunteer (460880)	Pre-BMP	02/22/1995–10/27/2005	259	19	44	7	16
	Post-BMP	01/09/2006–08/16/2016	91	26	43	6	14
Belle Fourche River Northwest of Elm Springs (460676)	Pre-BMP	02/09/1999–12/14/2005	224	29	82	10	12
	Post-BMP	01/17/2006–09/06/2016	488	29	128	31	24

The median TSS concentrations were reduced only at Site 460683 when comparing median values of the pre- and post-BMP implementation data. When assessing these changes in median TSS concentrations, the spatial location of the WQM sites in relation to the location of TSS BMP implementation projects in the watershed must be considered. For instance, Site 460130 is upstream of most sediment-reducing BMPs that have been implemented within the watershed and downstream from activities outside of the state. Exceedance of the TSS concentration standard at this site has increased from 13 percent to 30 percent. However, the only reduction in exceedance of the TSS concentration standard has been observed at Site 460880, which is downstream from the majority of the BMPs.

5.3.2 HORSE CREEK

Horse Creek is a key tributary within the watershed and contributes significant volumes of irrigation return flows to the Belle Fourche River during the BFID irrigation season. Water-quantity aspects that are pertinent to Horse Creek were previously identified; therefore, the following discussion will outline water quality parameters that have historically and, more recently, prompted monitoring efforts on Horse Creek. The location of Horse Creek in relation to the irrigation features is illustrated in Figure 5-5.

5.3.2.1 *E. COLI* WATER QUALITY DATA

Horse Creek has been assigned a Limited Contact Recreation beneficial use, according to the South Dakota 2016 303(d) list of impaired waterbodies. *E. coli* grab samples have been collected by RESPEC from May through September for the 2012–2016 irrigation seasons and were analyzed by Energy Laboratories (2012–2014) and Mid Continent Testing Laboratories, Inc. (2015–2016) in Rapid City, South Dakota. Over each monitoring season, 10–12 grab samples were collected with *E. coli* concentrations that ranged from 12 mpn/100 mL to 2,420 mpn/100 mL. Collected *E. coli* concentration data have been compared to the single-sample *E. coli* bacteria criterion of 1,178 mpn/100 mL that is designated for waterbodies with an assigned Limited Contact Recreation beneficial use. Over 5 years of sampling at HCR02, average *E. coli* concentrations have decreased, which is illustrated in Figure 5-10. Percent exceedance have also decreased in more recent years and is summarized in Table 5-7.

Figures 5-11 and 5-12 display the results of *E. coli* bacteria sampling that was performed on Horse Creek during the 2015 and 2016 monitoring season and is compared to flow at HCR02. In both monitoring seasons, only one out of the ten obtained *E. coli* grab samples was in excess of the single-sample *E. coli* bacteria criterion of 1,178 mpn/100 mL. Each season resulted in a 10 percent exceedance of the *E. coli* bacteria criterion for Limited Contact Recreations waters for the monitoring season. The exceedance during the 2015 monitoring season occurred during the first sample of the season (May 12, 2015) and measured 2,420 mpn/100 mL, while the exceedance in 2016 occurred on August 3 and measured 1,200 mpn/100 mL.

In addition to the 2016 monitoring season, RESPEC added a new site along Indian Creek (ICR03). Similar to Horse Creek, *E. coli* concentrations at ICR03 only exceed the single-sample criterion of 1,178 mph/100mL once during the 2016 monitoring season. On July 7, 2016, the *E. coli* grab sample obtained measured 2,420 mpn/100mL. Although the Limited Contact Recreation beneficial use does not apply to Indian Creek, comparing concentrations to criterion can provide a reference for assessing seasonal water quality trends between HCR02 and ICR03. *E. coli* sample results were plotted with flow at ICR03 in Figure 5-13.

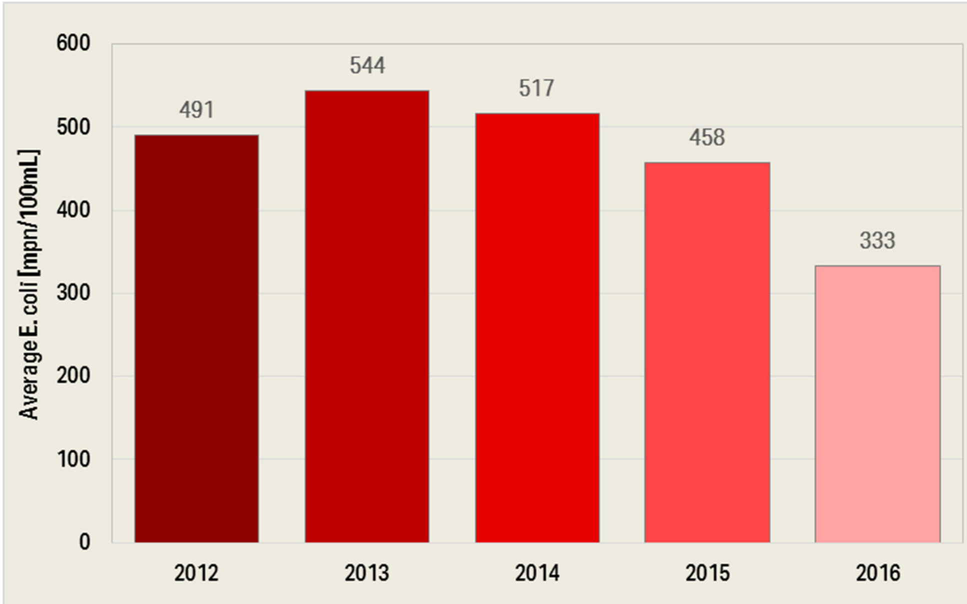

Figure 5-10. Average *E. coli* Concentrations for HCR02 for the 2012–2016 Monitoring Seasons.

Table 5-7. *E. coli* Statistics for HCR02 for the 2012–2016 Monitoring Seasons

Year	Average (mpn/100 mL)	Median (mpn/100 mL)	Total Samples	Number of Samples Exceeding Criterion	Percent Exceedance (%)
2012	491	163	12	1	8
2013	544	139	12	2	17
2014	517	182	10	2	20
2015	458	271	10	1	10
2016	333	148	10	1	10

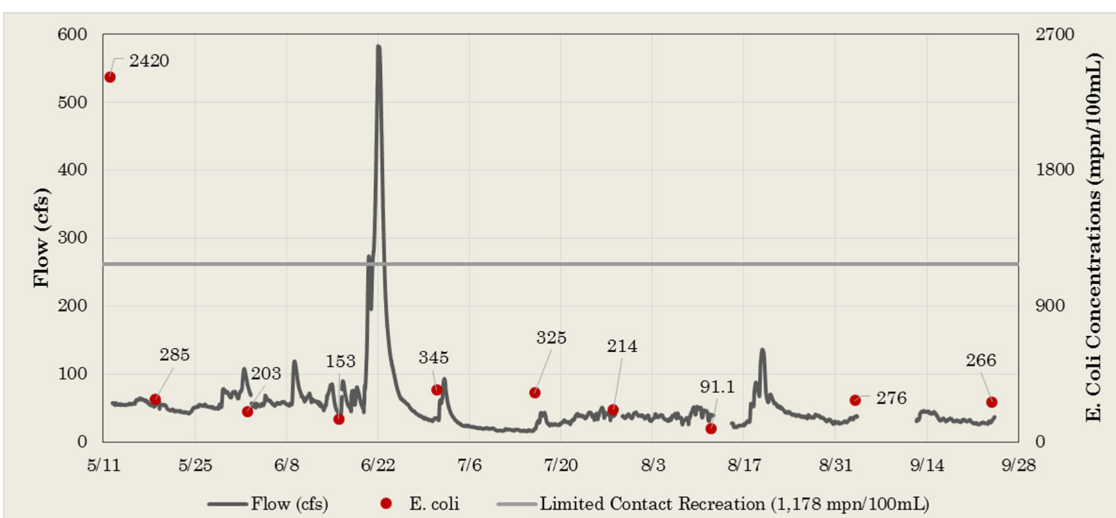

Figure 5-11. Continuous Flow and *E. coli* Concentrations at HCR02 for the 2015 Monitoring Season.

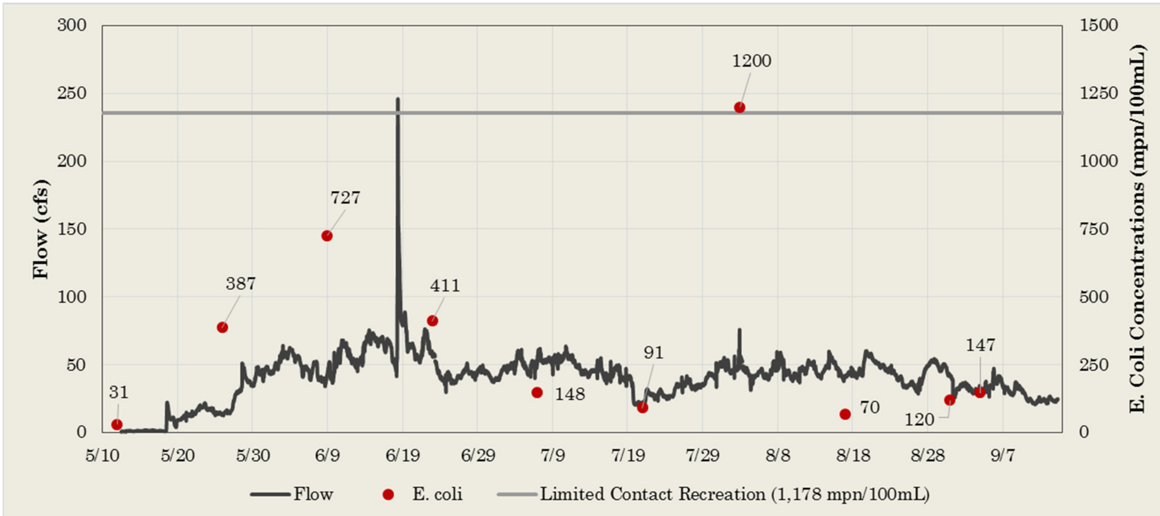

Figure 5-12. Continuous Flow and *E. coli* Concentrations at HCR02 for the 2016 Monitoring Season.

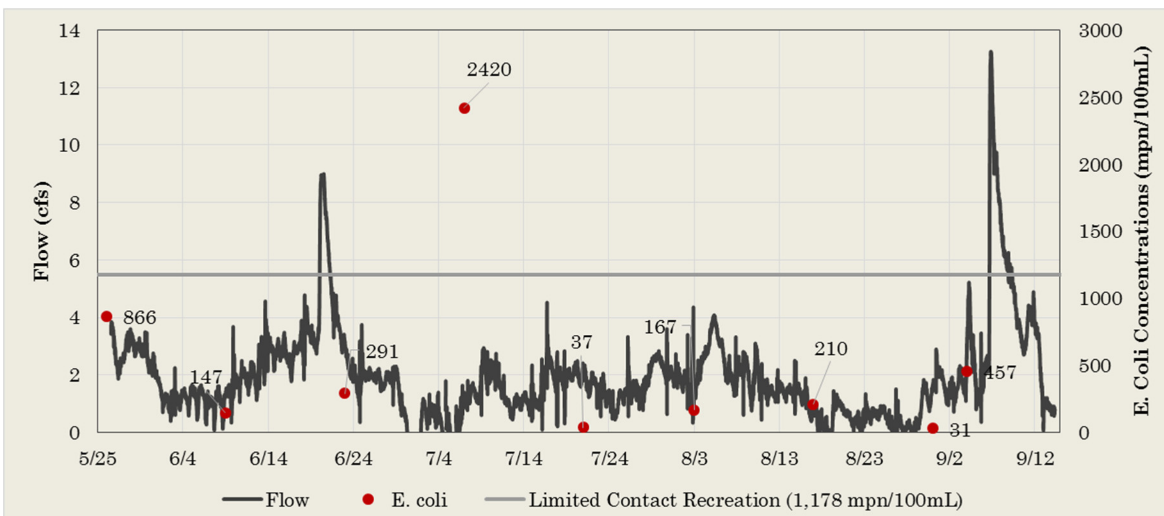

Figure 5-13. Continuous Flow and *E. coli* Concentrations at ICR03 for the 2016 Monitoring Season.

In comparison, *E. coli* concentrations were greater at HCR02 than ICR03 during six of the ten sampling events, with a 40 percent increase from upstream to downstream. However, ICR03 recorded the highest *E. coli* concentration of 2,240 mpn/100 mL.

5.3.2.2 TOTAL SUSPENDED SOLIDS

RESPEC began sampling for TSS in 2013 at HCR02. Average concentrations have decreased in recent years, and the highest recorded value was observed in June 2013. Figure 5-14 compares the average concentration of TSS (in mg/L), and Table 5-8 summarizes the number of samples collected and percent exceedances for each season. Horse Creek was under flood conditions during two sampling events in 2014, and the high concentrations were likely a result of these events. These observations may skew the average for 2014; however, they also indicate that overland runoff and washoff associated with precipitation potentially had the capacity to transport accumulated bacteria and sediment near or within the riparian area to Horse Creek.

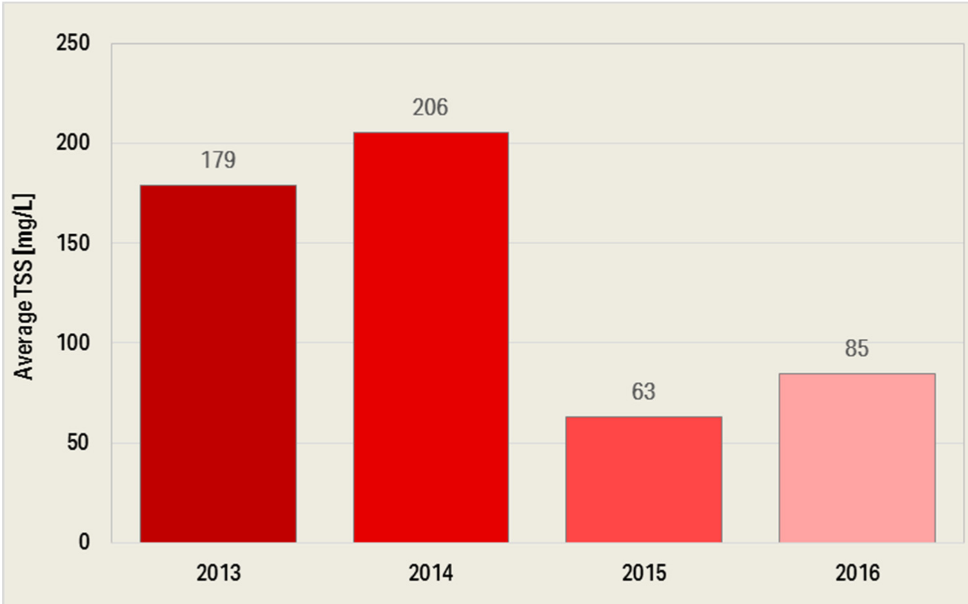

Figure 5-14. Average Total Suspended Solids Concentrations for HCR02 for the 2013–2016 Monitoring Seasons.

Table 5-8. Total Suspended Solids Statistics for HCR02 for the 2013–2016 Monitoring Seasons

Year	Average (mg/L)	Median (mg/L)	Total Samples	Number of Samples Exceeding Criterion	Percent Exceedance (%)
2013	179	51	12	2	17
2014	206	64	10	3	30
2015	63	55	10	0	0
2016	85	97	10	1	10

TSS sample results from 2015 and 2016 were plotted with flow at HCR02, as illustrated in Figures 5-15 and 5-16, respectively. None of the TSS grab samples obtained were in excess of the single-sample TSS criterion of 158 mg/L during the 2015 monitoring season. In 2016, one TSS grab sample obtained met but did not exceed the single-sample criterion for TSS. On June 23, 2016, the grab sample measured 158 mg/L.

At ICR03, TSS concentrations remained below the daily maximum criterion of 158 mg/L for every sampling event. Although the Warm-Water Permanent Fish Life beneficial use does not apply to Indian Creek, concentrations were compared to the criterion as a reference for assessing seasonal water quality trends between HCR02 and ICR03. TSS sample results were plotted with flow at ICR03 in Figure 5-17.

TSS concentrations were higher in nine of the ten samples at HCR02 than observed at ICR03. The sample results from the 2016 monitoring season suggest that generally, pollutant concentrations increase from upstream to downstream, after flowing through the irrigation district. Continual monitoring of HCR02 and ICR03 is advised to identify a trend in pollutant reductions from BMP implementations in the BFID and capture seasonal variabilities.

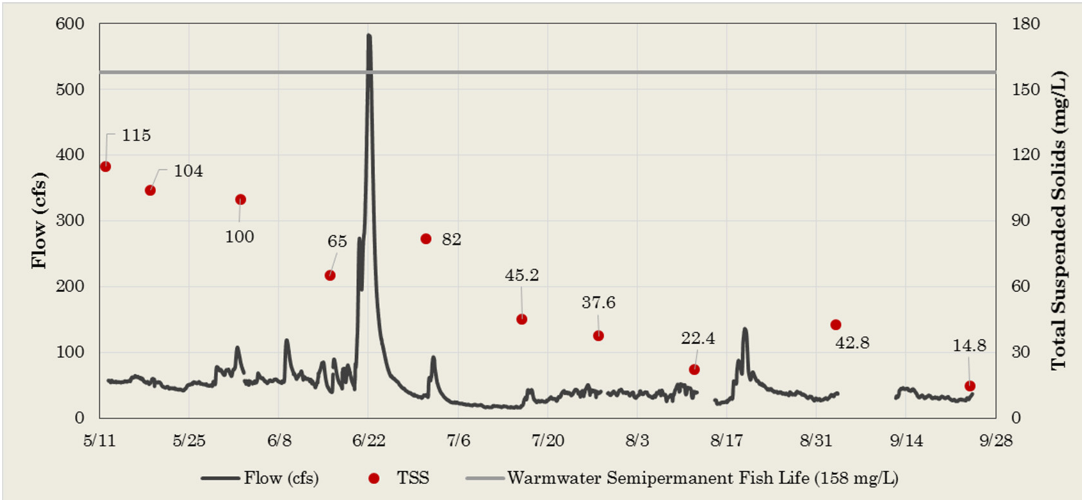

Figure 5-15. Continuous Flow and Total Suspended Solids Concentrations at HCR02 for the 2015 Monitoring Season.

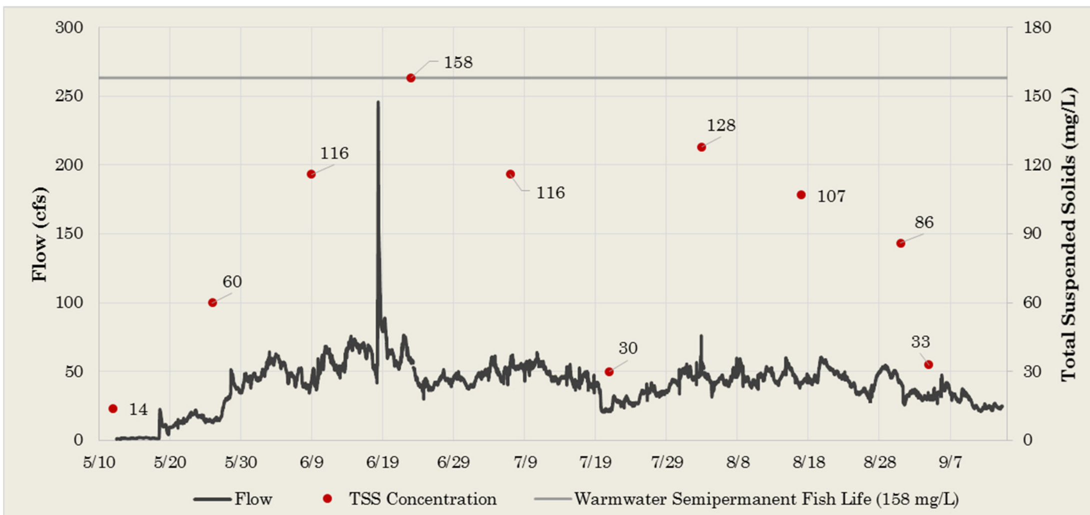

Figure 5-16. Continuous Flow and Total Suspended Solids Concentrations at HCR02 for the 2016 Monitoring Season.

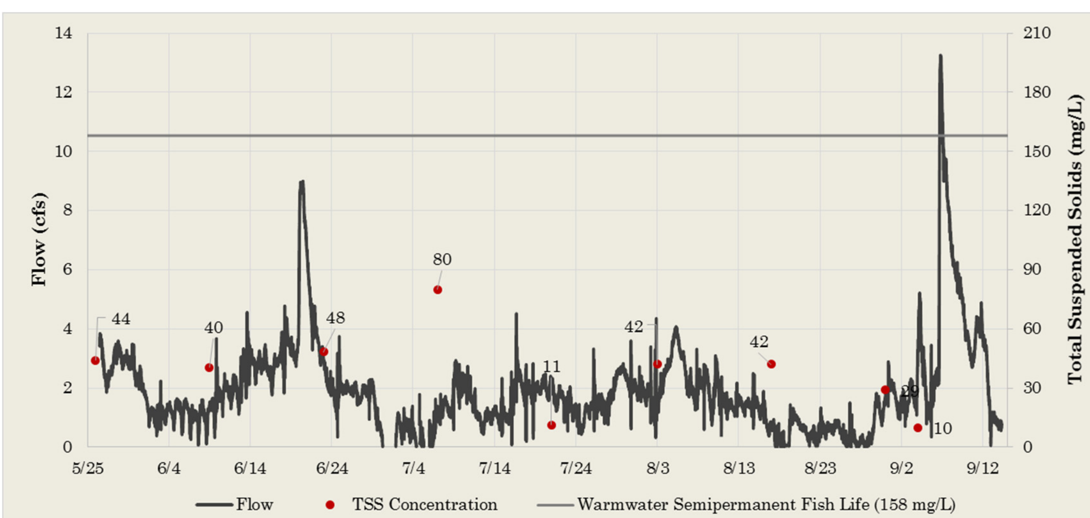

Figure 5-17. Continuous Flow and Total Suspended Solids Concentrations at ICR03 for the 2016 Monitoring Season.

5.3.3 WATER QUALITY SUMMARY: LOAD DURATION CURVES

Load duration curves (LDCs), which represent the allowable daily load under any given flow condition, were used to represent the observed TSS and *E. coli* loading for pre- (1995–2005) versus post- (2006–2016) BMP implementation, when applicable, at HCR02, WQM21, and WQM76 (Figures 5-18 through 5-23). Continuous flow and observed water quality data were used to calculate observed loads, which were plotted as points along the LDCs. Observed loads plotted above the LDC are in exceedance of the water quality standard. Exceedances during high flows are typically caused by a watershed runoff event, such as precipitation or irrigation. Low-flow exceedances are typically caused by direct pollutant loads or sources in close proximity to the stream, such as direct defecation by wildlife or livestock in the stream channel.

Water quality data that were available from March through May were analyzed as spring-observed loads and are represented by green points in Figures 5-18 through 5-23. Similarly, summer-observed loads include data from June through August and are identified by red points; fall-observed loads (September through November) are represented with orange points; and, when available, winter-observed data (December through the following February) are plotted as purple points. Observed loads are categorized as circular points for pre-BMP data and are symbolized as squares for post-BMP data in the figures.

Figures 5-18 through 5-20 illustrate the *E. coli*-observed loads for HCR02, WQM21, and WQM76, respectively. All exceedances occurred within the high flow range during the irrigation season, except for one sample collected at WQM21 during the spring. Exceedances during high flow indicate that irrigation return flows may have an impact to overall bacteria loading in the system.

Figures 5-21 through 5-23 compare TSS-observed loads to the allowable load for HCR02, WQM21, and WQM76, respectively. As with the *E. coli*-observed loads, all exceedances at HCR02 occurred during high flow. Three of the five exceedances were observed during the irrigation season, and all exceedances occurred during the summer. The historical dataset for the Belle Fourche River WQM sites include multiple samples that were collected annually and date from the mid 1990s. Observed loads have exceeded during all seasons at WQM21 and WQM76. Sixty percent of these exceedances were observed during the spring, and the majority (89 percent) occurred during high flow. Although more exceedances are observed over a wide range of flow at WQM76, WQM21 was the only site that exceeded the allowable load for TSS at low-flow, which was observed during the winter.

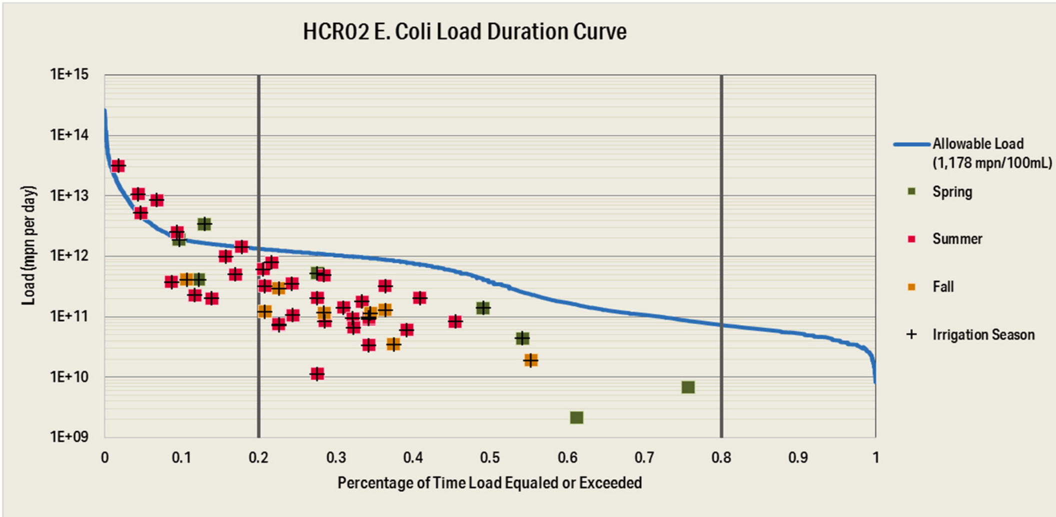

Figure 5-18. Load Duration Curve and *E. coli*-Observed Loads for HCR02.

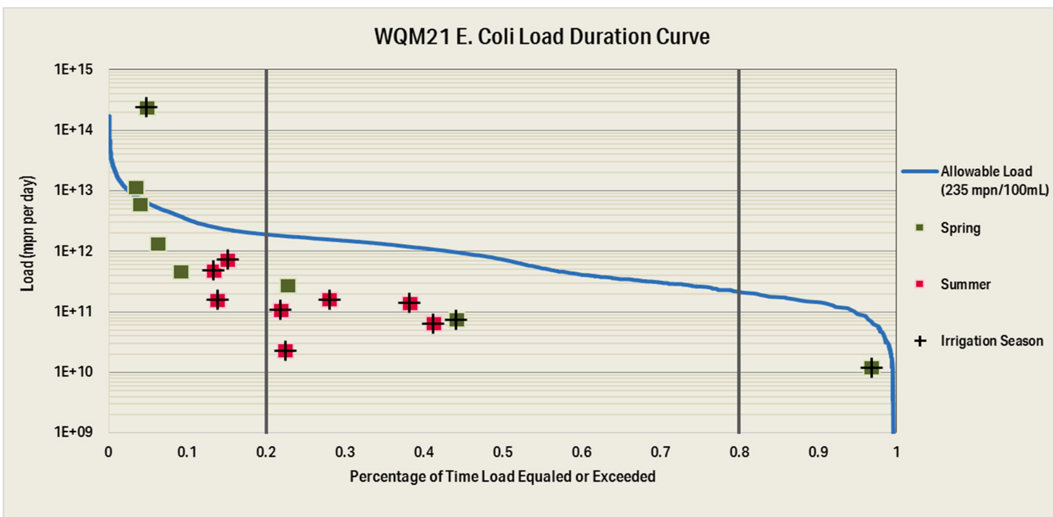

Figure 5-19. Load Duration Curve and *E. coli*-Observed Loads for WQM21.

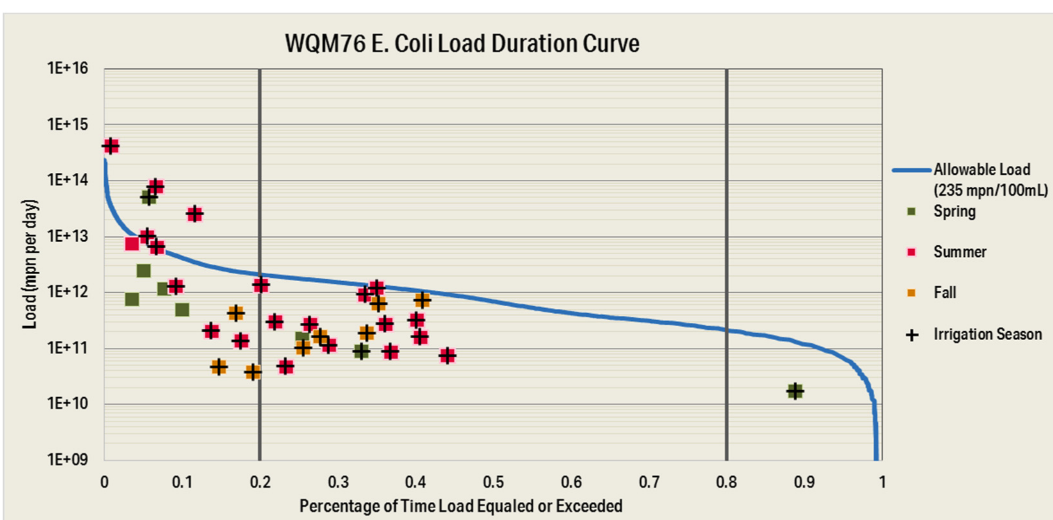

Figure 5-20. Load Duration Curve and *E. coli*-Observed Loads for WQM76.

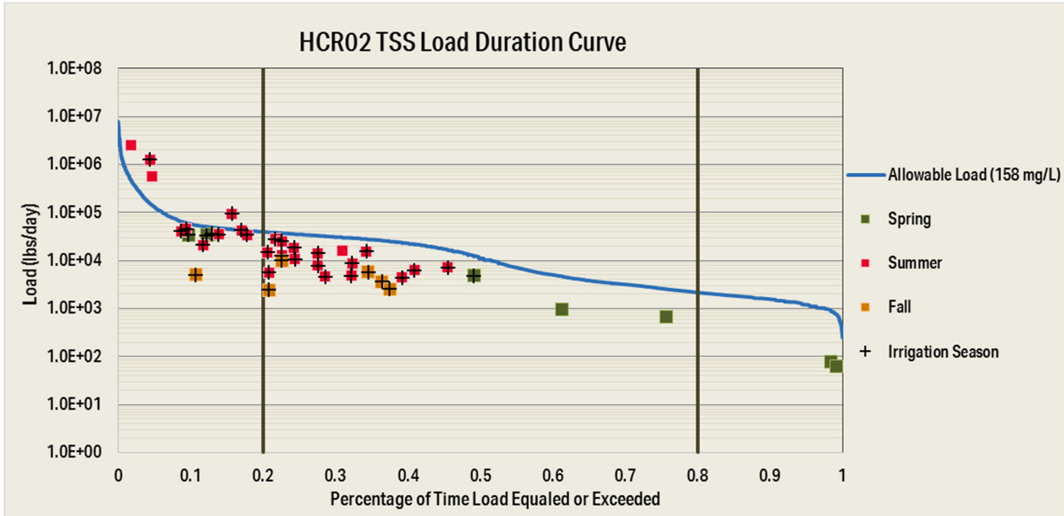

Figure 5-21. Load Duration Curve and Total Suspended Solids-Observed Loads for HCR02.

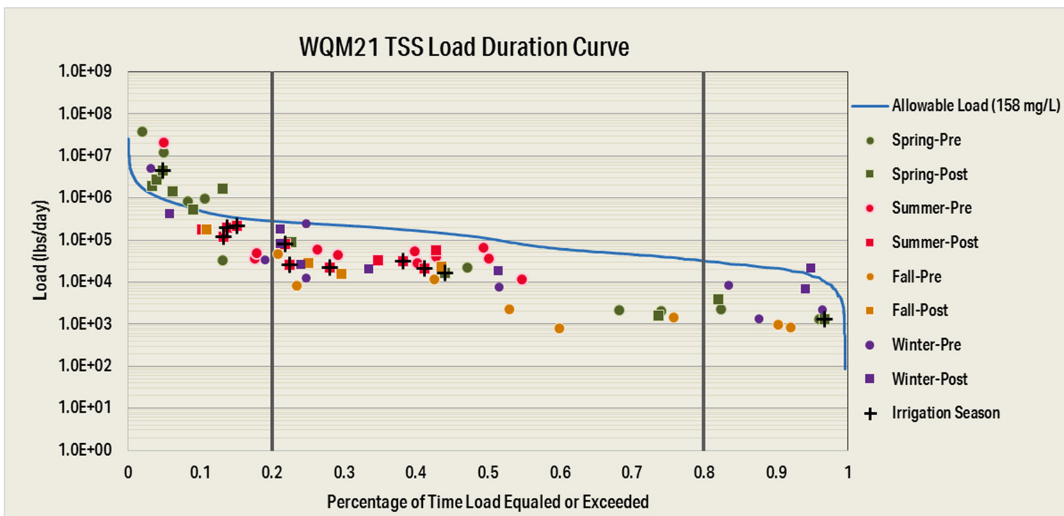

Figure 5-22. Load Duration Curve and Total Suspended Solids-Observed Loads for WQM21.

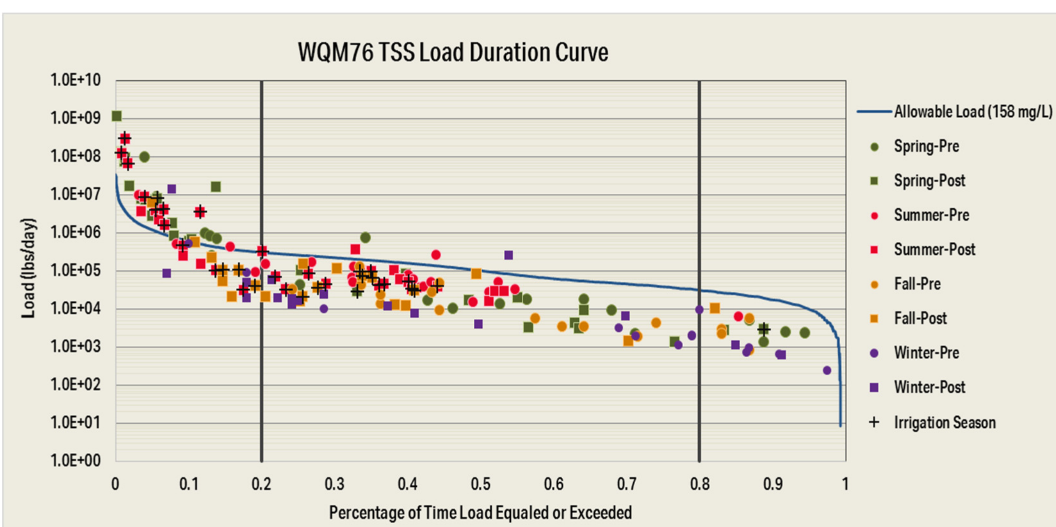

Figure 5-23. Load Duration Curve and Total Suspended Solids-Observed Loads for WQM 76.

6.0 RESULTS AND CONCLUSIONS

Continued public awareness for this ongoing project greatly enhances the effort put into improving water quality in the watershed. Combined efforts of radio advertisements, brochures, outreach booths, tours, the BFRWP website, and the soil-quality demonstration trailer were considered successful. Many comments and questions were received from the public who heard about the BFRWP from radio advertisements and sound bites. These activities increased interest and awareness from the general public in addition to the producers who were directly involved in an implementation project. The public's acceptance and support are huge assets when making watershed-wide improvements in water quality.

General interest from producers was received watershed wide because BMPs often benefit producers by making their land more productive and profitable while obtaining improved water quality and overall improving soil health and land conservation. The BFRWP believes that the financial incentive that was offered as cost-share is at a good balance to enhance the partnership between the BFRWP and the individual agriculture producer. The partnership created in each individual project is good assurance that the practice will be maintained for its usable life and continue to promote water quality and other benefits. Applications for projects often exceed allowable funds and generally a backlog of projects exist annually, which allows projects to be prioritized by those with the most direct benefit to water quality. The downside to this method is that some participants with excellent projects are overlooked because of their location or distance from the impaired waterbody. Some of these individuals may become disinterested after several years of unsuccessful applications. Although local abundant interest is apparent to convert flood irrigation systems to sprinklers and range/riparian improvement projects, EQIP funding has been reduced across the entire state of South Dakota for all practices. Therefore, less irrigated acres are being converted and less riparian acres are being improved than estimated for this segment.

Recent interest in no-till farming and cover-crop practices to improve overall soil health has been observed in the watershed. These practices directly affect water quality in the Belle Fourche River. Continued support of this practice through outreach and education would be beneficial to the BFRWP's goals of reducing sediment in the Belle Fourche River.

7.0 PROJECT BUDGET/EXPENDITURES

The BFRWP received a $1,211,500 EPA Section 319 Grant through the SD DENR to continue installing the BMPs that were recommended in the *Phase I Watershed Assessment Final Report and TMDL* [Hoyer and Larson, 2004]. Tables 7-1a, 7-2a, 7-3a, and 7-4a show the budgets of 319, 319/matching funds, nonmatching funds, and combined funds, respectively. These budgets were the final budgets after the Segment 7 amendment was approved. Tables 7-1b, 7-2b, 7-3b, and 7-4b are the final expenditure budgets for 319, 319/matching funds, nonmatching funds, and combined funds, respectively. Changes in these budgets were documented as exhibit amendments to the budget as they were made.

7.1 319 BUDGET

The total 319 budget remained the same with some changes between tasks. From *Task 1 Product 1a–Implement Improved Irrigation Application,* $15,043 was transferred to *Task 2 Product 2a Riparian/Rangeland BMPs*. The amount of $500 was transferred from *Task 1 Product 1a Implement Improved Irrigation Application* to *Task 3 Product 4 Information and Education*. These changes were made to zero out the budget and meet the July 2017 deadline. No other changes were made to the 319 budget.

7.2 MATCHING FUNDS BUDGET

All federal-match requirements were met in this project. Final match dollars were lower than originally estimated. The driving force behind this was the fact that the cost of irrigation sprinkler systems has decreased in the past 2 years, which reduces the overall matching dollars.

7.3 NONMATCHING FEDERAL FUNDS BUDGET

Overall, nonmatching funds were underestimated for the project by approximately $304,000. Federal dollars, including NRCS EQIP, can be variable from year to year, depending on the demand and estimating actual numbers is challenging. Changes occurred in all areas of the nonmatching budget to reflect actual dollars spent.

Table 7-1a. Planned Budget of 319 Funds

Project Description	Consultants ($)	Producer ($)	BFRWP ($)	Butte Conservation District ($)	Totals ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River TMDL to Reduce TSS and *E. coli*					
Task 1. Improve Irrigation Water Management					
Product 1. Improved Irrigation Water Delivery and Application					
1a. Convert 21 Flood-Irrigated Systems to Sprinkler Irrigation Systems		633,000			633,000
1b. Irrigation Scheduling	35,000				35,000
Task 2. Range and Riparian Area BMP Implementation and Improved Cropping Systems					
Product 2a. Implement Riparian/Rangeland BMPs on 3,000 Acres		165,000			165,000
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 Acres		10,000			10,000
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Project Design, Report Writing, Writing Future Grants, Annual Audit					
Task 3. Project Management and Administration					
Product 3. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit	250,000		30,000	40,000	320,000
Objective 3. Complete Essential Water Quality Monitoring					
Task 4. Water Quality Monitoring to Assess BMPs					
Product 4. Water Quality Monitoring	30,000				30,000
Product 5. Whitewood Creek Temperature TMDL	18,500				18,500
Total	333,500	808,000	30,000	40,000	1,211,500

Table 7-1b. Actual Budget of 319 Funds

Project Description	Consultants ($)	Producer ($)	BFRWP ($)	Butte Conservation District ($)	Totals ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River TMDL to Reduce TSS and *E. coli*					
Task 1. Improve Irrigation Water Management					
Product 1. Improved Irrigation Water Delivery and Application					
1a. Convert 17 Flood-Irrigated Systems to Sprinkler Irrigation Systems		617,407			617,407
1b. Irrigation Scheduling	35,000				35,000
Task 2. Range and Riparian Area BMP Implementation and Improved Cropping Systems					
Product 2a. Implement Riparian/Rangeland BMPs on 3,000 acres		180,043			180,043
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 acres		10,000			10,000
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Project Design, Report Writing, Writing Future Grants, Annual Audit					
Task 3. Project Management and Administration					
Product 3. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit	250,000		30,550	40,000	320,550
Objective 3. Complete Essential Water Quality Monitoring					
Task 5. Water Quality Monitoring to Assess BMPs					
Product 5. Water Quality Monitoring	30,000				30,000
Product 6. Whitewood Creek Temperature TMDL	18,500				18,500
Total	333,500	807,450	30,550	40,000	1,211,500

Table 7-2a. Planned EPA 319 and Matching Funds Budget

EPA 319 and Matching Funds Budget	EPA 319 ($)	Matching Funds ($)				Sum of Matching Funds ($)
		Producer (Cash and In-kind) ($)	Lawrence County (Cash) ($)	BFID (Cash and In-kind) ($)	WY DEQ (Cash)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River TMDL to Reduce TSS and *E. coli*						
Task 1. Improve Irrigation Water Management						
Product 1. Improved Irrigation Water Delivery and Application						
1a. Convert 21 Flood-Irrigated Systems to Sprinkler Irrigation Systems	633,000	1,400,000				1,400,000
1b. Irrigation Scheduling	35,000					
Task 2. Range and Riparian Area BMP Implementation and Improved Cropping Systems						
Product 2a. Implement Riparian/Rangeland BMPs	165,000	68,000				68,000
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 acres	10,000					
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering Projects, Report Writing, Writing Future Grants						
Task 4. Project Management and Administration						
Product 4. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit	320,000					
Objective 3. Complete Essential Water Quality Monitoring						
Task 5. Water Quality Monitoring to Assess BMPs						
Product 5. Water Quality Monitoring	30,000		14,000	10,500	14,000	38,500
Product 6. Whitewood Creek Temperature TMDL	18,500					
Total	1,211,500	1,468,000	14,000	10,500	14,000	1,506,500

Table 7-2b. Actual EPA 319 and Matching Funds Budget

EPA 319 and Matching Funds Budget	EPA 319 ($)	Matching Funds ($)				Sum of Matching Funds ($)
		Producer (Cash and In-kind) ($)	Lawrence County (Cash) ($)	BFID (Cash and In-kind) ($)	WY DEQ (Cash)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River TMDL to Reduce TSS and *E. coli*						
Task 1. Improve Irrigation Water Management						
Product 1. Improved Irrigation Water Delivery and Application						
1a. Convert 17 flood-irrigated systems to sprinkler irrigation systems	633,000	975,593				975,593
1b. Irrigation Scheduling	35,000					
Task 2. Range and Riparian Area BMP Implementation and Improved Cropping Systems						
Product 2a. Implement Riparian/Rangeland BMPs	165,000	138,513				138,513
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 Acres	10,000					
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering Projects, Report Writing, Writing Future Grants						
Task 4. Project Management and Administration						
Product 4. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit	320,000					
Objective 3. Complete Essential Water Quality Monitoring						
Task 5. Water Quality Monitoring to Assess BMPs						
Product 5. Water Quality Monitoring	30,000		16,175	12,131	16,175	44,481
Product 6. Whitewood Creek Temperature TMDL	18,500					
Total	1,211,500	1,114,106	16,175	12,131	16,175	1,158,587

Table 7-3a. Planned Nonmatching Funds Budget

EPA 319 and Nonmatching Funds Budget	Nonmatching Funds						Sum of Nonmatching Funds ($)
	SD DENR (Federal) ($)	NRCS EQIP (Federal) ($)	COE (Federal) ($)	BOR (Federal) ($)	USGS (Federal) ($)	Other Grants (Conservation Commission)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL to Reduce TSS and *E. coli*							
Task 1. Improve Irrigation Water Management							
Product 1. Improved Irrigation Water Delivery and Application							
1a. Convert 21 Flood-Irrigated Systems to Sprinkler Irrigation Systems		150,000					150,000
1b. Irrigation Scheduling							
Task 2. Range and Riparian Area BMP Implementation							
Product 2. Implement Riparian/Rangeland BMPs		167,000				266,000	433,000
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 Acres							
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering Projects, Report Writing, Writing Future Grants							
Task 4. Project Management and Administration							
Product 4. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit							
Objective 3. Complete Essential Water Quality Monitoring							
Task 5. Water Quality Monitoring to Assess BMPs							
Product 5. Water Quality Monitoring	70,000		14,000	7,000	173,400		264,400
Product 6. Whitewood Creek Temperature TMDL							
Total	70,000	317,000	14,000	7,000	173,400	266,000	847,400

Table 7-3b. Actual Nonmatching Funds Budget

EPA 319 and Nonmatching Funds Budget	Nonmatching Funds						Sum of Nonmatching Funds ($)
	SD DENR (Federal) ($)	NRCS EQIP (Federal) ($)	COE (Federal) ($)	BOR (Federal) ($)	USGS (Federal) ($)	Other Grants (Conservation Commission)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL to Reduce TSS and *E. coli*							
Task 1. Improve Irrigation Water Management							
Product 1. Improved Irrigation Water Delivery and Application							
1a. Convert 17 Flood-Irrigated Systems to Sprinkler Irrigation Systems		47,765					47,765
1b. Irrigation Scheduling							
Task 2. Range and Riparian Area BMP Implementation							
Product 2. Implement Riparian/Rangeland BMPs		591,000				263,000	854,000
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 acres							
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering Projects, Report Writing, Writing Future Grants							
Task 4. Project Management and Administration							
Product 4. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit							
Objective 3. Complete Essential Water Quality Monitoring							
Task 5. Water Quality Monitoring to Assess BMPs							
Product 5. Water Quality Monitoring	80,875		0	7,350	161,294		249,519
Product 6. Whitewood Creek Temperature TMDL							
Total	80,875	638,765	0	7,350	161,294	263,000	1,151,284

Table 7-4a. Planned Total Budget

Total Budget	EPA 319 ($)	Matching Funds ($)	Nonmatching Funds ($)	Line Item Total ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River TMDL to Reduce TSS and *E. coli*				
Task 1. Improve Irrigation Water Management				
Product 1. Improved Irrigation Water Delivery and Application				
1a. Convert 21 Flood-Irrigated Systems to Sprinkler Irrigation Systems	633,000	1,400,000	150,000	2,183,000
1b. Irrigation Scheduling	35,000			35,000
Task 2. Range and Riparian Area BMP Implementation				
Product 2a. Implement Range/Rangeland BMPs	165,000	68,000	433,000	666,000
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 acres	10,000			10,000
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering Projects, Report Writing, Writing Future Grants				
Task 3. Project Management and Administration				
Product 4. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit	320,000			320,000
Objective 3. Complete Essential Water Quality Monitoring				
Task 4. Water Quality Monitoring to Assess BMPs				
Product 5. Water Quality Monitoring	30,000	38,500	264,400	332,900
Product 6. Whitewood Creek Temperature TMDL	18,500			18,500
Total	1,211,500	1,506,500	847,400	3,565,400

Table 7-4b. Actual Total Budget

Total Budget	EPA 319 ($)	Matching Funds ($)	Nonmatching Funds ($)	Line Item Total ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River TMDL to Reduce TSS and *E. coli*				
Task 1. Improve Irrigation Water Management				
Product 1. Improved Irrigation Water Delivery and Application				
1a. Convert 17 Flood-Irrigated Systems to Sprinkler Irrigation Systems	617,407 (38%)	975,593 (59%)	47,765 (3%)	1,640,765
1b. Irrigation Scheduling	35,000 (100%)			35,000
Task 2. Range and Riparian Area BMP Implementation				
Product 2a. Implement Range/Rangeland BMPs	180,043 (15%)	138,513 12%)	854,000 (73%)	1,172,556
Product 2b. Implement Cover-Crop and No-Till Cropping Systems on 200 acres	10,000 (100%)			10,000
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Cultural Resources, Engineering Projects, Report Writing, Writing Future Grants				
Task 3. Project Management and Administration				
Product 4. Public Outreach, and Education Implementation Record Keeping, Cultural Resources, Engineering, Audits, Report Writing, Writing Future Grants, Annual Audit	320,550 (100%)			320,550
Objective 3. Complete Essential Water Quality Monitoring				
Task 4. Water Quality Monitoring to Assess BMPs				
Product 5. Water Quality Monitoring	30,000 (9%)	44,481 (14%)	249,519 (77%)	324,000
Product 6. Whitewood Creek Temperature TMDL	18,500 (100%)			18,500
Total	1,211,500	1,158,587	1,151,284	3,521,371

8.0 FUTURE ACTIVITY RECOMMENDATIONS

Segment 8 will continue over the next 2 years and will install the BMPs that were outlined in the *Phase I Watershed Assessment Final Report and TMDL* [Hoyer and Larson, 2004] and the *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan* [Hoyer, 2005]. Details for Segment 8 can be found in the BFRWP's project implementation plan. Additional segments will ensure that the overall goal of bringing the Belle Fourche River and other impaired waterbodies within the watershed into compliance with state TSS and bacteria standards is met. As additional TMDLs are completed for other lakes and tributaries in the watershed, implementing TMDLs that have been developed will be added to the Belle Fourche River Watershed project.

9.0 REFERENCES

Hoyer, D. P., 2005. *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan*, RSI-1821, prepared by RESPEC, Rapid City, SD, for the Belle Fourche Irrigation District, Newell, SD.

Hoyer, D. P. and A. Larson, 2004. *Phase I Watershed Assessment Final Report and TMDL*, prepared for the state of South Dakota, Pierre, SD.

Rolland, C. and D. P. Hoyer, 2005. *Belle Fourche Irrigation District Water Conservation Plan*, RSI-1824, prepared by RESPEC, Rapid City, SD, for the Belle Fourche Irrigation District, Newell, SD.

South Dakota Department of Environment and Natural Resources, 2016. *The 2016 South Dakota Integrated Report for Surface Water-Quality Assessment*, prepared by the South Dakota Department of Environment and Natural Resources, Pierre, SD.