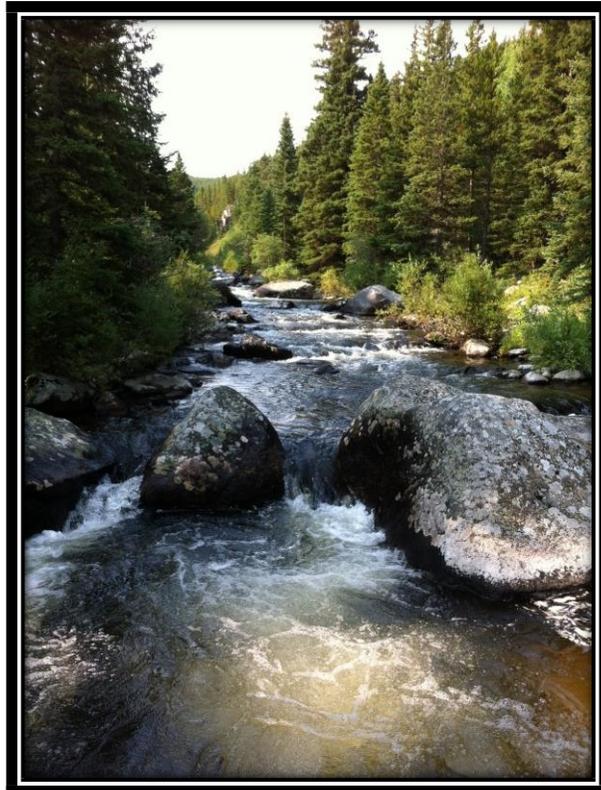


Upper Big Goose Creek Watershed Management Plan

Sheridan, Wyoming



Prepared for:
City of Sheridan, Wyoming
Sheridan Area Water Supply Joint Powers Board

Prepared by:



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Abbreviations

BMP:	Best Management Practices
CWA:	Clean Water Act
DEQ:	Department of Environmental Quality
EPA:	Environmental Protection Agency
GCDAG:	Goose Creek Drainage Advisory Committee
GCWPC:	Goose Creek Watershed Planning Committee
LT2:	EPA's Long Term 2 Enhanced Surface Treatment Rule
SAWSJPB:	Sheridan Area Water Supply Joint Powers Board
SDWA:	Safe Drinking Water Act
SCCD:	Sheridan County Conservation District
TMDL:	Total Maximum Daily Load
USFS:	United States Forest Service
USDA:	United States Department of Agriculture
WCP:	Watershed Control Plan
WGFD:	Wyoming Game and Fish Department

Executive Summary

Numerous planning documents and reports have been conducted on water resources throughout Sheridan County. Most of these plans address pollution that is found in the more urban areas and do not address *Cryptosporidium* pollution. In order to protect the community it was deemed necessary to develop a plan that would serve as a living document and only look at the portion of the watershed that provides drinking water to the Sheridan area.

The purpose of the Upper Big Goose Creek Watershed Management Plan is to address *Cryptosporidium* pollution in the Big Goose Creek watershed above Sheridan's drinking water intake. Once implemented the Upper Big Goose Creek Watershed Management Plan will guide preservation of the watershed and protect water quality, as well as protect the health of citizens within the watershed. This project will help achieve compliance with the Safe Drinking Water Act and maintain current compliance with the Clean Water Act above the source water intake.

The US Environmental Protection Agency supports a comprehensive strategy to address *Cryptosporidium* contamination in headwaters areas. The Upper Big Goose Creek Watershed Management Plan serves as the watershed control plan (WCP) for Sheridan and represents community commitment to water quality. The USDA Forest Service (USFS) has developed and implemented plans to address Clean Water Act (CWA) requirements in the Big Goose Creek watershed. The USFS efforts have met all CWA requirements and are in full compliance with the CWA water quality standards at this time. Elements of the USFS plans have been incorporated into this plan in order to address both the Safe Drinking Water Act (SDWA) and CWA. The completed WCP is designed to meet the standards set forth in 40 CFR 141.716(A)(2)¹ and will serve as the basis for a Watershed Control Program under the EPA's Long Term 2 Enhanced Surface Water Treatment Rule (LT2) rule.

The Upper Big Goose Creek Watershed Management Plan is meant to provide a framework for managing efforts to protect overall watershed health and decrease the likelihood for pollutants to enter the watershed. The goals of the Big Goose Creek Watershed Control Plan are to 1) Locate where and how *Cryptosporidium* is entering the watershed and identify sources., 2) Act to minimize potential contributions from all sources of pollutant contributors in the Upper Big Goose Creek Watershed, and 3) Increase public outreach, involvement, and education concerning the Big Goose Creek Watershed. The plan is intended to be a living document used to aid stakeholder work and water quality efforts.

¹ Water systems can receive a 0.5-log *Cryptosporidium* treatment credit for implementing a watershed control program that meets the requirements of this section of the EPA's Watershed Control Program Source Toolbox Components.

Section 1: Introduction and Background

Project Purpose and Need

Sheridan, Wyoming was incorporated in 1884 at the confluence of Little Goose and Big Goose Creeks. Over a century later, these creeks are vital resources for the community. The creeks serve as the scenic cornerstone of Sheridan's parks and pathways system. It is common to see residents walking, jogging and biking the paths along the creeks and in summer months, children frequently fish and swim in Big Goose Creek as it flows through Kendrick Park. More important than just a scenic landmark in Sheridan, the Big Goose Creek serves as Sheridan's municipal drinking water supply.

The Sheridan community faces nonpoint source pollution challenges in its efforts to maintain high quality, safe drinking water. *Cryptosporidium* pollution hinders water quality in the Upper Big Goose Creek watershed. Nonpoint source pollution, also known as polluted runoff, remains the nation's largest water quality challenge. Nonpoint source pollution involves numerous sources, a variety of stakeholders, and a large geographic area. Due to the complexity and difficult nature of nonpoint source pollution, the EPA encourages communities to employ a holistic watershed approach to addressing nonpoint source pollution.

Nonpoint source pollution is widespread. It can occur any time activities disturb the land or water. Agriculture, forestry, grazing, septic systems, recreational activities, urban runoff, construction, physical changes to stream channels, and habitat degradation are potential sources of nonpoint source pollution. Careless or uninformed household management also contributes to nonpoint source pollution problems.² Given the unique challenges of nonpoint source pollution, developing a locally based watershed plan offers the best opportunity to address the sources of these pollutants.

The City of Sheridan and Sheridan Area Water Supply Joint Powers Board (SAWSJPB) maintain two water treatment plants – the Big Goose Water Treatment Plant and the Sheridan Water Treatment Plant. Both plants draw their source water from Big Goose Creek, which flows out of the Bighorn Mountains. Most of the Upper Big Goose Creek watershed is federal property administered by the Bighorn National Forest.

Given the central role that the Big Goose Creek plays in the Sheridan community, it is critical that it meets water quality standards.

Community Support

The Sheridan community has shown strong support for protecting water quality. Local polls consistently show high support for water quality protection. Sheridan residents have voted in recent years to dedicate \$250,000 annually in optional sales taxes to protect water quality and maintain parks and open spaces. The Downtown Sheridan Association and Trout Unlimited, in partnership with the City, have undertaken multi-phase projects to restore Big Goose Creek in Kendrick Park to a more natural state. By placing boulders and check dams within the creek, they have improved the habitat for fisheries and also increased oxygenation of the water. The City has worked with Trout Unlimited and the Sheridan County Conservation District (SCCD) on a second habitat improvement project at South Park in Sheridan. The SCCD has assisted landowners with a variety of water quality projects including providing off-channel stock water and riparian fencing. These voluntary efforts demonstrate the community's commitment to the Goose Creeks and have begun to improve water quality in the creeks. The Upper Big Goose Creek Watershed Management Plan represents a continued commitment to water quality by addressing conditions above the community's source water intake.

² <http://water.epa.gov/polwaste/nps/outreach/point1.cfm>

Goals

This Watershed Control Plan is designed to be a flexible framework for addressing *Cryptosporidium* and nonpoint source pollution in the Big Goose Creek watershed above the community's water treatment plant. Once implemented, the Upper Big Goose Creek Watershed Management Plan will preserve and protect water quality as well as protect the health of citizens within the watershed. Addressing nonpoint source pollution in the Upper Big Goose Creek Watershed will also help supplement water quality efforts currently underway below the source water intake. The WCP will also help achieve compliance with the LT2 rule under the Safe Drinking Water Act and continue to meet water quality standards under the Clean Water Act through the implementation of appropriate best management practices.

There are three overarching goals of the Big Goose Creek Watershed Control Plan

1. Identify existing sources of *Cryptosporidium* in the Upper Big Goose Creek watershed and locate how and where *Cryptosporidium* is entering the watershed.
2. Act to minimize sources of *Cryptosporidium* in the Upper Big Goose Creek Watershed.³
3. Increase public outreach, involvement, and education in the Big Goose Creek Watershed.

Clean Water Act and Safe Drinking Water Act

The Safe Drinking Water Act and the Clean Water Act intersect in protecting surface water used as drinking water. Both laws address water quality and water pollution challenges. Sheridan currently has obligations under each act.

Safe Drinking Water Act

The Safe Drinking Water Act is the main federal law that ensures the quality of drinking water in the United States. Under SDWA, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.

Congress originally passed the SDWA in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources including rivers, lakes, reservoirs, springs, and ground water wells.

SDWA authorizes the EPA to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. The EPA, states, and water systems then work together to make sure that these standards are met. According to EPA regulations, a system that operates at least 60 days per year and serves 25 people or more or has 15 or more service connections, is regulated as a public water system under the SDWA.

Under the SDWA, EPA requires public water systems to monitor for coliform bacteria. Systems analyze first for total coliform, because this test is faster to produce results. Any time that a sample is positive for total coliform, the same sample must be analyzed for either fecal coliform or *E. coli*.

Cryptosporidium is regulated under the Safe Drinking Water Act.

Wyoming is the only State that has not applied to the EPA for authority to administer the Public Water System Supervision (PWSS) program under the SDWA. EPA Region 8 directly implements the PWSS program in Wyoming. EPA is responsible for:

³ It is assumed since all sources of *Cryptosporidium* are mobile and may bring *Cryptosporidium* in with them from outside the watershed that all possible sources contribute to contamination.

- Oversight of monitoring/reporting of water testing performed by public water systems
- Sanitary surveys
- Technical assistance to water operators
- Laboratory certification
- Compliance determinations
- Formal enforcement
- Homeland security

Clean Water Act

The objective of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint source pollution, providing assistance to publicly owned treatment works for the improvement of wastewater treatment, and maintaining the integrity of wetlands.

The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972.

Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry and has the regulatory and approval role in State and Tribal water quality standards

EPA Long Term 2 Enhanced Surface Water Treatment Rule

The SAWSJPB and the City of Sheridan are installing expensive water treatment upgrades stemming from the presence of *Cryptosporidium* in Sheridan's source water. These upgrades are required by EPA's Long Term 2 (LT2) Enhanced Surface Treatment Rule (71 FR 654; 40 C.F.R. Part 141, Subpart W, *Enhanced Treatment for Cryptosporidium*). In response to a large outbreak in Milwaukee and concern that *Cryptosporidium* was responsible for other smaller outbreaks across the United States, EPA developed the Long Term 2 Enhanced Surface Water Treatment Rule to improve drinking water quality and provide additional protection from disease-causing microorganisms and contaminants. EPA adopted the LT2 rule on January 6, 2006. The LT2 rule applies to all public water systems that use surface water or ground water under the direct influence of surface water.

The LT2 rule requires municipal systems to monitor their source water, calculate an average *Cryptosporidium* concentration, and use those results to determine if their source is vulnerable to contamination and whether they need to install additional treatment systems. On March 23, 2008, the City of Sheridan submitted to the U.S. Environmental Protection Agency the results of water quality sampling showing the presence of the parasite *Cryptosporidium* in the source water for Sheridan's water system (Sampling results can be found in *Appendix A*). Based on the level of contamination, the City of Sheridan determined that it would be classified as "Bin 2" for purposes of the Long Term 2 ("LT2") Enhanced Surface Water Treatment Rule. This means the SAWS and the City must achieve credit for a 1-log (90%) reduction of *Cryptosporidium* in addition to the removal already achieved by the conventional filtration plant under normal operations.

Cryptosporidium

Cryptosporidium is a microscopic parasite that causes the disease cryptosporidiosis. *Cryptosporidium* is spread through the stool of an infected animal or human and can contaminate surface waters used for drinking water. *Cryptosporidium* can cause stomach cramps or pain, diarrhea, dehydration, vomiting, fever, and weight loss. The parasite is especially dangerous for persons with compromised immune systems such as the elderly, children up to age 4, children with congenital diseases, individuals undergoing cancer treatment, and AIDS patients.

An outer shell protects *Cryptosporidium* oocysts⁴ that allow it to live in the environment for a long period of time. *Cryptosporidium* oocysts are extremely resilient and can withstand chlorine disinfection. This makes assessing the risk of *Cryptosporidium* contamination and developing a management plan extremely important.

The largest outbreak of any waterborne illness since record keeping began occurred in Milwaukee, Wisconsin between March and April of 1993 due to *Cryptosporidium* contamination. During this outbreak, over 400,000 Milwaukee residents became ill and approximately 100 residents died due to symptoms of *Cryptosporidium*. The social and economic impacts of this outbreak were significant, with over 725,000 days of work and school missed to the massive outbreak. The cost of the system improvements, along with costs to the water utility, city, and Health Department associated with the disease outbreak were \$89 million. ⁵

⁴ An oocyst is a thick walled structure containing a zygote formed by a parasitic protozoan. Oocysts can live for extended lengths of time in fecal matter or in moist soils.

⁵ <http://cfpub.epa.gov/watertrain/pdf/swp.pdf>

Section 2- Watershed Planning

Protecting water resources requires looking at water quality issues from a watershed perspective. The watershed approach is advantageous because it considers all activities within a landscape that potentially affect watershed health.⁶ Watershed planning and management consists of coordinated activities aimed at controlling, enhancing, or restoring watershed functions.

The EPA has for many years encouraged states and others to develop watershed plans to help protect and restore our waters. Nonpoint source pollution is complex. Due to the substantial costs to address it, and frequent reliance on voluntary action by individual landowners, successfully addressing nonpoint source pollution to achieve water quality standards often requires years of support from a coalition of stakeholders, programs, and funding sources. Watershed planning helps address water quality problems in a holistic manner by fully assessing the potential contributing causes and sources of pollution, then prioritizing restoration and protection strategies to address these problems.

The benefits to communities of protecting their drinking water supplies might best be understood by describing the costs of failing to protect them.⁷ These costs include those that are relatively easy to capture in economic terms and those that are not. Easily quantifiable costs of drinking water supply contamination include:

- Treatment and remediation;
- Finding and developing new supplies and providing emergency replacement water;
- Abandoning a drinking water supply due to contamination;
- Paying for consulting services and staff time;
- Litigating against responsible parties;
- Conducting public information campaigns when incidents arouse public and media interest in source water pollution;
- Meeting the regulations of the Safe Drinking Water Act, such as the disinfection byproduct and monitoring requirements;
- Loss of property value or tax revenue; and
- Loss of revenue from boating or fishing when a lake or reservoir is used as a drinking water supply.

Costs that are not easily quantified include:

- Health related costs from exposure to contaminated water;
- Lost production of individuals and businesses, interruption of fire protection, loss of economic development opportunities; and
- Lack of community acceptance of treated drinking water.⁸

Watershed Plan Requirements

There are numerous potential sources of *Cryptosporidium* in Sheridan's watershed including sewage discharges and nonpoint sources associated with animal feces. The feasibility, effectiveness, and sustainability of control measures to reduce *Cryptosporidium* contamination of water sources is thus regarded by EPA as site-specific. Consequently, municipal water systems are required to work with stakeholders in the watershed to develop a site-specific program that is then reviewed and approved by the EPA.

⁶ <http://www.epa.gov/owow/protecting/restore725.pdf>

⁷ <http://cfpub.epa.gov/watertrain/pdf/swpbmp.pdf>

⁸ <http://cfpub.epa.gov/watertrain/pdf/swp.pdf>

There are **four basic elements** of an approved watershed plan. These include the following:

1. *Delineation of Area of Influence.* An essential element for a watershed plan is the identification of the “area of influence,” outside of which there is not a significant likelihood of *Cryptosporidium* fecal contamination that affects the treatment plant intake. Identification of *Cryptosporidium* sources, associated control measures, and future watershed surveys will be targeted within this area. The analysis submitted to the EPA must contain information of the watershed’s hydrology.
2. *Identification of Cryptosporidium Sources.* Potential as well as actual sources of *Cryptosporidium* contamination within the delineated area of influence must be identified and the relative impact on source water quality assessed.
3. *Analysis of Control Measures.* *Cryptosporidium* control measures included in the watershed plan may include such diverse activities as structural best management practices (BMPs), land use control regulations, and public education. Control measures may include 1) the elimination, reduction, or treatment of wastewater or stormwater discharges, 2) treatment of *Cryptosporidium* contamination at the sites of the waste generation or storage, 3) prevention of *Cryptosporidium* migration from sources, or 4) any other measures that are effective, sustainable, and likely to reduce *Cryptosporidium* contamination of source water. The application must analyze control measures that address the sources of *Cryptosporidium* contamination identified for the water treatment plant source water. The analysis of control measures must discuss the effectiveness and feasibility of each measure in reducing *Cryptosporidium* loading in the source water.
4. *Partnerships for Source Water Protection.* Public Water Systems in the same watershed typically need to evaluate and control the same *Cryptosporidium* sources. Consequently, in order to pool resources and reduce duplication of efforts, in many cases the state and the Public Water Systems in the watershed should work together to develop a single joint watershed plan.

A plan that is funded through section 319 of the CWA must also include nine minimum elements. Although this plan was not funded through section 319 many of the elements have been incorporated into this plan.

Nine minimum elements to be included in CWA section 319-funded watershed plans for threatened or impaired waters and are a requirement for CWA section 319 implementation funds:

1. Identify causes and sources of pollution
2. Estimate pollutant loading into the watershed and the expected load reductions
3. Describe management measures that will achieve load reductions and target critical areas
4. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan
5. Develop an information component
6. Develop a project schedule
7. Describe the interim, measurable milestones
8. Identify indicators to measure progress
9. Develop a monitoring component

Section 3- Stakeholders and Partnerships

Identifying stakeholders and establishing partnerships is an extremely important aspect of watershed protection. It is important to involve those who have a direct stake in the planning process and determine the role each stakeholder and partner will have in the planning and implementation process.

Successful partnerships will determine the ultimate implementation success of a watershed control plan. The Sheridan community has been working cooperatively for over a decade to address water quality challenges. Most of the important partners and stakeholders have a long-standing relationship and have collaborated on numerous projects.

Since the overwhelming majority of the Big Goose Creek Watershed is located on land managed by the USFS, the number of stakeholders is smaller than it is in most watersheds. A number of government agencies and forest users constitute the group of impacted stakeholders and partners.

City of Sheridan

The City of Sheridan's Water Supply and Treatment Subdivision is charged with ensuring that quality drinking water is available to Sheridan citizens at all times, while at the same time maximizing the use of our most valuable resource – water – through conservation.

Mission Statement: Through safe, professional and cost effective work practices, provide a constant supply of high quality, safe drinking water.

In order to carry out this mission, the Water Treatment Subdivision operates the Sheridan Water Treatment Plant, Big Goose Water Treatment Plant, and the Intake Facility. The treatment plants draw water from Big Goose Creek and supplement supply from the Twin Lakes, Dome Lake, and Park Reservoirs during peak use times.

Sheridan County

Sheridan Area Water Supply Joint Powers Board

Sheridan Area Water Supply Joint Powers Board is the rural water system surrounding the City of Sheridan. The Sheridan County Public Works Office takes applications to connect to the water system, prepares water service agreements with developers, and administers board business such as monthly meetings, budget and finances, and contracts with consultants and contractors. SAWSJPB maintains records, does future planning, and coordinates with the City of Sheridan for billing and maintenance of the water system.

Sheridan County Public Works

The Sheridan County Public Works office is responsible for administration of the Zoning and Division of Land Rules and Regulations. Public Works answers zoning district and land use questions, and questions regarding division of any land in the County. The Public Works office facilitates the creation of and updates to long-range plans for Sheridan County including a Comprehensive Plan. Elements of the Comprehensive Plan include Land Use, Transportation, County Utilities, Sensitive Areas, Natural & Man Made Hazards, and Open Space. Sheridan County Public Works is also responsible for permitting under the Sheridan County Land Use Regulations including Rezoning, Quarry, Variance, Conditional Use permits, Subdivision permits and exemptions, and Mobile Home Park Licenses. Public Works coordinates with the Sheridan County Planning and Zoning Commission on permit requests at monthly meetings.

Sheridan County Public Works oversees the septic permit process. Construction of a new or replacement septic system, including a partial replacement must be permitted with the County.

USDA Forest Service

The USFS manages 193 million acres of national forests and grasslands that contain 400,000 miles of streams, 3 million acres of lakes, and many aquifer systems that serve as the largest source of drinking water in the contiguous United States.⁹ The Bighorn National Forest covers 1,115,073 acres. The Forest Service must meet both National regulations set by the Environmental Protection Agency and State regulations set by the Wyoming Department of Environmental Quality.

The USFS must adhere to numerous laws, standards, guidelines, and regulations when carrying out management of USDA Forest Service lands. These provide the primary management direction for the Forest. The Tongue River District of the Bighorn National Forest manages the Big Goose Creek Watershed. USDA Forest Service Guidance, Standards and Guidelines, and Terms and Conditions that apply to Big Goose Creek Watershed within the Bighorn National Forest include:

- National Best Management Practices for Water Quality Management on National Forest System Lands
- Regional Watershed Conservation Practices
- Forest Plan Direction
- National Environmental Policy Act (NEPA) Documents
- Terms and Conditions of Permits
- Operating Plans (Grazing-Annual Operating Instructions)
- Land and Resource Management Plan for the Bighorn National Forest

The Bighorn National Forest is in compliance with the applicable regulations and guidelines they are responsible for under the CWA.

Sheridan County Conservation District

The Sheridan County Conservation District plays a vital role in ensuring that conservation programs and technical and financial assistance are provided to Sheridan County residents. The Tongue River and Goose Creek watershed efforts have identified water quality concerns on the watersheds and provide means for making improvements. SCCD facilitates local watershed planning efforts and administers a local cost-share assistance program for improvements to Animal Feeding Operations and septic systems, as well as work on streambank/channel restoration projects.

While the major part of the local program in Sheridan County consists of providing technical and financial assistance for water resource improvement projects, the SCCD/NRCS partnership recognizes that natural resource education is a necessary component of any conservation program. Local conservation districts in Wyoming have statutory authority (State Statutes 11-16-103 and 11-16-122(b)(v)) to assume the responsibility and leadership for information and education programs related to water quality and to provide the technical expertise related to natural resource management issues. SCCD carries out numerous public outreach programs and activities throughout the year.

Wyoming Association of Rural Water Systems

Wyoming Association of Rural Water Systems (WARWS) is a member driven, non-profit Association, affiliated with National Rural Water Association (NRWA). WARWS, NRWA and its state affiliates comprise the largest utility membership organization in the nation representing nearly 31,000 small and rural water and wastewater systems that serve over 1/3 of all Americans. WARWS provides on-site, one-on-one technical assistance and training.

⁹ http://www.fs.fed.us/pnw/pubs/pnw_gtr812.pdf

Sheridan Area Water Supply is a member of the Wyoming Association of Rural Water Systems.

United States Environmental Protection Agency Region 8

EPA Region 8 is responsible for clean and safe surface water and ground water. Wyoming is the only State that has not applied to the EPA for authority to administer the Public Water System Supervision (PWSS) program under the SDWA. Therefore, EPA Region 8 directly implements the PWSS program in the State of Wyoming. This covers public water systems with 15 or more service connections or that serve 25 or more persons for more than 60 days per year.

Wyoming Department of Environmental Quality

The Wyoming Department of Environmental Quality Watershed Protection Program is responsible for a variety of planning and water quality project implementation activities. The major functions include Water Quality Standards, Non-point Source Planning and Grant Administration, Water Quality Assessment, Water Quality Monitoring, Water Quality Laboratory, CWA Section 401 Certifications and Wetlands Protection, TMDL Coordination, and Data Quality Assurance.

USDA Forest Service Grazing Permittees

Grazing permittees are individuals or organizations that have acquired the privilege to graze livestock on National Forest or National Grasslands. There are four current grazing permittees within the Big Goose Creek Watershed.

Section 4-Past Efforts/Plans and Current Planning Documents

Over the past decade, the Sheridan community launched an unprecedented effort to address nonpoint source pollution in the Goose Creeks. In 2000, the Sheridan County Conservation District, City of Sheridan, and the Sheridan County Commission formed the Goose Creek Drainages Advisory Group (GCDAG) to address water quality in the Goose Creeks. Using Section 319 funds awarded by the Wyoming Department of Environmental Quality, the GCDAG completed a watershed assessment and then, in 2003, helped launch the Goose Creek Watershed Planning Committee (GCWPC) – a larger watershed effort including both local governments and watershed landowners.

Over the past ten years, the participants in the GCWPC have implemented numerous projects to improve water quality in the entire watershed. For example, the Conservation District has coordinated an information and education campaign highlighting water quality issues and has helped fund stream bank stabilizations, septic system replacements, and livestock facility improvements. The City of Sheridan and Sheridan County worked together to develop a Comprehensive Plan that protects riparian areas along the Goose Creeks. Sheridan County has adopted a conservation-design zoning ordinance that provides density bonuses for developers who agree to cluster their developments, install advanced water treatment systems and develop away from creeks to minimize water quality impacts.

Goose Creeks Planning Documents			
	Plan/Study	Agency	Date
1	Goose Creek Watershed Assessment Final Report	Sheridan County Conservation District	July-03
2	The Goose Creek Watershed Management Plan	Sheridan County Conservation District	Dec-04
3	River Walk: A Qualitative Assessment of the Little Goose and Big Goose Creek Through Downtown Sheridan	Downtown Sheridan Association and the City of Sheridan with additional funding provided by Trout Unlimited	April-06
4	Goose Creek Watershed Monitoring Project	Sheridan County Conservation District	Aug-06
5	Sheridan County Comprehensive Plan	Sheridan County	Dec-13
6	Strategic Habitat Plan	Wyoming Game and Fish Department	Revised November 2008
7	Final Goose Creek Watershed TMDLs	Wyoming Department of Environmental Quality	Sep-10
8	Tongue River Basin Management Plan	Wyoming Game and Fish Department, Fish Division	Last Update: January 2010 Next Update: January 2015
9	2009 Goose Creek Watershed Interim Monitoring Project	Sheridan County Conservation District	Oct-11
10	Big Goose Creek Watershed Control Program Preliminary Assessment	City of Sheridan and Sheridan Area Water Supply Joint Powers Board	Aug-11
11	Goose Creek Watershed Improvement Effort Implementation Strategy	Goose Creek Watershed Committee	January-12

Figure 1- Planning Documents

The City has developed stormwater standards for construction and development, purchased regenerated street sweepers to keep sediment from reaching the creeks, created incentives to encourage residents with septic systems to hook into the City’s sanitary sewer system, and installed stormwater interceptors to capture sediment.

Watershed plans are developed through a cooperative integration of existing assessment reports and processes, using existing and appropriate data and information. Over the past ten years, numerous agencies have developed planning documents designed to protect water quality. Although these planning documents do not address the Big Goose Creek Watershed above the source water intake, these plans should be consulted while planning any future projects.

1. Goose Creek Watershed Assessment Final Report Sheridan County Conservation District July 2003

The Goose Creek Watershed Assessment Final Report is an assessment meant to conduct a more complete evaluation of the watershed and its uses and to maintain local control of watershed improvements. The report

includes project goals and related tasks, a description of the project area, stream listings, classifications and standards, historic and current data sources, monitoring and assessment plans, quality assurance and quality control, cumulative effects and planning prioritization and watershed planning. The report also includes maps and collected data charts and graphs.

2. The Goose Creek Watershed Management Plan
Sheridan County Conservation District
December 2004

The Goose Creek Watershed Management Plan was developed by the Sheridan County Conservation District, the Natural Resources Conservation Service, Sheridan County officials, City of Sheridan officials, the Sheridan County Planning Commission, the Wyoming Department of Environmental Quality, landowners and watershed residents. The Goose Creek Watershed Management Plan includes watershed assessment and concerns, watershed improvement actions and recommendations, tables providing information concerning the estimated completion dates for the watershed improvement action items, monitoring and evaluation information and a description of future implementation efforts.

3. River Walk: A Qualitative Assessment of the Little Goose and Big Goose Creek Through Downtown Sheridan
Downtown Sheridan Association and the City of Sheridan with additional funding provided by Trout Unlimited
April 2006

The River Walk assessment of the Big and Little Goose Creeks along the proposed River Walk through downtown Sheridan contains creek data (drainage areas, gages, regional curves, historical flood flow data, United States Army Corp of Engineers flood project, qualitative assessment of the Creeks). The assessment includes a description of the objectives, goals and constraints of the project. The River Walk assessment also includes a conceptual design, list of potential impacts and a strategy that identifies tasks and a proposed schedule timeline.

4. Goose Creek Watershed Monitoring Project
Sheridan County Conservation District
August 2006

The Goose Creek Watershed Monitoring Project document contains a description of past and current monitoring efforts on the Goose Creeks. It includes both historic and current data. Charts and graphs detailing data on the Goose Creeks are included in the document.

5. Sheridan County Comprehensive Plan
Sheridan County
December 2008

The Sheridan County Comprehensive Plan outlines Sheridan County's vision and goals for the future and provides guidance for staff and elected and appointed officials to determine directions and make choices about short- and long-range needs.

Goal 2.1: The County will conserve and restore its riparian corridors and rivers and streams.

Goal 2.2: The County will maintain its overall water quality and quantity.

6. Strategic Habitat Plan
Wyoming Game and Fish Department
Revised November 2008

Wyoming Game and Fish includes the Goose Creeks in strategic plans that reference larger watersheds or habitat types. Strategic habitat plans clarify for the public and WGFD conservation partners how priority areas were developed and what they represent. The habitat plans include brief write-ups on Crucial Habitat Priority Areas and Enhancement Priority Habitat Areas. Included are the habitat value, the reason the area was selected, the area boundary description, species, solutions/actions and a habitat area narrative.

7. Final Goose Creek Watershed TMDLs

Wyoming Department of Environmental Quality

September 2010

The total maximum daily load (TMDL) analysis for the Goose Creek Watershed is an analysis of eleven impaired waters within the Goose Creek Watershed. It includes water quality data from 1998 to 2005. The TMDL identifies water quality concerns, water quality criteria and standards, previous and ongoing work in the watershed, characteristics of the watershed, water quality data, pathogen load analysis and source identification, sediment analysis, water quality objectives, monitoring plans and recommended measures and priorities. The TMDL also includes an appendix of various Goose Creek watershed maps.

8. Tongue River Basin Management Plan

Wyoming Game and Fish Department, Fish Division

Last Update: January 2010

Next Update: January 2015

Wyoming Game and Fish does not have any specific planning documents for the Goose Creeks. Rather, they have broader strategic plans that reference larger watersheds or habitat types. The Draft Tongue River Basin Management Plan includes a basin description, a list of species present and action items for the species and a description of management background that includes brief write-ups on regulations, stocking, key partnerships and agreements. The Draft Plan also includes a section on management direction that outlines management goals, objectives and activities.

9. Goose Creek Watershed Interim Monitoring Project

Sheridan County Conservation District

January 2011

SCCD conducts interim water quality monitoring to observe changes in water quality in the Goose Creek Watershed over the long-term. Interim monitoring evaluates trends in bacteria and sediment, along with benthic macroinvertebrates and habitat assessments at a limited number of stations. The purpose of the ongoing project is to evaluate changes in water quality over time and look for long term trends.

10. Big Goose Creek Watershed Control Program Preliminary Assessment

City of Sheridan and Sheridan Area Water Supply Joint Powers Board

August 2011

The Big Goose Creek Watershed Control Program Preliminary Assessment is an initial analysis of the Big Goose Creek Watershed meant to guide and inform a future more detailed and thorough watershed plan. The assessment looks at possible and likely sources of *Cryptosporidium* and lays out the guidelines for developing a watershed plan.

11. Goose Creek Watershed Improvement Effort Implementation Strategy 2012-2015

Goose Creek Watershed Committee

January 2012

The mission of the Goose Creek Watershed Improvement Effort is to establish and maintain a voluntary watershed plan that engages local citizens in the remediation of water quality issues in the Goose Creek watershed, now and into the future.

The Goose Creek Watershed Improvement Effort is a collaborative partnership among the Sheridan County Conservation District (SCCD), Sheridan County, the City of Sheridan, and landowners/residents, and other local stakeholders.

In the Goose Creek Watershed Improvement Effort Implementation Strategy the SCCD incorporated items from the TMDL and other studies and input from steering committee meetings into 13 action items and associated tasks.

USDA Forest Service

Along with the community planning documents the USDA Forest Service operates under a variety of plans, guidelines, laws, and regulations that impact the Big Goose Creek Watershed. The documents that pertain to the Big Goose Creek Watershed Control Plan can be found with the list of BMPs in *Appendix B*.

Section 5- Watershed Characterization

A watershed characterization describes the physical and hydrologic properties of the watershed, such as soil, land use, elevation, climate, and streamflow. This section is meant as a summary characterization of the Big Goose Creek Watershed. A more detailed characterization can be found in the Goose Creek Watershed TMDLs.

The Big Goose Creek watershed is a subwatershed of the Goose Creek Watershed. The headwaters of the Big Goose Creek lie within the Cloud Peak Wilderness in the Bighorn National Forest. The creek drains the southwestern portion of the Goose Creek Watershed. Eventually the Big Goose Creek converges with the Little Goose Creek within the City of Sheridan to form Goose Creek.¹⁰

The Big Goose Creek Watershed comprises an area of 203 square miles (130,192 acres). The upper segments above the water intake are managed by the USFS. Only 3,560 acres above Sheridan's source water are private. The US Forest Service manages the remaining watershed acreage.

Geology and Soils

Geology, topography, and soil formation affect how water flows across the land, and the types of vegetation that are supported by the watershed. The USFS has provided a detailed discussion of geology of the watershed within the Forest Service Boundaries.¹¹ According to the Forest Service, the Goose Creek geographic area has been extensively glaciated. The glaciers that formed during Wisconsin glaciation period has shaped landforms over half of the geographic area. Terminal moraines, potholes, cirques, lateral moraines, recessional moraines, and rock striations are common. All man-made reservoirs are located in the glaciated portion of the geographic area. The highest point in the geographic area is a peak above Cross Creek Lake (11,760 feet). The lowest point within the forest boundary is where Little Goose Creek meets the forest boundary at 4,840 feet. Generally, the Bighorn Mountains range from 8,000 and 13,000 feet, and transition fairly abruptly to a narrow band of foothills located about 2,000 feet above the plains.

Soils in the geographic area are shallow in depth; in many areas they are less than 12 inches thick. The sedimentary parent material produces a soil that is heavier in texture than the granitic soils. The soil pH ranges from 6.0 to 7.5 in this area. Rooting has occurred throughout all horizons on the granitic soils. Texture on the non-glaciated granitic portion of the geographic area is sandy loam to loam. The pH varies from 5.6 to 6.5, the majority of the soil having a pH of 6.0. The residual soil has a depth of approximately 25 inches, with the B-horizon having a coarser texture than the A-horizon¹².

Precipitation in the watershed ranges from a high of about 30 inches annual rainfall in the Bighorn Mountains to approximately 13-15 inches of annual rainfall in the Sheridan area¹³.

How water moves through the landscape, both at the surface and subsurface, is an important consideration in watershed conditions. The USFS summarized hydrology and water quality of the Goose Creek system as follows:

"The Goose Creek watershed is a tributary to the Tongue watershed. The two watersheds join several miles below the forest boundary. The Goose geographic area consists of two main tributaries: the Big and Little Goose watersheds. The Goose geographic area has a total of 150 miles of perennial streams along with 282 miles of intermittent. Drainage efficiency is the most important factor in determining the time it takes precipitation to become runoff. Lag time is the

¹⁰ Goose Creek TMDLs

¹¹ USFS Goose Geographic Area Existing Condition Assessment for Forest Plan Revision, December 4, 2002. Page 11.

¹² USFS, 2002, page 13.

¹³ Powder River Water Plan, http://waterplan.state.wy.us/plan/powder/finalrept/finalrept_hires.pdf

*time it takes water to concentrate at a certain point on the watershed after precipitation occurs. Lag time at the mouth of Big Goose Creek is 8.6 hours. The fall of the main stem of Big Goose Creek is 420 feet per mile*¹⁴.

The USFS also provides information regarding the hydrologic flow patterns within the Big Goose Creek watershed. Generally, minimum flows occur in January/February, when much precipitation is captured as snow in the system, with peak flows occurring between May 10 and June 28.¹⁵ Waterflows in the watershed are affected by numerous reservoirs and irrigation ditches. The location, flow, and water quality data from these diversions is extensively documented in the State's Powder/Tongue River Basin Water Plan, Technical Memoranda, Appendix A.¹⁶

Vegetation Cover

The Forest Service reported that 80% of the area within their jurisdiction in the Goose Geographic Area is in forest cover¹⁷. Within the land in National Forest, the area closest to surface waters, known as the riparian zone, is significant with respect to how contaminants potentially enter the water supply.

Riparian Zones

The extent and condition of riparian zones can have an effect on water quality and quantity conditions within the watershed. The Forest Service defines riparian zones as being those areas within 100 feet horizontally from both edges of all perennial streams¹⁸. In 2002, the Forest Service mapped 10,457 acres of riparian zone within Forest Service boundaries along Big Goose Creek and its tributaries¹⁹. The condition of the vegetation in the riparian zone is critical in controlling sediment inputs into the stream, as well as regulating temperature and stabilizing streambank conditions.

¹⁴ USFS Goose Geographic Area Existing Condition Assessment for Forest Plan Revision, December 4, 2002. Page 15.

¹⁵ USFS, 2002, page 22.

¹⁶ Available on line at <http://waterplan.state.wy.us/plan/powder/techmemos/diversions/biggoose.html>

¹⁷ USFS, 2002, page 25.

¹⁸ USFS, 2002, page 22.

¹⁹ USFS, 2002, page 23, table 13. Combined area for Cross Creek above reservoir, East Fork above reservoir, East and West Fork above Beckton, and Big Goose and Rapid above Sheridan.

Section 6- Monitoring Data and Plan

A monitoring plan will play a crucial role in preventing pollutants in the watershed. A monitoring plan provides a guide for why, how, when, and where to monitor water quality. There are three goals for this monitoring plan.

1. Determine the source of the *Cryptosporidium*.
2. Determine where *Cryptosporidium* is located in the watershed.
3. Gather information to be used for the Watershed Control Plan.

This section includes a monitoring plan that was developed before completion of the Big Goose Creek Watershed Control Plan and can serve as a guide for future monitoring plans.

Past Data

Since January 19, 2004, the City of Sheridan and SAWSJPB have been sampling for *Cryptosporidium* at the Sheridan source water intake. The LT2 rule requires municipal systems to monitor their source water, calculate an average *Cryptosporidium* concentration, and use those results to determine if their source is vulnerable to contamination and whether they need to install additional treatment. It is based on these monitoring samples that SAWSJPB and the City are classified as “Bin 2” under the LT2 rules.

Currently data is only available for the “presence” of *Cryptosporidium*. Testing has not occurred to determine the source of *Cryptosporidium* or where it might be entering the watershed. There are three possible sources for the *Cryptosporidium* contamination in the Big Goose Creek watershed – humans, livestock, and wildlife. In order to better implement a Watershed Control Plan, these questions must be answered.

No *Cryptosporidium* has been detected since November 2014.

Site Selection

The location of water-quality sampling sites is directly related to the data needed to meet monitoring objectives. Sampling sites must be strategically located to receive the most useful and reliable data. Based on hydrology, land use, water flow, water temperature, and tributary locations, five sites were selected for their potential in determining the location and source of *Cryptosporidium*. These sites are located on the east fork of Big Goose Creek, the west fork of Big Goose Creek, and Big Goose Creek above the source water intake in Big Goose Canyon. The following are the geographic coordinates for the sampling sites:

1. West Fork Big goose - 44° 39' 27.8"N, 107° 15' 18.9"W, Elev. 7212'
2. East Fork Big Goose - 44° 37' 24.2"N, 107° 12' 38.1"W, Elev. 7262'
3. Big Goose Canyon- 44° 41' 47.44"N, 107° 11' 24.28"W, Elev. 5232'
4. Alternate East Fork Big Goose - 44°37'26.61"N, 107°12'44.74"W, Elev. 7229'
5. Alternate West Fork Big Goose - 44°37'45.18"N, 107°17'8.65"W, Elev. 7942'

Upper Big Goose Creek Watershed

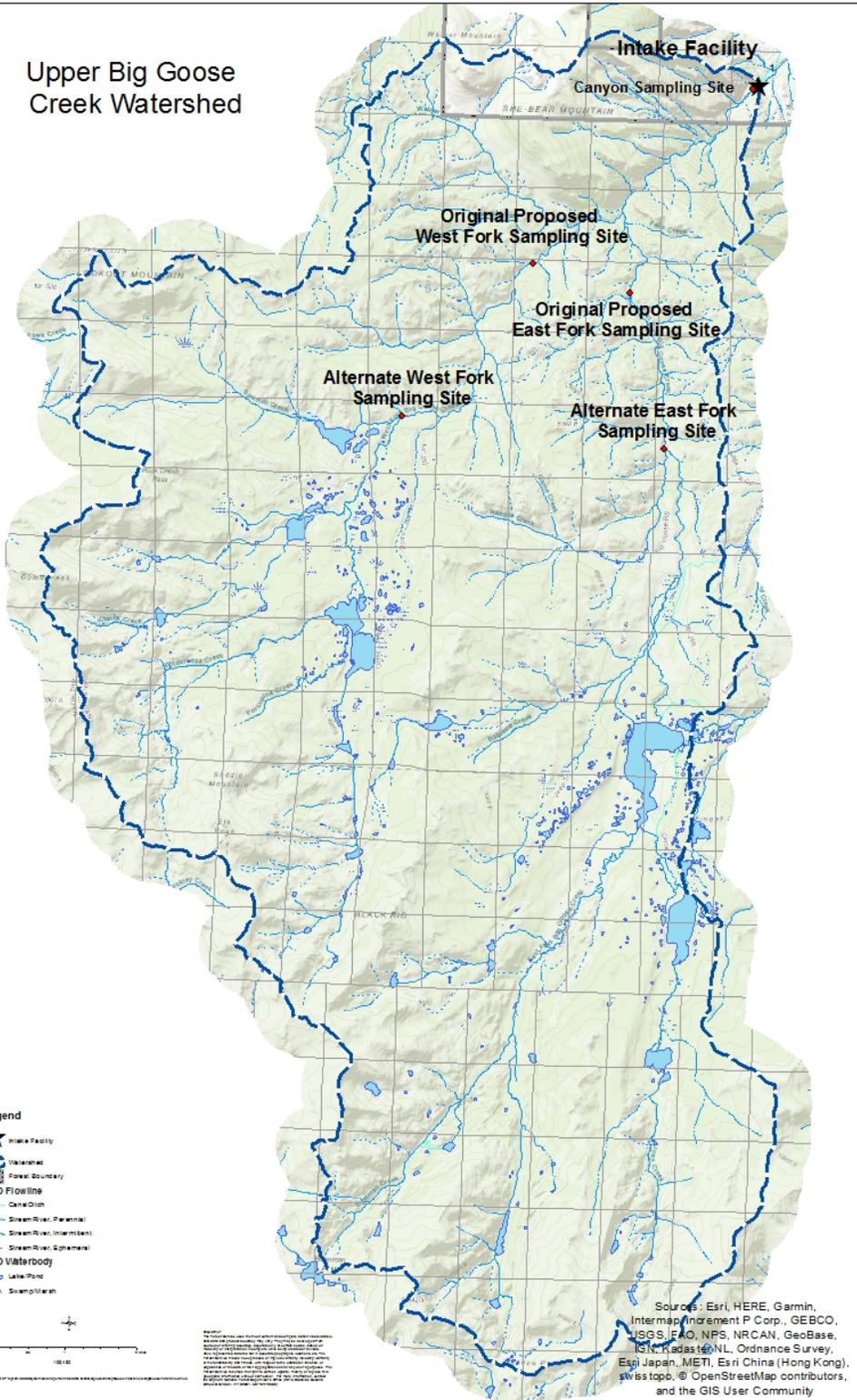


Figure 2- Map of Monitoring Sites

Sampling Protocol

Any sampling and collection done by the City and SAWSJPB should follow the guidelines outlined in Section 8.0, Sample Collection and Storage, of the EPA's *Method 1623.1: Cryptosporidium and Giardia in Water by Filtration/IMS/FA*.²⁰

CH Diagnostics in Berthoud, CO tests the samples sent by the City of Sheridan and provides materials necessary for collecting water samples.

Laboratory Results

The EPA has implemented a certification program for laboratories performing drinking water analyses for compliance with regulations issued pursuant to SDWA. The City of Sheridan and SAWSJPB have been sending water samples to approved lab CH Diagnostics for analysis. In early summer of 2013 Tom Manolis, water treatment superintendent for the City of Sheridan, contacted CH Diagnostics to set up a system for determining genotyping of any *Cryptosporidium* oocysts found to be present in water samples taken from the Big Goose Creek.

If *Cryptosporidium* was found to be present, it was arranged to send results to Dr. Sharon Long with the Wisconsin State Laboratory of Hygiene. Dr. Long is an expert in *Cryptosporidium* genotyping and was referred by the Source Water Collaborative. Dr. Long's laboratory has full Method 1623 and 1623.1²¹ capabilities and is an LT2 rule reference laboratory.

²⁰ <http://water.epa.gov/scitech/drinkingwater/labcert/upload/epa816r12001.pdf>

²¹ EPA method designed to assess *Cryptosporidium* and *Giardia* occurrence in raw surface waters used as source waters for drinking water treatment plants.

Schedule

The City of Sheridan and SAWSJPB should continue monthly sampling at the source water intake. In addition, further sampling will be conducted using past sampling results as a guide. Based on spikes in *Cryptosporidium* in past years, sampling should be done once in late spring or early summer, once in August, and once between mid-October and mid-November.

Continuation of Monitoring

Monitoring should continue at the same schedule and at the same locations until such time that a genotype can be determined from a positive *Cryptosporidium* test result. Once the source of *Cryptosporidium* is determined, this plan should be used to effectively address the source and apply the appropriate management plans as revised.

Section 7-Area of Influence

A first step in developing a WCP is to identify the area of influence of the affected watershed. This is the area within which surface waters collect and drain. Understanding the boundaries of how and where surface water and precipitation drain off of the landscape defines the watershed boundaries. Watershed boundaries are determined by topography, geology, and water flows.

In its simplest form, a watershed defines the area within which water drains when it flows downstream, as well as the area of influence, from the mountain peaks to the valley floors. The United States Geologic Service (USGS) has developed a classification system for watershed boundaries throughout the United States called the hydrologic unit code²³.

From the USGS website: *"The United States is divided into 21 broad hydrologic units, which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. The hydrologic units are arranged or nested within each other, from the largest geographic area (regions) to the smallest geographic area (cataloging units). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. The first level of classification divides the Nation into 21 major geographic areas, or regions. These geographic areas contain either the drainage area of a major river, such as the Missouri region (within which the Big Goose Creek Watershed occurs, as a portion of the Powder/Tongue River Basin), or the combined drainage areas of a series of rivers, such as the Texas-Gulf region, which includes a number of rivers draining into the Gulf of Mexico.*

The second level of classification divides the 21 regions into 221 subregions. A subregion includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage area.

The third level of classification subdivides many of the subregions into accounting units. These 378 hydrologic accounting units are nested within, or can be equivalent to the subregions.

The fourth level of classification is the cataloging unit, the smallest element in the hierarchy of hydrologic units. A cataloging unit is a geographic area representing part of or all of a surface drainage basin, a combination of drainage basins, or a distinct hydrologic feature. These units subdivide the subregions and accounting units into smaller areas. There are 2264 Cataloging Units in the Nation. Cataloging Units sometimes are called "watersheds".

Figure 4 shows the area of influence for the Big Goose Creek Watershed. For the purposes of this Watershed Characterization, the Big Goose Creek Watershed is defined and mapped by the combined area of the following three twelve digit hydrologic unit codes, as defined by USGS:

- Upper East Fork Big Goose Creek, above Bighorn Reservoir: HUC 100901010201
- Lower East Fork Big Goose Creek above Park Reservoir: HUC 100901010202
- West Fork Big Goose Creek: HUC 1009010203

²³ <http://water.usgs.gov/GIS/regions.html>

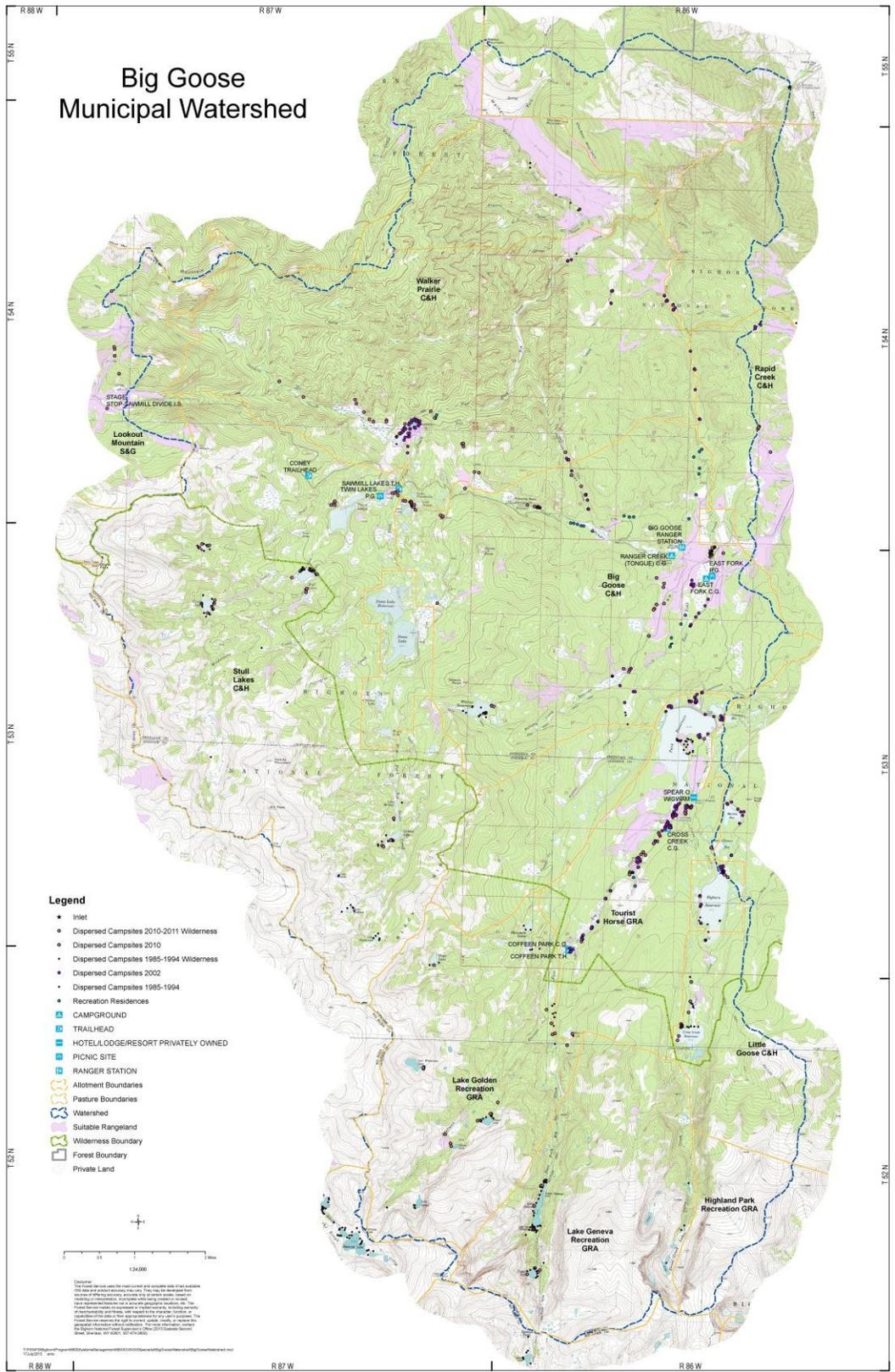


Figure 4: Area of influence for the Big Goose Creek Watershed

This area encompasses roughly one hundred and twenty square miles. The headwaters of the Big Goose Creek Watershed include the eastern flanks of the Cloud Peak Wilderness within the Bighorn National Forest. Major drainages within the watershed include the East and West Forks of Big Goose Creek, Little Goose Creek and its tributaries, and Soldier's Creek. Soldier's Creek flows into Goose Creek below the City of Sheridan, and is therefore excluded from further discussion.

The City of Sheridan's water supply intake is located along Big Goose Creek at the mouth of Big Goose Canyon, in the vicinity of the Alliance Diversion, and three miles downstream of the confluence of the East Fork and West Forks of Big Goose Creek (Figure 5).

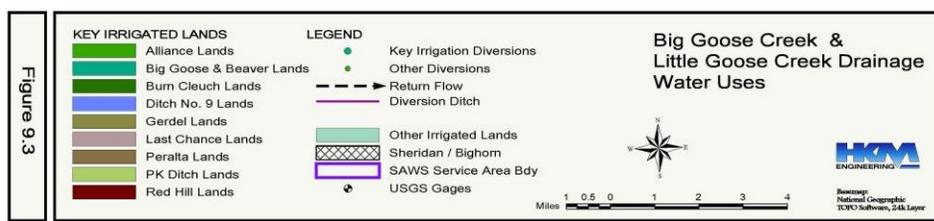
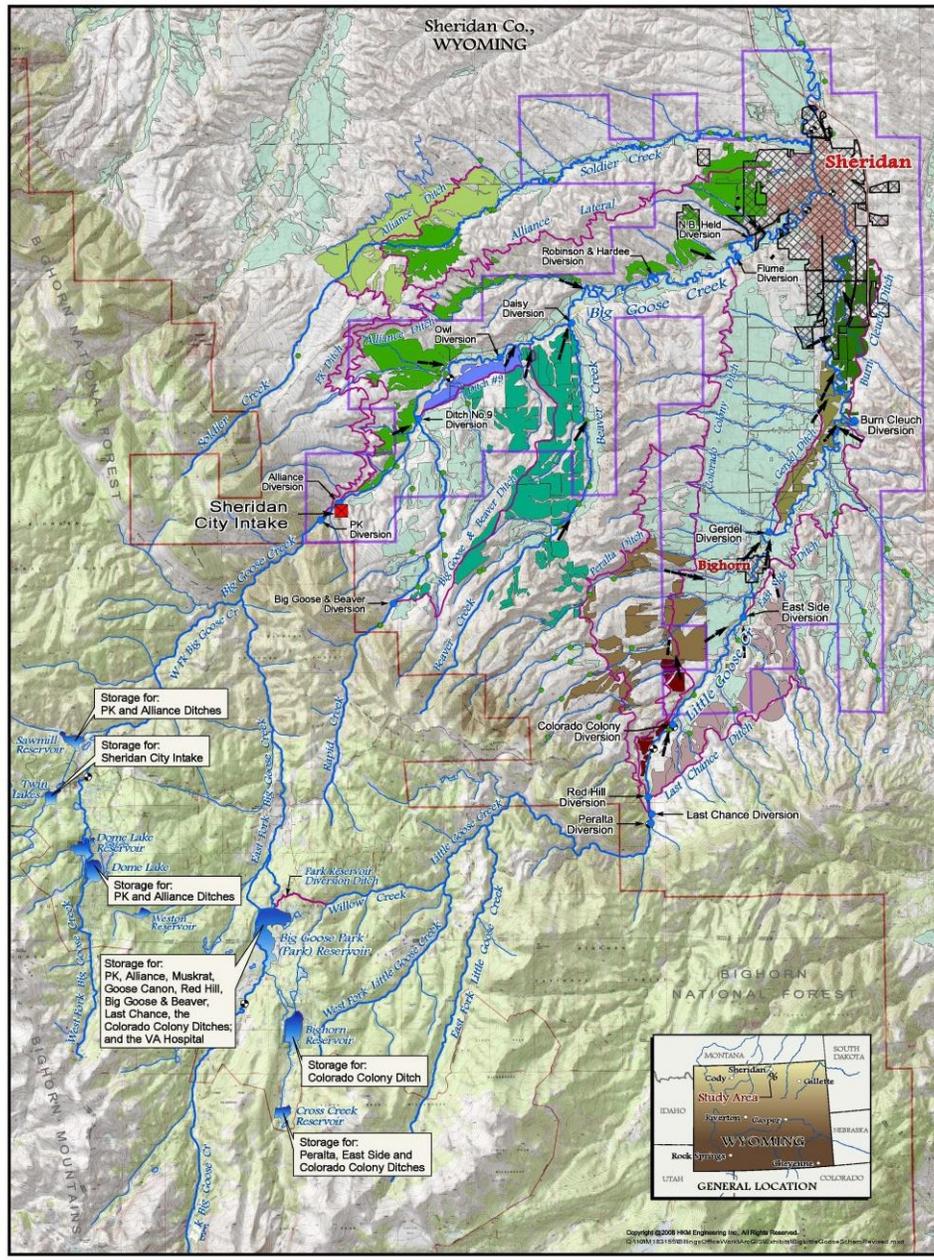


Figure 5: Sheridan water supply intake

Source: Final Report for the City of Buffalo-Sheridan Area Water System-Lake DeSmet, Level 1 Study. Prepared by HKM.

The West Fork of Big Goose Creek originates in the Cloud Peak Wilderness. While the West Fork only drains 20% of the total watershed, it contributes 30% of the total runoff to the flow of Big Goose Creek. The West Fork flows unimpeded for a five-mile stretch from its headwaters to Upper Dome Lake reservoir, where it is impounded. The East Fork originates six miles into the Cloud Peak wilderness to its confluence with Cross Creek whence it flows into Big Goose Park (Park) Reservoir. The upper six miles of the East Fork are unimpeded.

Section 8- Identification of Potential and Possible *Cryptosporidium* Sources

There are three potential and probable contributors to *Cryptosporidium* pollution in the Big Goose Creek Watershed upstream of the city's water supply intake—livestock, humans, and wildlife. Due to a lack of information currently available it is not possible to definitively determine the source of *Cryptosporidium*. Gathering the needed information and data to determine the source of *Cryptosporidium* is outlined as part of the implementation of this plan.

Livestock

The Big Goose Creek Watershed above the City of Sheridan water intake is almost entirely located on federal land administered by the USDA Forest Service. There are four Forest Service Cattle and Horse Allotments on the main stem of the Big Goose Creek and on the East Fork and West Fork of the Big Goose Creek that could be contributing to the *Cryptosporidium* contamination to Sheridan's source water. These are the Walker Prairie C & H-Lower Unit, the Walker Prairie C & H, the Big Goose C & H, and the Rapid Creek C & H.

The Tongue River Ranger District of the Bighorn National Forest manages the grazing allotments. Each year the Forest Service issues Annual Operating Instructions (AOIs) to permittees on the allotments. The AOIs include numbers of authorized cattle, authorized season of use, pasture rotation, allowable use standards, and other management requirements meant to protect forest resources. There are currently 969 head of cattle permitted within the watershed. Grazing on public lands occurs for the typical season of July to the end of September. Cattle are rotated in and out of the watershed throughout the summer so the actual number of cattle in the watershed fluctuates. There are no seasonal restrictions on grazing on the approximately 3000 acres of private land within the watershed.

No current testing has been done to determine the genotype of the Cryptosporidium oocysts that have been present in the Big Goose Creek watershed. Without genotyping data, contributors to source water pollution in the Big Goose Creek Watershed cannot definitively be determined. There is no way to determine if livestock have contributed to the Cryptosporidium that has been detected over the last decade.

Wildlife

The Wyoming Game and Fish Department (WGFD) is responsible for control, propagation, management and protection and regulation of all wildlife in the state of Wyoming. WGFD does not have specific data on wildlife concentrations within the Big Goose Creek watershed but rather population estimates at the herd unit level with most herds encompassing significantly more area than the Tongue River District of the Bighorn National Forest.

Elk

The WGFD has a winter trend count management objective for the North Bighorn Elk Herd Unit (Hunt Areas 35, 36, 37, 38, 39, 40). The Department uses trend count survey information to gauge where numbers are in relation to the objective. Hunt Areas 37 and 38 are part of the North Bighorn Elk Herd Unit and encompass the Tongue River District of the Bighorn National Forest. During WGFD's 2013 winter trend count survey, 1175 elk were observed in Area 37 (the winter count objective was 800 so elk numbers were plus 375 of objective) and 1255 elk in Area 38 (the winter count objective was 1000 so elk numbers were plus 255 of objective).

Mule Deer

For the North Bighorn Mule Deer Herd Unit (Hunt Areas 24, 25, 27, 28, 50, 51, 52, 53) the WGFD does not have a way to separate out the Hunt Area most pertinent for the Big Goose Creek Watershed. Hunt Area 25 encompasses most of the Tongue River District. However, the post-season population management objective for the entire herd is 25,000 deer and it was estimated that the population was about 13,800 following the 2012 hunting season or about 45% below objective.

Black Bear

For Bighorn black bear (Hunt Areas 1, 2, 3, 4, 5, 6) WGF D does not do a population estimate but rather uses age and female-male composition of harvest to indicate if it appears the population is on the increase, reduction, or stable mode. Harvest in 2012 (and other recent years) has given mixed results for males and females. It appears that the population is more or less stable at this time. Hunt Area 2 and part of Area 4 cover the Tongue River District. Those two hunt areas have the best black bear habitat in the Bighorn Mountains. The majority of bears are located here and the majority of harvested bears come from Hunt Areas 2 and 4.

Moose

The Bighorn Moose Herd (Hunt Areas 1, 34, 42) post-season population management objective is 500. WGF D estimates the population at about 450 following the 2012 hunting season. Hunt Area 1 encompasses the Tongue River District but WGF D does not have a separate estimate for that area.

No current testing has been done to determine the genotype of the Cryptosporidium oocysts that have been present in the Big Goose Creek watershed. Without genotyping data, contributors to source water pollution in the Big Goose Creek Watershed cannot definitively be determined. There is no way to determine if wildlife has contributed to the Cryptosporidium detected over the last decade. In addition wildlife migration patterns are not fully understood in the upper Big Goose Creek watershed so there is no current way to correlate Cryptosporidium detections with wildlife in the watershed.

Human

Recreation numbers

The Bighorn National Forest provides year-round recreation opportunities and is a popular destination for a variety of outdoor activities such as hiking, horseback riding, hunting, off road vehicles, snowmobiles, cross country skiing, camping, and fishing. With this use comes an increased risk of pollution in the Big Goose Creek Watershed.

Traffic

Most visitors travelling and recreating in the Big Goose Creek watershed use Sheridan County Road 26 (Red Grade Road) as an entry point into the Bighorn National Forest. Red Grade Road runs up in the mountains west of the town of Big Horn, into the National Forest, and through the Big Goose Creek Watershed.

The Sheridan County Engineers Office has been collecting data on the average daily traffic of all vehicles going up Red Grade Road in the summer for a week's period.

This data shows the high volume traffic the Big Goose Creek Watershed can see on any given week in the summer.

Daily Traffic on Red Grade Road	
Year	Average Vehicles Per Day Over One Week
2007	344
2009	483
2011	464
2013	377

Campgrounds

Cross Creek Campground

The Cross Creek Campground is located near the East Fork of the Big Goose Creek and is open as long as it is accessible from June to September. A vault toilet is available.

East Fork Campground

The East Fork Campground is open from June to September. A vault toilet is available. A camp host resides on this site.

Cabins and septic systems

There are approximately 65 recreational cabins in the Big Goose Creek Watershed. None of these are in close proximity to the water intake but most are in close proximity to water bodies that connect to Big Goose Creek.

There are three significant private property inholdings upstream of the water intake. These are: 1) the East Fork inholding- 7.40 miles upstream; 2) Bighorn Reservoir inholding- 10.73 miles upstream; and 3) Dome Lake inholding- 11.21 miles upstream. The East Fork inholdings are owned by seventeen different owners and contain a total of 15-20 structures. The Bighorn Reservoir inholding surrounds the Bighorn Reservoir and does not have any recreational cabins located on it. Dome Lake is an inholding established by the railroads during the mid-1800s. It is still in private ownership today and contains approximately 15 structures located on the west side of Dome Lake. While there are private lands outside of the forest upstream from the water intake, there do not appear to be any cabins or other structures on those lands.

In addition to these inholdings, there are 3 summer home groups and 7 isolated cabins on the National Forest lands in the Big Goose Creek drainage as well as Spear-O-Wigwam, a former guest ranch now operated by Sheridan Community College.

The largest of the summer home groups is the Ranger Creek SHA located approximately 6.29 miles upstream from the water intake. Each isolated cabin above the Big Goose Ranger Station has a septic system and/or an outdoor vault toilet. Four isolated cabins above Big Goose Creek Ranger Station all have outhouses, 3 vault toilets and one pit toilet. The remaining isolated cabin closer to Sawmill Lakes also has an outdoor vault toilet. The three summer home groups include 14 vault toilets and 2 septic systems.

Spear-O-Wigwam sits on a 17-acre Forest Service permit on the south end of Park Reservoir. Spear-O-Wigwam is operated as a mountain campus for Sheridan Community College and includes a lodge and 11 cabins.

The Forest Service does not have a set schedule in which the vault toilets must be pumped out, but cabin owners are responsible for making sure it is done. There is no set rule for when vault toilets should be pumped, but the Forest Service recommends it happen when they are ½ full or less. Inspections of each cabin are done every 4 years.

No current testing has been done to determine the genotype of the Cryptosporidium oocysts that have been present in the Big Goose Creek watershed. Without genotyping data, contributors to source water pollution in the Big Goose Creek Watershed cannot definitively be determined.

Relative Impact of Actual and Potential Sources of *Cryptosporidium*

The EPA has not identified any indicators that correlate strongly with *Cryptosporidium*, however, the Long Term 2 Enhanced Surface Water Treatment Rule, allows small systems (less than 10,000 people) to sample for *E. coli* as a way to identify if a water source is likely to exceed a *Cryptosporidium* level of 0.075 oocysts/L. This allowance was based on data sets that indicated a low false negative rate for certain *E. coli* trigger levels when used to identify plants that exceeded a mean *Cryptosporidium* concentration of oocysts/L. In the absence of genotype testing to analyze and determine actual sources of *Cryptosporidium*, daily average *E. coli* loads set forth in the Goose Creek Watershed TMDL report were used to estimate the possible relative impact of the potential sources.

The Goose Creek Watershed TMDLs estimated nonpoint sources in the entire Goose Creek watershed. A list of nonpoint pathogen sources and *E. coli* loads on public lands above Sheridan's source water intake are shown in Figure 7. Grazing in the watershed

Nonpoint Source	Percent of Daily Average Load
Grazing	59%
Wildlife and Waterfowl	36%
On-site Wastewater Treatment (septic systems)	5%

Figure 7: Nonpoint Pathogen Sources and Daily Average *E. coli* Loads in the Upper Goose Creek Watershed (Source: Goose Creek Watershed TMDLs)

above the source water intake occurs on both public and private lands. Above Sheridan's source water intake, 3,560 acres are private. The remaining watershed acreage is located on public lands. Assuming that there is some relationship in source between *E. coli* and *Cryptosporidium* (in the absence of any better and more definitive data), grazing is likely to have the largest impact on *Cryptosporidium* occurrence in the watershed followed by wildlife. Human sources would likely have the smallest impact on *Cryptosporidium* in the watershed.

The EPA recommends, due to lower analytical cost, that in addition to the proposed periodic *Cryptosporidium* sampling that periodic *E. coli* sampling with enumeration analysis be conducted at key points along the Big Goose Creek. Spikes in *E. coli* levels could indicate hot spots for fecal contamination and potential contributing causes and help target areas for the *Cryptosporidium* testing. Fecal studies could also be conducted on fresh cow dung for *Cryptosporidium* detection as it is reasonable to assume that if *Cryptosporidium* is found in the fecal studies that cattle are likely contributors to contamination in the Upper Big Goose Creek Watershed.

Section 9- Control Measures

Developing, implementing, and enforcing control measures for water quality in rural watersheds is very difficult, particularly where the vast majority of the watershed is owned by federal or state agencies with limited resources. As noted previously, the source of pollution can come from both natural and human means. Due to the limited resources to enforce regulations, standards, and practices, the use of control measures and best management practices are designed to prevent pollution. These control measures rely heavily on property owners, the public, and stakeholders to implement.

Even if a water sample shows a presence of *Cryptosporidium*, and the source is determined, control methods for other potential sources should be continued.

A list of control measures and best management practices developed by partner agencies can be found in *Appendix B*.

The effectiveness and feasibility of each action item to be completed during the implementation of the Upper Big Goose Creek Watershed Management Plan can be found in the chart located in *Section 12: Implementation of the Plan*. Action items were ranked as high, moderate, and low based on their importance and likelihood for success and were evaluated for effectiveness and feasibility based in part on the following criteria:

High

- Addresses data gaps.
- Addresses potential and possible sources directly.
- Being implemented or mostly implemented through current funding and budgets.
- Provides strong likelihood for long term success.

Moderate

- Addresses potential and possible sources either directly or indirectly.
- Being implemented through current budgets or is relatively cost effective to address.
- Can have an impact on overall watershed protection on its own
- Has likelihood for long term success.

Low

- Addresses potential and possible sources only indirectly.
- Not currently being addressed through current planning or funding
- Not cost effective.
- Likelihood for long term success is based on the action item being addressed in conjunction with other control measures.

Section 10- Funding Options and Tools

A variety of funding sources are available to assist in the implementation of source water protection projects and activities. Funding is available through programs that support education; land acquisition; agricultural best management practice implementation; urban, wetland and riparian forest buffer establishment, and many others. Funding options exist on the federal, state, local, and private levels. Grant eligibility is often dependent on the specifics of individual proposed projects. Grant funding is also dependent on the granting agency receiving appropriated funds.

Federal

USDA Natural Resource Conservation Service –Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. Funds are awarded through NRCS field offices. In most cases a 25% nonfederal match is required.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/wy/programs/financial/eqip/>

USDA Natural Resource Conservation Service-Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) was created in the 2014 Farm Bill and is a comprehensive and flexible program that uses partnerships to stretch and multiply conservation investments and reach conservation goals on a regional or watershed scale. The Regional Conservation Partnership Program promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners.

Through RCPP, NRCS and state, local and regional partners coordinate resources to help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

Eligible partners include agricultural or silvicultural producer associations, farmer cooperatives or other groups of producers, state or local governments, American Indian tribes, municipal water treatment entities, water and irrigation districts, conservation-driven nongovernmental organizations, and institutions of higher education.

<http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/rcpp/?cid=stelprdb1242732>

Wyoming Department of Environmental Quality - Section 319 Grants

Section 319 funds support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects.

319 funding for projects on public land requires a nonfederal match of 40%. Eligible 319 activities include BMP implementation, information and education, and a limited amount of problem identification.

<http://deq.state.wy.us/wqd/watershed/nps/NPS.htm>

NRCS—Agricultural Management Assistance

Agricultural Management Assistance provides financial assistance to agricultural producers to voluntarily address resource issues such as water management, water quality, invasive species control, and erosion control by incorporating conservation into their farming or ranching operations.

Eligible land includes: 1) Privately owned land; 2) Publicly owned land where the land is a working component of the participant's agricultural operation, and the participant has control of the land for the term of the contract; and

3) Tribal, BIA allotted, or Indian land.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/wy/programs/financial/ama/>

EPA Environmental Education Grants

The purpose of the Environmental Education Model Grants Program is to provide money to support environmental education projects that increase the public's awareness about environmental issues and provide them with the skills to take responsible actions to protect the environment.

This grant program provides financial support for projects that design, demonstrate, and/or disseminate environmental education practices, methods, or techniques, and that will serve as models that can be replicated in a variety of settings.

<http://www2.epa.gov/education/environmental-education-ee-grants>

State

Wyoming State Revolving Funds

The Wyoming State Revolving Funds Program (SRF) consists of two separate but similar funds. SRF loans are normally at 2.5% interest rate over up to 20-year terms. SRF loans do not require any matching funds. The Drinking Water State Revolving Fund is for drinking water systems, including source, treatment plant, storage tanks, and transmission and distribution line projects. The Clean Water State Revolving Fund is for sanitary sewer treatment and collection, stormwater control, landfill water pollution control, and other water pollution control projects.

<http://deq.state.wy.us/wqd/www/SRFindex.asp>

Wyoming Department of Agriculture—Water Quality Grants

Water quality grants available to conservation districts for water quality related projects, such as education, BMP projects, water quality monitoring, or research.

<http://wyagric.state.wy.us/divisions/nrp/conservation-districts/funding-resources/water-quality>

Wyoming Water Development Commission—Small Water Project Program (SWPP)

The purpose of the SWPP is to participate with land management agencies and sponsoring entities in providing incentives for improving watershed condition and function. Projects eligible for SWPP grant funding assistance include the construction or rehabilitation of small reservoirs, wells, pipelines and conveyance facilities, springs, solar platforms, irrigation works, windmills and wetland developments.

http://wwdc.state.wy.us/small_water_projects/small_water_project.html

Wyoming Wildlife and Natural Resource Trust

The purpose of the Trust is to enhance and conserve wildlife habitat and natural resource values throughout the state. Any project designed to improve wildlife habitat or natural resource value is eligible for funding. More than 80 separate entities have received funding since the program began in 2006. Conservation districts have sponsored the greatest number of funded projects. Application deadlines are March 1 and September 1 annually.

Local

City of Sheridan

The City of Sheridan can provide funding for capital expenditures as well as operating costs through the revenue

from water utility rates, issuance of bonds, and other local sources.

Sheridan Area Water Supply Joint Powers Board

SAWSJPB can provide funding for capital expenditures as well as operating costs through the revenue from water utility rates, issuance of bonds, and other local sources.

Sheridan County Conservation District Cost Share Programs

SCCD offers financial assistance for projects that benefit water quality. SCCD receives money from federal sources to implement projects at the local level.

Other

Wyoming Community Foundation

The WYCF makes grants across a broad array of charitable areas including arts and culture, conservation and natural resources, education, civic projects and health and human services. Eligible organizations include nonprofit organizations exempt from federal taxation under Section 501(c)(3) of the Internal Revenue Code, and on occasion, public/governmental agencies.

<http://www.wycf.org/grants/index.html>

Wyoming Agriculture in the Classroom—Wyoming Youth for Natural Resources

Wyoming Youth for Natural Resources (WYNR) is a grant program designed to encourage Wyoming youth to develop imaginative wildlife and natural resources conservation projects that incorporate education, technology, volunteering and service to others. The program is a collaborative effort of the Wyoming Community Foundation and Wyoming Agriculture in the Classroom. Grants may be made to public schools, youth organizations or other nonprofit organizations exempt from federal taxation under Section 501(c)(3) of the Internal Revenue Code and, on occasion, to public/governmental agencies.

<http://www.wyaitc.org/index.php/get-involved/wynr-grants/>

Section 11- Public Outreach

Public outreach and education are important components of watershed protection and planning. Since nonpoint source pollution can come from any variety of activities, controlling that pollution ultimately relies on informed active watershed users. The goal of a public outreach campaign should be to create a community of informed citizens committed to watershed protection that understands how to address water quality challenges through individual and collaborative efforts.

A public outreach campaign should include numerous outreach activities, all forms of media, a memorable slogan and logo, educational materials, and public events such as Sheridan Earth Day, Third Thursday, Taste of Sheridan, etc. A stand-alone event, similar to the Trees for Trash day, addressing watershed protection should also be considered. An event that solely focuses on watershed protection and not in conjunction with other events will help show the importance the community places on watershed protection.

Outside of general events and informational materials, identifying and analyzing the unique target audiences is crucial. It is important to segment the audience as much as possible to address each group in very specific ways that speak to their individual contributions to improving water quality in the watershed. This way, the message resonates with each group and their own interests.

A specific message and campaign should be developed for the following groups:

- Grazing permittees
- Sportsmen and women
- Hikers
- Off-road vehicle trail users
- Horseback riders
- Campers
- Visitors to the Bighorn National Forest
- Citizens of Sheridan
- Local conservation and environmental groups
- Elected officials

Section 12- Implementation of the Plan

Implementation Action Items

Action items were developed with the input of the City of Sheridan, Sheridan County, Sheridan County Conservation District, and the USFS. These agencies constitute the watershed control plan implementation team and together have the technical skills necessary to see successful implementation of the plan.

Before developing implementable action items for the watershed control plan, a list of appropriate BMPs was developed. The BMP list was then used to develop the action items that would have the most benefit for controlling pollution in the Big Goose Creek watershed. The action items are meant to ensure the goals of the watershed plan are met. The Big Goose Creek Watershed Control Plan is intended to be a living document and should be amended as need arises.

Broad land management planning emphasizes environmental goals and objectives that cover all aspects of water quality. Careful planning reduces confusion in management and aligns goals and enforcement throughout a watershed. Without clear and consistent land management planning and regulatory enforcement, watershed protection becomes extremely difficult. The Big Goose Creek Watershed Control Plan should be used as a guide, along with all other pertinent planning documents and efforts, to see that management goals are met.

When implementing the Big Goose Creek Watershed Plan, all persons using the Big Goose Creek watershed should be held accountable for actions that do not comply with current Sheridan County and USFS rules and regulations. The goal of all rules and regulations within the watershed is to protect the source of Sheridan's drinking water. Appropriate rules and regulations are currently in place and should be properly enforced.

Special Area

Along with the implementation items listed in this section, stakeholder agencies should study and explore the feasibility of establishing a Special Area within the Big Goose Creek watershed to add an extra layer of protection to the community's drinking water supply. Limited areas of National Forest System lands may have special attributes that merit special management. These areas can be designated by law or may be designated administratively as special areas. Designated areas are managed to emphasize specific related values. Other uses are permitted in the areas to the extent that these uses do not disrupt the purposes of the Special Area. The law or decision designating each area would provide specific objectives and guidelines for management of each area.

Plan Administration and Oversight

The City of Sheridan will provide the administration for the Big Goose Creek Watershed Control Plan and will lead water

quality monitoring and data analysis efforts. The City will act as a facilitator and will conduct meetings with partner agencies and stakeholders as necessary to develop strategies for plan implementation. During such meetings, the City, partner agencies, and stakeholders will work together to identify costs and prioritization for project implementation. Projects listed as higher priorities should receive the first available funds. Lower priority projects should be addressed as more funding becomes available. No costs or commitments of labor will be incurred on behalf of the City, partner agencies, or any stakeholder without their approval. The City will either assign staff or hire a consultant to facilitate meetings and to oversee plan implementation.

Goal 1: Identify existing sources of Cryptosporidium in the Big Goose Creek Watershed						
Action Item	Responsible Agency	Schedule	Indicator	Cost*	Action Item currently being implemented and included in current budgeting	Effectiveness and Feasibility
1. Develop ongoing monitoring plan. ²⁴	City of Sheridan, Sheridan County, SAWSJPB	Annually	Completed monitoring plan	\$9,540		<p style="text-align: center;">HIGH</p> <p>This action item would fill in needed data gaps to determine Cryptosporidium</p>

²⁴ The EPA recommends, due to lower analytical cost, that in addition to the proposed periodic *Cryptosporidium* sampling that periodic *E. coli* sampling with enumeration analysis be conducted at key points along the Big Goose Creek. Spikes in *E. coli* levels could indicate hot spots for fecal contamination and potential contributing causes and help target areas for the *Cryptosporidium* testing.

						sources.
2. Conduct monitoring once a month at Sheridan intake. If a sample tests positive for <i>Cryptosporidium</i> , conduct genotype test.	City of Sheridan, Sheridan County, SAWSJPB	Ongoing	Completed sampling test results	\$15,900	X	<p>HIGH</p> <p>This action item would fill in needed data gaps to determine <i>Cryptosporidium</i> sources and allow for prioritization for implementation of the plan action items in the future.</p>
3. Stay engaged in the latest research, literature, science, and data concerning <i>Cryptosporidium</i> and how factors such as rainfall, snowpack, streamflow, land use, and hydrology	City of Sheridan, SAWSJPB	Ongoing	Collected reports and data	\$500		<p>MODERATE</p> <p>This action item could fill in needed data gaps to determine <i>Cryptosporidium</i> sources and allow for prioritization for implementation of</p>

can impact <i>Cryptosporidium's</i> presence within a watershed.						the plan action items in the future.
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*Costs are estimates and some action items are one-time expenses with minimal maintenance costs thereafter. Some costs include current expenditures and do not constitute a need for new revenue sources.

Goal 2: Address likely sources of pollutant contributors in the Big Goose Creek Watershed						
Action Item	Responsible Agency	Schedule	Indicator	Cost	Action Item currently being implemented and included in current budgeting	Effectiveness and Feasibility
<i>Erosion and Pathogen</i>						
1. Use BMPs to	USDA Forest Service	Ongoing as needed	Signage, properly constructed trails, parking lots, dirt roads,	\$4,340	X	MODERATE

minimize and control the amount of sediment reaching water bodies, such as conserving vegetative ground cover and avoiding ground disturbance on steep slopes or sensitive soils.	City of Sheridan, Sheridan County		and construction projects implemented with sediment BMPs			Cryptosporidium can live outside of the body for extended periods of time given the right conditions. Controlling sediment reaching waterbodies can decrease the likelihood Cryptosporidium will reach waterbody.
2. Revegetate or stabilize disturbed	<i>LEAD AGENCY:</i> USDA Forest Service	Ongoing as needed	Monitor completed revegetation projects for success. Photos of successful project placed on file. Projects	\$11,550	X	MODERATE

areas.			noted in annual budget or work plan.			Cryptosporidium can live outside of the body for extended periods of time given the right conditions. Controlling runoff can decrease the likelihood Cryptosporidium will reach waterbody.
	<i>SUPPORT AGENCIES:</i> City of Sheridan, Sheridan County					
3. Conduct annual livestock grazing BMP reviews.	USDA Forest Service	Annually/Ongoing	Completed BMP review forms	\$7,150	X	HIGH Livestock should be managed according to Annual Operating Instructions to reduce the chances livestock contribute to

						Cryptosporidium in the creek.
4. Monitor prescribed burn areas for revegetation and erosion.	USDA Forest Service	Ongoing as needed	Photo point survey results	\$6,500	X	MODERATE
						Controlling runoff caused by erosion can decrease the likelihood Cryptosporidium will reach the Big Goose Creek.
5. Use BMPs: water bars, seeding, planting, repairing damaged road drainage to stabilize areas by suppression	USDA Forest Service	Ongoing as needed	Completed action, past project monitoring.	\$12,500	X	LOW
						This is unlikely to be significant alone but will help ensure watershed protection as a part of the entirety of plan implementation.

activities.						
Trails and Recreation						
1. Monitor and maintain motor vehicle road/trails.	USDA Forest Service	Ongoing as needed	Completed projects, annual work plan	\$16,000	X	<p style="text-align: center;">LOW</p> <p>This is unlikely to be significant alone but will help ensure watershed protection as a part of the entirety of plan implementation.</p>
2. Manage motor vehicle use roads/trails to minimize adverse effects to soil, water quality, and riparian	USDA Forest Service	Ongoing as needed	Signage, presentations/communications with motor vehicle users, patrol days completed, and citations issued.	\$11,050	X	<p style="text-align: center;">LOW</p> <p>This is unlikely to be significant alone but will help ensure watershed protection as a part of the</p>

resources.						entirety of plan implementation.
3. Maintain, repair, upgrade, reroute, or close stream crossings when needed to minimize sediment delivery to water bodies.	USDA Forest Service	Ongoing as needed	Motor Vehicle Use Map (MVUM), patrol days	\$6,700	X	<p style="text-align: center;">LOW</p> <p>This is unlikely to be significant alone but will help ensure watershed protection as a part of the entirety of plan implementation.</p>
<i>Vault and Pit Toilets and Septic Tanks</i>						
1. Pump vault toilets at public facilities.	USDA Forest Service	Ongoing as needed	Vault toilets pumped and cleaned	\$4,900	X	<p style="text-align: center;">HIGH</p> <p>Pumping of vault toilets will remove possible <i>Cryptosporidium</i> sources.</p>
2. Conduct	Sheridan	Upon completion	# of septic tank inspections	\$8,600	X	HIGH

septic tank inspections of new construction or repair.	County	of project					
							Systems that are properly constructed and working can keep Cryptosporidium out of the Big Goose Creek.
							HIGH
3. Conduct assessment of cabin toilet facilities.	USDA Forest Service	Ongoing as needed	Completed assessment	\$5,320			Data is needed in order to address which toilet facilities are most likely to be contributors to Cryptosporidium in the Big Goose Creek.

Goal 3: Increase public outreach, involvement, and education in the Big Goose Creek Watershed						
Action Item	Responsible Agency	Schedule	Indicator	Cost	Action Item currently being implemented and included	Effectiveness and Feasibility

					in current budgeting	
<i>Outreach</i>						
1. Conduct informational surveys to both educate public and learn where there is a need for more education.	City of Sheridan, Sheridan County, SAWSJPB, SCCD ²⁵	Ongoing as needed	# of completed surveys	\$4,100	X	HIGH Surveys will fill in data gaps help prioritize future action items during plan implementation.
2. Conduct watershed model activities with elementary age school children.	SCCD	Annually	# of elementary students presented to	\$6,500	X	MODERATE Informational activities can gain public buy in for watershed protection, eliminate future pollution through education, and are reasonably cost effective.

²⁵ SCCD- Sheridan County Conservation District

3. Conduct watershed education with secondary students.	SCCD	Annually	# of secondary student presented to	\$4,100	X	MODERATE
						Informational activities can gain public buy in for watershed protection, eliminate future pollution through education, and are reasonably cost effective.
4. Conduct meetings with stakeholders and organizations to encourage participation and partnership in watershed protection.	City of Sheridan, Sheridan County, SAWSJPB, SCCD	Ongoing as needed	# of stakeholder meetings held	\$5,500	X	HIGH
						Targeting actual active users of the water resource can enlist assistance from the citizens with the most at stake.
5. Consider	USDA Forest	Annually	# of volunteers	\$6,500	X	HIGH

volunteer assistance in stream protection from individuals living in or using the watershed resources.	Service, SCCD					Targeting actual active users of the water resource can enlist assistance from the citizens with the most at stake.
Educational Materials						
1. Develop plan for watershed signage.	USDA Forest Service, City of Sheridan, Sheridan County, SAWSJPB, SCCD	Ongoing as needed	Completed signage plan	\$6,350		MODERATE Informational signage will alert the public to their location in the watershed and the importance of protecting it.
2. Develop and distribute signage	USDA Forest Service, City of	Ongoing as needed	# of signs dispersed	\$6,700		MODERATE

at Forest Service designated information areas located within the watershed.	Sheridan, Sheridan County, SAWSJPB		within the watershed			Informational activities can gain public buy in for watershed protection, eliminate future pollution through education, and are reasonably cost effective.
3. Develop and disperse information about Sheridan's watershed with paperwork involved with grazing permits, recreational permits, special use permits.	<i>LEAD AGENCY:</i> USDA Forest Service	Annual/Ongoing	Information packets developed and # of packets distributed	\$7,500		HIGH
	<i>SUPPORT AGENCIES:</i> City of Sheridan, Sheridan County, SAWSJPB					Targeting actual active users of the water resource can enlist assistance from the citizens with the most at stake.
4. Develop and disperse	USDA Forest Service, City of	Ongoing as needed	# of brochures mailed	\$3,400		HIGH

information to cabin owners in the watershed above the intake.	Sheridan, Sheridan County, SAWSJPB, SCCD					Targeting actual active users of the water resource can enlist assistance from the citizens with the most at stake.
5. Educate Camp Hosts about the issue and use Camp Hosts to disperse information to campers.	USDA Forest Service	Ongoing as needed	# of Materials distributed to campers	\$3,400		HIGH Targeting actual active users of the water resource can enlist assistance from the citizens with the most at stake.
6. Develop and disperse	City of Sheridan, Sheridan	Ongoing as needed	# of brochures given to lodges	\$1,700		MODERATE

information at lodges and resorts frequented by motor vehicle users and other forest visitors.	County, SAWSJPB		and resorts			Informational activities can gain public buy in for watershed protection, eliminate future pollution through education, and are reasonably cost effective.
7. Build a page on each agency's website with information on the Big Goose Creek Watershed and develop and implement a social media campaign including information on Facebook and Twitter.	USDA Forest Service, City of Sheridan, Sheridan County, SCCD	Ongoing as needed	Completed page on websites	\$5,100		MODERATE Informational activities can gain public buy in for watershed protection, eliminate future pollution through education, and are reasonably cost effective.
8. Clearly delineate and mark	USDA Forest Service	Ongoing as needed	Marked motor vehicle areas	\$5,100	X	MODERATE

designated motor vehicle use routes in the field where practicable.						Informational activities can gain public buy in for watershed protection, eliminate future pollution through education, and are reasonably cost effective.
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Administration and Oversight						
Action Item	Responsible Agency	Schedule	Indicator	Cost	Action Item currently being implemented and included in current budgeting	Effectiveness and Feasibility
1. Administration and oversight of watershed control plan.	City of Sheridan	Annually	Proper oversight of the plan and progress of action item completion	\$6,300		HIGH Proper administration and oversight is crucial to ensuring the success of the

						watershed control plan.
2. Qualified personnel conduct required watershed sanitary survey.	US Environmental Protection Agency	Annually	Completed watershed sanitary survey	-		HIGH Action required for receiving LT2 Cryptosporidium removal credit

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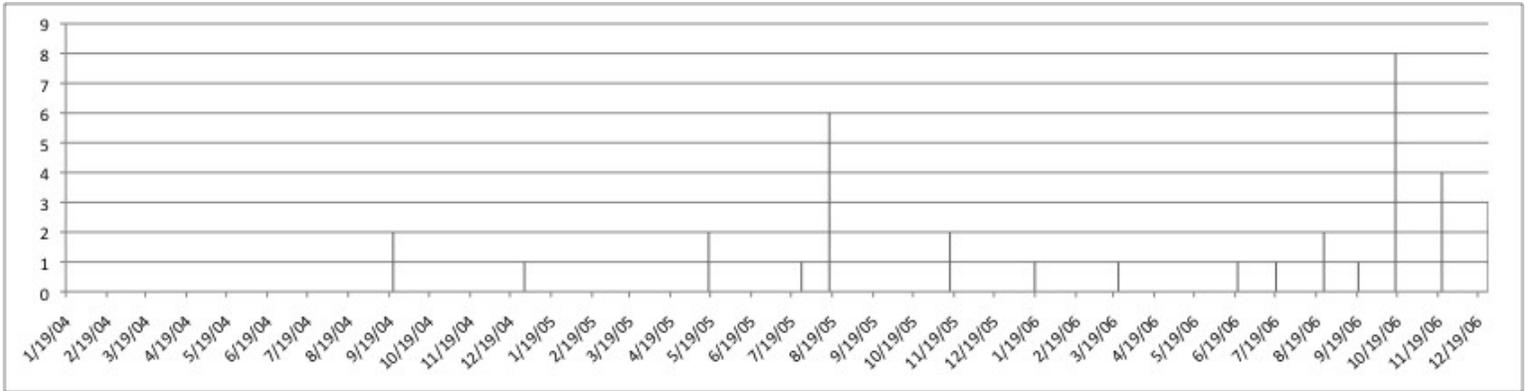
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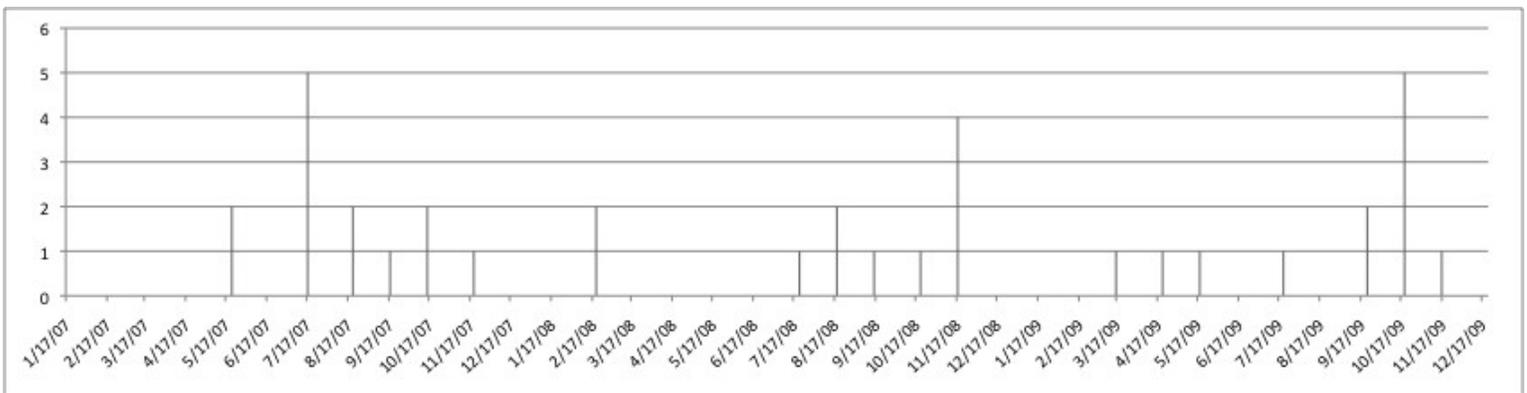
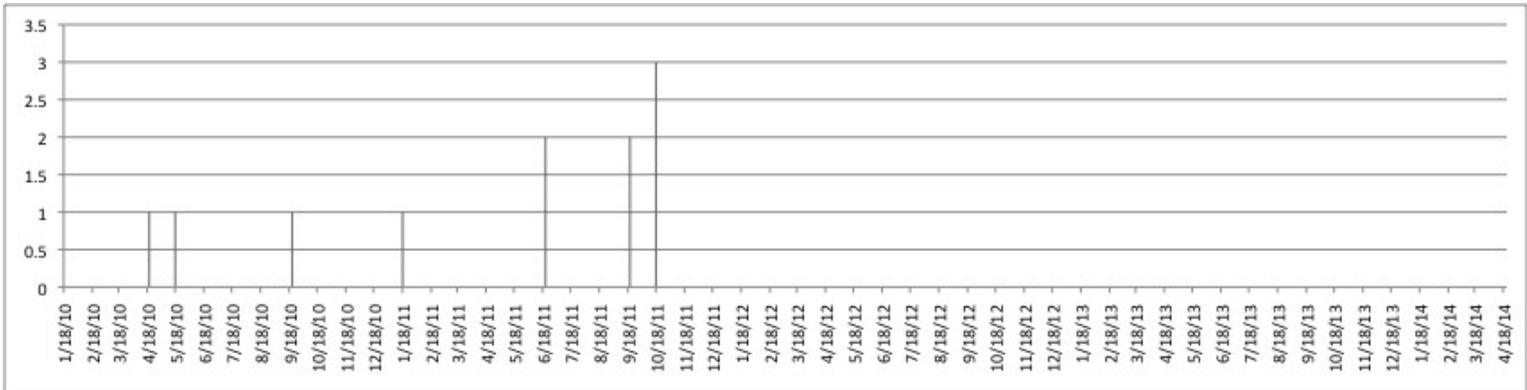
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Appendix A: Cryptosporidium Sampling Results 2004-April 2014

2004-2006*



2007-2009 2010-April 2014



*Measured in oocysts/liter.

Appendix B: Best Management Practices

Sheridan Water Quality Protection Plan for Big Goose Creek					
<p>The City of Sheridan, Sheridan County, and the US Forest Service all have regulatory requirements to protect water quality in the Big Goose Creek Watershed. Best Management Practices provide science-based criteria and standards for land managers to follow while making and implementing decisions about uses and projects that affect natural resources. Best Management Practices are based on legal obligations, agency practices and guidelines, and the best available scientific knowledge.</p>					
Best Management Practice	Purpose of Best Management Practice	Livestock, Human, Wildlife	Source	Supporting Existing Plan/Document	
Sediment Management					
1	<p>Erosion and sediment control - use practices to conserve and reduce the amount of sediment reaching water bodies including avoiding activities on steep or unstable slopes and revegetating or stabilizing cut slopes along roads. This can include optimizing the number of stream crossings and maintaining stable stream crossings.</p>	<p>Minimizing erosion and controlling sediment will decrease the amount of sediment in a water body. Sediment can carry pathogens and pollutants. Minimizing sediment can reduce costs of treating source water.</p>	<p>Livestock Human Wildlife</p>	<p>https://extension.usu.edu/waterquality/htm/bmps. Wyoming Forestry Best Management Practices, Forestry BMPs Water Quality Protection Guidelines</p>	<p>Bighorn National Forest Revised Land and Resource Management Plan. Bighorn National Forest Regional Watershed Conservation Practices Handbook (11.1, 11.2, 12.6, 13.1-4).</p>
2	<p>Riparian Buffer - Maintain existing riparian buffers.</p>	<p>Riparian areas can act like a natural sponge. Conservation riparian buffers can trap sediment and can help prevent pathogens and pollutants from entering water bodies. Riparian areas</p>	<p>Livestock</p>	<p>https://extension.usu.edu/waterquality/htm/bmps</p>	<p>Bighorn National Forest Revised Land and Resource Management Plan. Forest wide Direction Soil, Water, Riparian, and Wetland Standards and Guidelines, Bighorn National Forest Regional Watershed Conservation Practices Handbook (12-</p>

		in lands managed for grazing are especially critical for stream health and water quality protection.			1, 12-3, 12-4). Sheridan County Rules and Regulations Governing Division of Land.
3	Fire suppression and prescribed burning - stabilize all areas that have significantly increased erosion potential or drainage patterns altered by suppression activities by installing water bars, seeding/planting, and repairing damaged road drainage.	These actions reduce the potential for ash and sediment impacts on the water supply source.	Human	Wyoming Forestry Best Management Practices, Forestry BMPs Water Quality Protection Guidelines	Bighorn National Forest Revised Land and Resource Management Plan. Bighorn National Forest Regional Watershed Conservation Practices Handbook.11.2, 14.1. Forest Service Handbook. 2523.
4	Restrict motor vehicle use to designated routes for dispersed camping and big game retrieval to avoid, minimize, or mitigate adverse effects on soil, water quality, and riparian resources.	Motor vehicle use can cause damage and erosion in riparian areas. Minimizing erosion and controlling sediment will decrease the amount of sediment in a water body. Sediment can carry pathogens and pollutants. Minimizing sediment entrainment and transport can reduce costs of treating source water.	Human	USDA National Best Management Practices for Water Quality Management on National Forest Service Lands, April 2012	Bighorn National Forest Revised Land and Resource Management Plan. Forest Service Manual (2353.28, 7716). Forest Service Handbook (2309.18 23.2). Bighorn National Forest Regional Watershed Conservation Practices Handbook (12.4).
5	Designate season-of-use periods when soils are particularly prone to unacceptable erosion, rutting, or compaction.	Motor vehicle use can cause damage and erosion in riparian areas. Minimizing erosion and controlling sediment will decrease the amount of sediment in a water body. Sediment can carry pathogens and pollutants. Minimizing sediment can reduce costs of treating source water.	Human	USDA National Best Management Practices for Water Quality Management on National Forest Service Lands, April 2012	Bighorn National Forest Revised Land and Resource Management Plan. Forest Service Manual (2353.28, 7716). Forest Service Handbook (2309.18 23.22) Bighorn National Forest Regional Watershed Conservation Practices Handbook (13.1)
6	Properly site motor vehicle trails and rehabilitate designated motor vehicle use areas that are causing unacceptable adverse	Locating, relocating, and maintaining motor vehicle trails in areas with stable soils with a minimum distance from water bodies can help minimize	Human	USDA National Best Management Practices for Water Quality Management on National Forest Service	Bighorn National Forest Revised Land and Resource Management Plan. Forest Service Manual (2353.28, 7716). Forest Service Handbook (2309.18 23.22). Bighorn National Forest Regional

	effects to soil, water quality, and riparian resources.	sediment inflow to water bodies. Minimizing erosion and controlling sediment, with proper management and rehabilitation where needed, will decrease the amount of sediment in a water body. Sediment can carry pathogens and pollutants. Minimizing sediment can reduce costs of treating source water.		Lands, April 2012	Watershed Conservation Practices Handbook (12.1, 12.2, 13.1, 13.2, 13.3, 13.4)
Pathogen and Pollution Management					
7	Grazing management - managing livestock grazing to minimize the water quality impacts	Proper grazing management can limit livestock interactions with sensitive areas and reduce water quality problems. Keeping cattle from gathering behind closed control gates near Sheridan's source water intake can keep pathogens from entering Big Goose Creek.	Livestock	https://extension.usu.edu/waterquality/htm/bmps	Bighorn National Forest Plan: Soil, Water, Riparian, and Wetland Standard 1. Annual Operating Instructions for grazing permittees. Bighorn National Forest Regional Watershed Conservation Practices Handbook (11.1, 12.1) Bighorn National Forest Revised Land and Resource Management Plan.
8	Revegetation - in harvested areas re-establish protective vegetation	Exposed soil leads to erosion and sediment in water bodies. Scientifically defined reproduction methods can assist in keeping pollutants out of water bodies and protect against erosion and sediment.	Human	Wyoming Forestry Best Management Practices, Forestry BMPs Water Quality Protection Guidelines	Forest Service Revised Land and Resource Management Plan. Bighorn National Forest Regional Watershed Conservation Practices Handbook (11.2)
9	Planning riparian area-adequate stream management zone width maintained and retention of tree requirements met during timber projects.	Reducing access to stream banks reduces potential erosion. Maintaining tree growth acts as a buffer to streams and serves as a trap for sediment and pathogens.	Human	Wyoming Forestry Best Management Practices, Forestry BMPs Water Quality Protection Guidelines, 2007 - 2011 Comparison Worksheet (Garden Creek Timber Sale, WY)	US Forest Service Timber Sale Contracts. Bighorn National Forest Regional Watershed Conservation Practices Handbook (12.1). Bighorn National Forest Revised Land and Resource Management Plan.

10	On-site septic and sewage system - installation and maintenance per rules and regulation for Sheridan County, WY	Septic systems can be sources of pathogens in a watershed. Various illnesses and diseases have been attributed to bacteria and viruses associated with water contaminated by septic systems. Rules and regulations for the proper care and maintenance of on-site septic systems can help prevent pathogens getting into the watershed. Properly maintained systems should not release harmful pollutants to water bodies.	Human	Wastewater Facility Sheridan County Wyoming, Dec. 15, 2009	Rules and Regulations Governing Wastewater Facilities. Sheridan County, WY. Bighorn National Forest Regional Watershed Conservation Practices Handbook (15.1)
11	Correctly handle and apply pesticides, herbicides, fertilizers and chemicals so as to reduce possible adverse effects on water quality	Proper handling and storage of chemicals can reduce the chance that those substances could contaminate stream water.	Human	2007 - 2011 Comparison Worksheet (Garden Creek Timber Sale, WY)	Bighorn National Forest Regional Watershed Conservation practices Handbook (15.1, 15.2, 15.3).
Public Outreach					
12	Encourage public information and involvement – post signs that you are in the watershed that is the source of the City of Sheridan’s water supply, volunteer stream monitoring by individuals living in or using the watershed resources, informational surveys, stakeholder meetings, and watershed organizations to encourage participation and	An effective outreach campaign is an important aspect of any water quality improvement effort. Outreach and education can help create an awareness of water resources, educate people about what’s threatening the resources, and encourage protective action.	Human	EPA National Menu of storm water Best Management Practices - Public Education	

	partnerships				
13	Education - Encourage public to use online tools such as EPA's "How's My Waterway" app and "Surf Your Watershed" website to learn more about their watershed	Web tools and technologies available can help to foster watershed awareness and reach new and younger audiences.	Human	EPA Office of Wetlands, Oceans, and Watersheds http://cfpub.epa.gov/surf/locate/index.cfm	
14	Education - Conduct watershed education programs in the public and private schools.	Education programs designed specifically for students can increase watershed awareness.	Human	EPA Office of Wetlands, Oceans, and Watersheds http://water.epa.gov/aboutow/owow/kids.cfm	
15	Use Camp Hosts to educate campers in Big Goose Creek Watershed	Camp hosts can be used to dispense watershed information to campers unaware of watershed location and proper watershed protection.	Human		
16	Clearly delineate and mark designated motor vehicle use areas in the field where practicable.	Addressing specific users of a watershed is an effective tool to help motivate people to adopt behaviors that will help improve and protect water quality.	Human	USDA National Best Management Practices for Water Quality Management on National Forest Service Lands, April 2012	Forest Service Manual (2353.28, 7716). Forest Service Handbook (2309.18 23.22). Bighorn National Forest Revised Land and Resource Management Plan
17	Use suitable public relations and information tools and enforcement measures to encourage the public to conduct motorized vehicle use activities within designated areas in a manner that will avoid, minimize, or mitigate	Targeted outreach to specific users of a watershed is an effective tool to help motivate people to adopt behaviors that will help improve and protect water quality.	Human	USDA National Best Management Practices for Water Quality Management on National Forest Service Lands, April 2012	Forest Service Manual 2353.28, 7716. Forest Service Handbook 2309.18 23.22

	adverse effects to soil, water quality, and riparian resources.				
18	Include factsheets and brochures about Sheridan's watershed with paperwork involved with grazing permits, recreational permits, special even permits. Place information on the watershed at Forest Service kiosks located within the watershed.	Targeted outreach to specific users of a watershed is an effective tool to help motivate people to adopt behaviors that will help improve and protect water quality.	Human	EPA Office of Water Nonpoint Source Control Branch, Guide for Conducting Watershed Outreach Campaigns, November 2010.	

