Little Powder River Watershed Restoration Plan

DEVELOPED IN COOPERATION BY:

LITTLE POWDER RIVER WATERSHED STEERING COMMITTEE
CAMPBELL COUNTY CONSERVATION DISTRICT

Gillette, Wyoming
2019

Signature Page

On February 21, 2018 residents of the Little Powder River watershed agreed to initiate a watershed planning effort to address bacteria and other concerns in the watershed.

Following a 45 day public comment period, the Little Powder Watershed Steering Committee approved the Little Powder River Watershed Restoration Plan on August 1, 2019.

Richard Hauber, Chair LPWSC

The Campbell County Conservation District Board of Supervisors adopted and approved the submission of the Little Powder River Watershed Restoration Plan to the Wyoming Department of Environmental Quality on August 13, 2019.

Lindsay Wood, Chair

Casey Elkins, Vice Chair

Richard Hauber, Supervisor

Jaime Tarver, Secretary/ Treasurer

BJ Clark, Supervisor

The Little Powder River Watershed Restoration Plan has been filed with the Campbell County Clerk.

Campbell County Clerk

Date

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Acronyms and Abbreviations

Acronyms/ Abbreviations	Definitions
AMA	Agriculture Management Assistance- NRCS program
AU	Animal Unit
CBM	Coalbed methane
CCCD	Campbell County Conservation District
CWA	Clean Water Act
BLM	Bureau of Land Management- U.S. Department of the Interior
BMP/ BMPs	Best Management Practices
E.coli	*Escherichia coli*
EQIP	Environmental Quality Incentives Program – NRCS Program
HUC	Hydrologic Unit Code
LPRWSC	Little Powder River Watershed Steering Committee
MLRA	Major Land Resource Area
MST	Microbial Source Tracking
NGO	Non-governmental organization
NTU	Nephelometric Turbidity Unit
NRCS	Natural Resources Conservation Service- United States Department of Agriculture
RCPP	Regional Conservation Partnership Program- NRCS program
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
USEPA/ EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UW	University of Wyoming
WACD	Wyoming Association of Conservation Districts
WDA	Wyoming Department of Agriculture
WDEQ	Wyoming Department of Environmental Quality
WDEQ-WQD	Wyoming Department of Environmental Quality- Water Quality Division
WYPDES	Wyoming Pollutant Discharge Elimination System

Executive Summary

The Little Powder River Watershed consists of approximately 1,295,560 acres (2,024 square miles) located in northern Campbell County, in northeast Wyoming. The Little Powder River originates just north of the city of Gillette and extends north into Montana, eventually entering the Powder River northeast of Broadus, Montana. Major tributaries to the Little Powder River include Rawhide, Cottonwood, Wildcat, and Horse Creeks. Most of these streams are ephemeral throughout much of their length and only experience flow following precipitation. Accessible public land is limited along the Little Powder River and recreational activities are infrequent.

When pollutants, such as *Escherichia coli (E. coli)* bacteria, exceed water quality standards, the stream is considered "impaired" and states are required by the Clean Water Act (CWA) to establish a Total Maximum Daily Load (TMDL) for that pollutant. The CWA also mandates that every two years the States evaluate water quality data. The results are summarized in a report and the impaired waterbodies are tabulated into a list, known as the Wyoming 303(d) List. In 1999, United States Geological Survey (USGS) gauge (#06324970) collected data near the Montana border and showed exceedances of the fecal bacteria criterion and the Little Powder River was placed on the 303(d) List in 2002. In 2010, the Wyoming Department of Environmental Quality (WDEQ) extended the impaired segment of the Little Powder River upstream to the confluence with Spring Creek. The most recent 303(d) list (WDEQ, 2018) continues to include the Little Powder River, due to exceedances of the *E. coli* criterion for primary contact recreation use. In 2002, the Campbell County Conservation District (CCCD) initiated water quality monitoring and planning efforts within the Little Powder River Watershed. The Little Powder River Watershed Steering Committee (LPRWSC), comprised of landowners and residents, used the monitoring data and local knowledge of the watershed to develop the Little Powder River Watershed Plan. The plan was adopted in 2006 and provided guidance for monitoring, implementation of best management practices (BMPs), and educational activities. The LPRWSC was reconvened in 2018 to update and revise the watershed plan, utilizing sampling data collected between 2002 and 2016.

Subwatershed divisions within the Little Powder River Watershed are based upon boundaries defined by the USGS. CCCD used the 10 digit hydrologic unit code (HUC) or 5th level subwatershed divisions, to characterize the Little Powder River Watershed. The Little Powder River Restoration Watershed Plan includes five subwatersheds; Horse Creek, Spring Creek, Olmstead Creek, Rawhide Creek, and Cottonwood Creek.

The regulatory concern for the Little Powder River Watershed is *E. coli* bacteria concentrations in excess of Wyoming Water Quality Standards for primary contact recreation. To fully achieve the primary contact recreation standard of 126 cfu/100 ml, bacteria levels would need to be reduced by over 70%. The LPRWSC does not feel this is achievable in the short term but has developed this watershed plan to reduce bacteria loads by 5% in the next five years to progress toward meeting the primary contact recreation standard.

The LPRWSC recognizes the limitations in the reduction estimates as presented. To fully understand the dynamics of the watershed, especially for *E. coli*, additional sampling data

encompassing different flow and climate patterns will aid in determining bacterial loads. The LPRWSC will continue to adjust load and load reduction estimates as additional data are collected.

The Little Powder River Watershed Restoration Plan includes 24 action items organized into three broad categories: watershed plan implementation, water quality, and awareness and education. Each action item has one or more interim milestones to enable the LPRWSC to assess whether action items are being completed as planned. This watershed plan also provides for additional water quality monitoring for bacteria and other parameters.

The action items include providing incentives for implementing BMPs, water quality monitoring, information and education activities, and other activities. Each action item lists the entity responsible for the completion of the action, and the approximate amounts and potential sources of funding needed. The incentive-based program for implementing BMPs will require an application process, with applications reviewed by the LPRWSC. All projects will be evaluated based on their potential to benefit water quality and funding will be allocated appropriately.

As the plan is implemented, some action items may not be necessary or may not be achievable as planned, or there may be other items not yet considered. In addition, as more data and information become available, CCCD may need to adjust load information and reduction estimates. Therefore, the watershed plan will remain dynamic and be updated as needed to meet the needs of current and future watershed issues.

Introduction

2.1 Resource Description

With its origin just north of Gillette, the Little Powder River is bounded on the east by the Belle Fourche and the Little Missouri River Watersheds and on the west by the Powder River Watershed. The Little Powder River Watershed consists of 1,295,560 acres. The basin relief is 1,870 feet and the channel length is 177 miles. Flowing northward, the Little Powder River enters the Powder River several miles northeast of Broadus, Montana. Few population centers exist in the watershed with Recluse, Wyoming on the drainage divide between Little Powder River and Powder River. A number of significant tributaries flow into Little Powder River. These include: Rawhide, Cottonwood, Wildcat and Horse Creeks. Highway 59 dissects the watershed for the majority of its length (Map 2.1). USGS data indicates that perennial flow is common on the stream with only nine no-flow records at the two primary sites monitored in the watershed since 1975.

Land Use and Ownership– The principal land uses in the Little Powder River Watershed are agriculture/grazing, wildlife/recreation, and energy development. Potential influences to water quality and quantity in the watershed include surface coal mines and discharges of water from oil and gas production. Existing and operational surface coal mines include: Buckskin Mine, Eagle Butte, Rawhide Mine, and Dry Fork Mine all north of the City of Gillette. Surface ownership percentages in the Little Powder Watershed are roughly 3.4% Bankhead Jones, 9.8% Bureau of Land Management (BLM), 1.4% National Grasslands, 78.7% Private, and 6.8% State Lands. Private land makes up the majority of the landmass within the watershed. This is an important note because there are no points at which the Little Powder River can be accessed through public lands without crossing private lands. For the general public as a whole, the lack of public access limits the potential risk to human health from exposure to waterborne pathogens during recreational activities.

Geology – Tertiary age geology dominates the Little Powder River watershed. From south to north, these include the Wasatch Formation and the Tongue River Member, Lebo Shale Member and Tullock Member of the Fort Union Formation, with the parent materials providing the silt/sand substrate typical of the high plains prairie streams in Campbell County.

Streamflow –The USGS operates a gauging station, the "Little Powder River AB Dry Creek" station (#06324970), located in the northern portion of the watershed. Figure 1 presents the discharge rates measured at the #06324970 station for the time period 2007 through 2018. USGS data indicates that perennial flow is common on the stream with peak flows occurring in early summer. Elevated stream flow can influence *E.coli* by bringing in sources of *E. coli* deposited near the streambank through overland flow or flooding out of the banks. Another potential influence of streamflow on *E. coli* is resuspension of streambed sediments that may

have *E. coli* attached to the sediment (Hyer and Moyer 2004, Hyer 2007). See Appendix A for additional streamflow data.

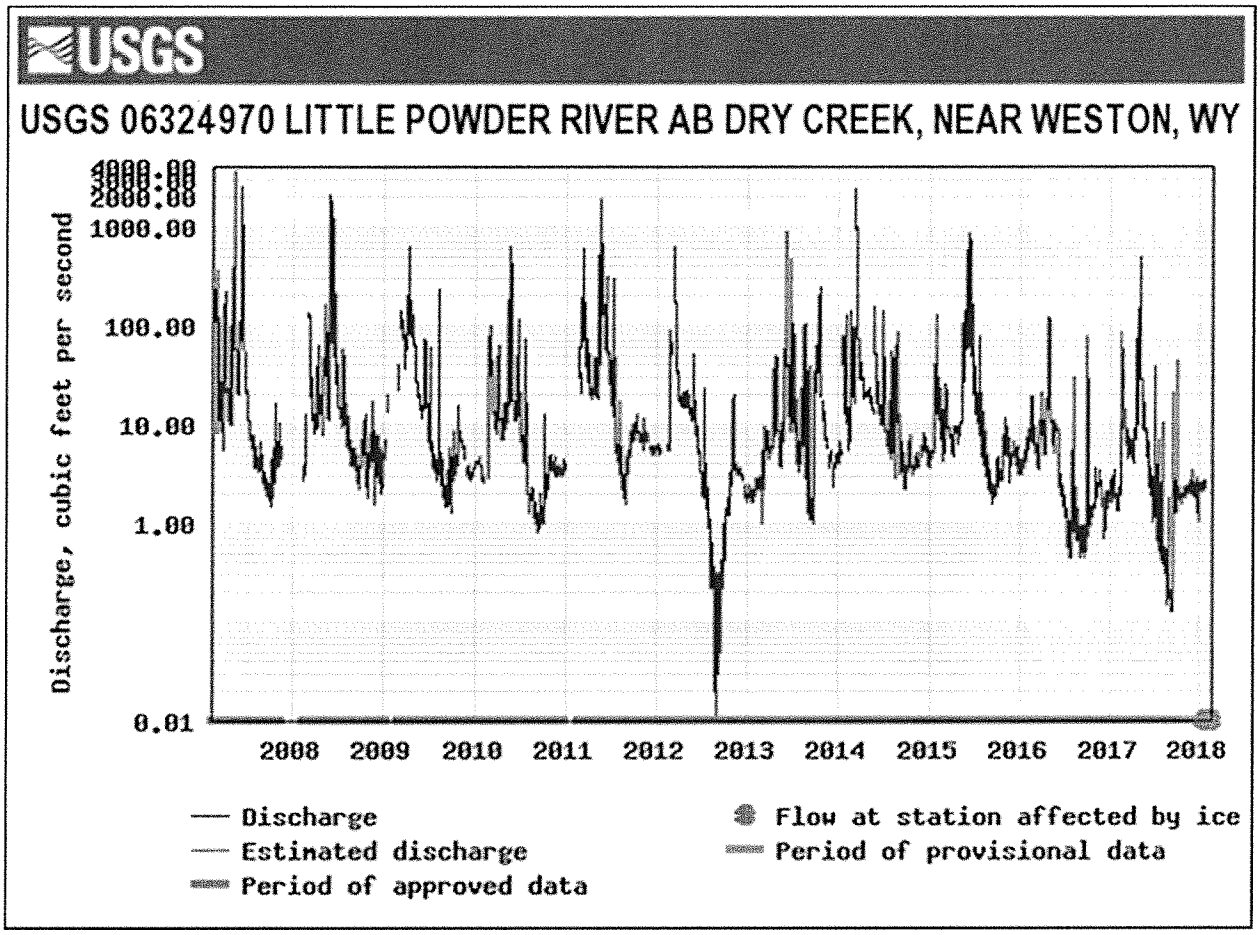
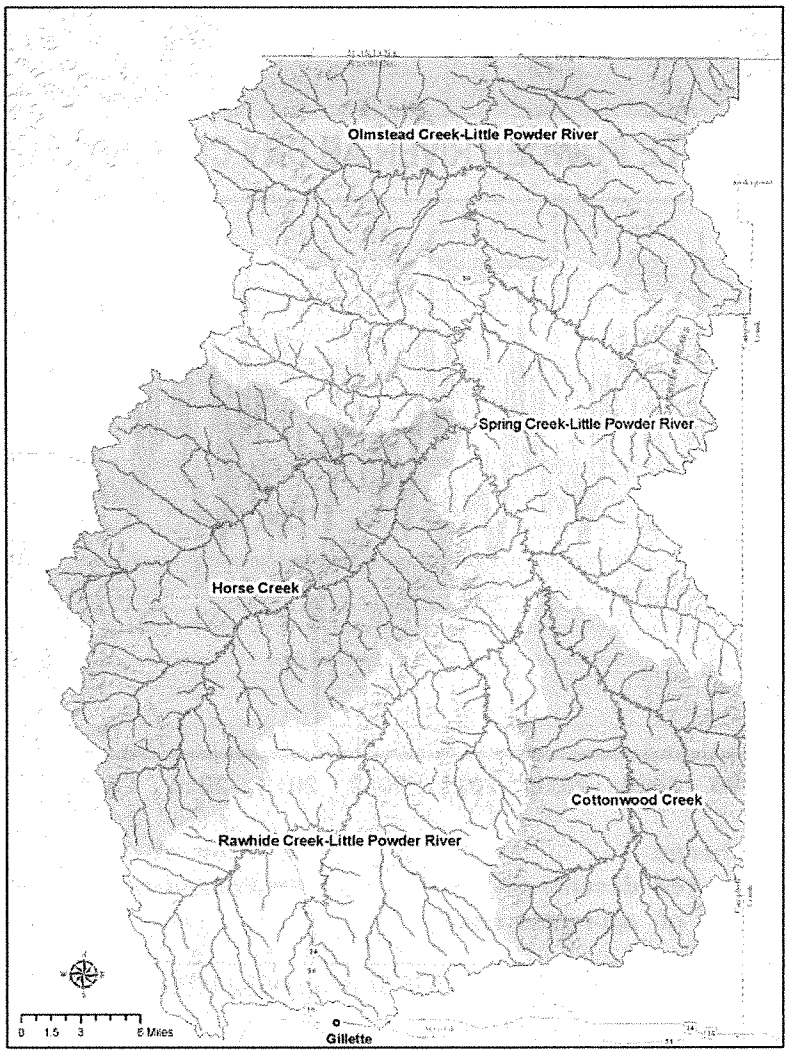


Figure 1. Discharge at Little Powder River USGS Station 06324970

Map 2.1 Little Powder Watershed, HUC 10 Sub-Watersheds



The watershed lies within the Major Land Resource Area (MLRA) 60B- Pierre Shale Plains, North Part (NRCS, 2018).

2.2 Stream Classification and Listing

Under the CWA, States are required to determine and describe the condition of all waters of the State, including surface waters; this is done by assessing the watercourse condition and classifying waters by their existing and potential beneficial uses. Each use classification has a specific set of water quality numeric and narrative criteria, which describe the classification. Wyoming has classified their surface waters, and these classifications are presented in the Water Quality Rules and Regulations, Chapter 1 – Wyoming Surface Water Quality Standards, see Table 2.1.

Table 2.1 Surface Water Classes and Use Designations (WDEQ, 2007)

Class	Drinking Water	Game Fish	Non-Game Fish	Fish Consumption	Other Aquatic Life	Recreation	Wildlife	Agriculture	Industry	Scenic Value
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3A	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3C	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4A	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Streams within the Little Powder River Watershed fall into one of two stream classes. These stream classes include 2AB and 3B waters.

2AB waters are defined by the Wyoming Department of Environmental Quality as:

> Waters known to support game fish populations or spawning and nursery areas at least seasonally and all their perennial tributaries and adjacent wetlands and where a game fishery and drinking water use is otherwise attainable. Class 2AB waters include all permanent and seasonal game fisheries and can be either "cold water" or "warm water" depending upon the predominance of cold water or warm water species present. All Class 2AB waters are designated as cold water game fisheries unless identified as a warm water game fishery by a "ww" notation in the *Wyoming Surface Water Classification List*. Unless it is shown otherwise, these waters are presumed to have sufficient water quality and quantity to support drinking water supplies and are protected for that use. Class 2AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value uses (WDEQ, 2018).

3B waters are defined by WDEQ as:

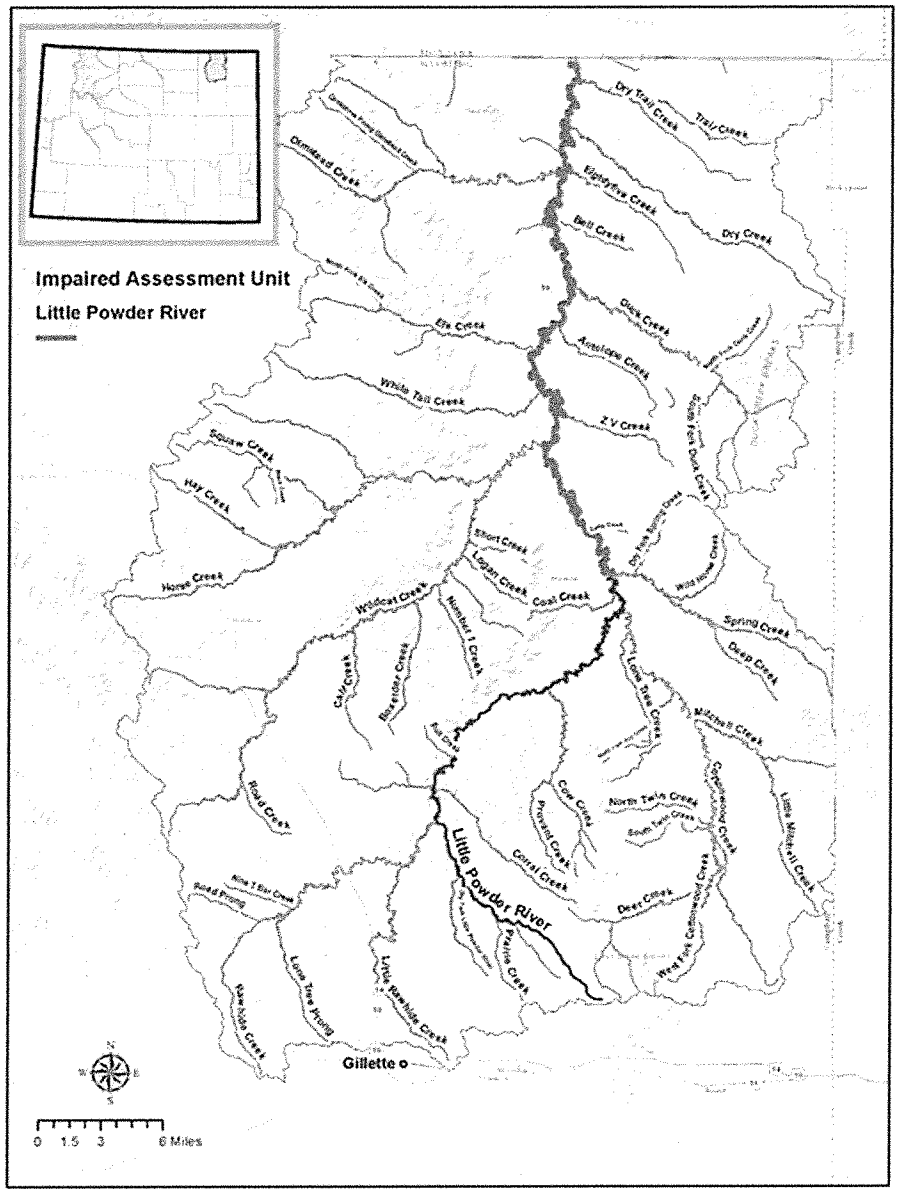
> Tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable. Class 3B waters are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. In general, 3B waters are characterized by frequent linear wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 3B waters. Within the Little Powder Watershed there is one 2AB waterbody and 34 class 3B waterbodies (Table 2.2).

Table 2.2 Classification on streams in the Little Powder River Watershed

Class 2AB Waterbodies	Class 3B Waterbodies		
Little Powder River	Trail Creek	Dry Creek	Eightyfive Creek
	Olmstead Creek	Spring Creek	North Fork Olmstead Creek
	Duck Creek	Elk Creek	White Tail Creek
	ZV Creek	Horse Creek	Wildcat Creek
	Spring Creek	Squaw Creek	South Squaw Creek
	Hay Creek	Spring Creek	Cottonwood Creek
	Mitchell Creek	Little Mitchell Creek	Hope Creek
	Deer Creek	Cow Creek	Corral Creek
	Rawhide Creek	Lower Rawhide Creek	Draw No. 3
	Draw No. 6	Red Fox Draw	Dry Fork Little Powder River
	Moyer Spring Creek	Garner Lake	Prairie Creek
	East Fork		

Additionally, the CWA mandates that every two years the States evaluate water quality data. The results are summarized in a report and the impaired waterbodies are tabulated into a list, known as the Wyoming 303(d) List. The 303(d) List includes all of the waters within Wyoming that are impaired and do not fully support existing or designated uses. **Water is deemed to be "impaired" or "non-supporting" if any of the narrative or numeric criteria associated with the classification of the stream reaches in question are shown to be unmet or adversely affected by human activity.**

Map 2.2 Little Powder River Watershed, Impaired Stream Segment



In 1999, USGS gauge (#06324970) collected data near the Montana border and showed exceedances of the fecal bacteria criterion and the Little Powder River was placed on the 303(d) List in 2002. In 2002 the CCCD conducted a study to assess water quality and quantity on the Little Powder River. This initial monitoring was driven by the need for baseline water quality and quantity characteristics in light of coalbed natural gas production. This study showed exceedances in the geometric means (5 samples in 30 days separated by 24 hours) for both *E.coli* and *Fecal coliform* (EDE Consultants, 2004). Prior to July of 2007 regulatory standards for establishing impaired or threatened streams for bacteria were based on concentrations of *fecal coliform* bacteria. In order to collect geometric means these samples

were to be taken five times in thirty days separated by a minimum of twenty-four hours. After July of 2007 the rule was revised to look at the concentrations of *E.coli* bacteria with a geometric mean consisting of 5 samples in thirty days and each sample be separated by a minimum of 24 hours (WWC Engineering, 2008). In 2010, the WDEQ extended the impaired segment of the Little Powder River upstream to the confluence with Spring Creek based on data which exceeded the fecal coliform standard, See Map 2.2 (WDEQ, 2018). This extension was based on data collected by the CCCD through a section 319 Project. Results from the study indicated that the lower reach of the river did not support its contact recreation uses from the Montana line upstream an undetermined distance above Olmstead Creek (WDEQ, 2010). In 2014 the bacteria standard changed again requiring geometric means consist of 5 samples separated by ten days within a sixty day period. The most recent report entitled "Wyoming's 2016/2018 Integrated 305(b) and 303(d) Report" continues to include one (1) stream within the watershed, the Little Powder River, due to exceedances of the *Fecal Coliform* criterion for primary contact recreation use (Table 2.3).

Table 2.3 *E.coli* water quality standard for streams and lakes in Wyoming

Beneficial Use	Geometric Mean [c] (organisms per 100 mL)	Recreational Use Category	Single Sample Maximum [d] (Organisms per 100 mL)
Primary Contact Recreation [a]	126	High Use Swimming Areas	235
		Moderate Full Body Contact	298
		Light Used Full Body contact	410
		Infrequent Used Full Body Contact	576
Secondary contact Recreation [b]	630	Not applicable	

Based on: Section 27 Chapter 1 Water Quality Rules and Regulations (DEQ, 2013)
Notes:
a. Streams designated for primary recreation are subject to primary contact recreation criteria during the summer season, which is May 1 through September 30, and secondary contact recreation criteria during the winter season, which is October 1 through April 30.
b. Streams designated for secondary contact recreation are subject to secondary contact recreation criteria throughout the year.
c. The geometric mean criteria are not to be exceeded during any consecutive 60-day period.
d. According to Section 27(c), single sample maximum criteria are only applicable to streams designated for primary contact recreation during the summer season. The rule further states that these criteria are for posting recreational advisories at public recreation areas and for determining effluent limitations for permitted point sources; the cannot be used to assess use attainment or for TMDL development.

When exceedances to the water quality standards occur, States are required to establish a TMDL, or a TMDL alternative plan for that stream and the pollutant. This is a requirement under the CWA and requires states to determine the amount of pollutant that a waterbody can

receive while meeting the water quality standard. It also requires identification of pollutant reductions needed within a watershed to meet the water quality standard.

2.3 Planning Authority

There are several authorities under Wyoming State Statues, as well as Wyoming Association of Conservation Districts (WACD) and the CCCD policies which provide the CCCD with the authority to conduct watershed planning. Below is a summary of those authorities:

Under Wyoming Statute §11-16-103 Legislative declarations and policy, the CCCD is to,

> provide for the conservation of the soil, and soil and water resources of this state, and for the control and prevention of soil erosion and for flood prevention or the conservation, development, utilization, and disposal of water, and thereby to stabilize ranching and farming operations, to preserve natural resources, protect the tax base, control floods, prevent impairment of dams and reservoirs, preserve wildlife, protect public lands, and protect and promote the health, safety and general welfare of the people of this state.

Wyoming Statute §11-16-122 grants Conservation Districts the ability to,

> conduct surveys, investigations and research and disseminate information relating to . . . the conservation, development, utilization and disposal of water. . . in cooperation with the government of this state or its agencies . . . [to] develop comprehensive plans for . . . conservation of soil and water resources . . .[that] specify in detail the acts, procedures, performances, and avoidances necessary or desirable to carry out the plans [and to] make public the plans and information and bring them to the attention of owners and occupiers of land within the district.

In 1996, the WACD, the Natural Resources Conservation Service (NRCS), and the Wyoming Department of Agriculture (WDA) saw an increasing need for Conservation Districts to represent local interests and take the lead in watershed planning efforts. As a result they developed the Watershed Strategic Plan, which was updated in 2000, to guide watershed planning efforts across the state (WACD, 2000). This document insists that "any watershed effort led by a conservation district should be landowner driven . . . [and] any participation on behalf of any landowner is strictly voluntary." CCCD further strengthens this idea through its policy on local involvement in TMDL development by stating "the District believes the current watershed planning and implementation efforts are extremely important in meeting clean water goals."(CCCD, 2017).

The Little Powder River Watershed Plan meets the goal of the Wyoming Nonpoint Source Management Plan Update (WDEQ, 2013) by furthering efforts "to identify sources of nonpoint source pollution to surface water and ground water of the State of Wyoming and to prevent and reduce nonpoint source pollution such that water quality standards are achieved and

maintained." This plan implements objectives of the Wyoming Nonpoint Source Management Plan Update by conducting an assessment of the condition of surface waters, implementing information and education programs, and through the involvement of the LPRWSC and local landowners, developing and implementing watershed management plans. In addition, this plan is focused on meeting the criteria of an alternative restoration approach. The alternative restoration approach or TMDL alterative focuses on addressing nine essential elements of an EPA Watershed Based Plan as described in the EPA Nonpoint Source Program and Grants Guidelines for states and Territories issued April 12, 2013.. These elements include identification of causes and sources of pollutant(s), expected load reductions, identification of nonpoint source management measures, technical and financial assistance needed, education and outreach, implementation schedule, identification of milestones to achieve desired reductions, development of criteria to evaluate load reductions, and monitoring activities (EPA, 2008).

According to the EPA a TMDL alternative can be justified in cases where there is, "... presence of watershed groups or other parties interested in implementing the alternative restoration approach [and there is] available funding opportunities for the alternative restoration approach..." (EPA, 2015). Since 2003 the LPRWSC, CCCD, and NRCS have been actively participating in watershed management. They have identified and prioritized concerns, set goals and objectives, and outlined the activities to achieve the objectives. To continue this effort the CCCD applied for EPA section 319 funding in the fall of 2016 to develop a TMDL alternative plan. With this funding assistance the CCCD and the LPRWSC was able to create the Little Powder River Watershed Restoration Plan, which includes elements to seek additional funding, implement the plan, and provide for plan evaluation.

2.4 Public Participation

Public participation is vital to the watershed planning process that was conducted by CCCD to develop this watershed plan. Watershed planning efforts led by Conservation Districts within the State of Wyoming are completed using the WACD Watershed Strategic Plan, which specifically addresses public participation with the following statement:

> Public input is one of the most important steps in the watershed planning process. The conservation district can choose the extent of public input when creating their plan. At a minimum, the district should follow the Administrative Procedures Act (W.S. §16-3-101 et seq.,) which requires a public notification process, a timed 45 day public hearing/review process, and final approval of the plan by the board of supervisors.

CCCD originally initiated awareness efforts for the impairments on Little Powder River on November 14, 2002 by hosting a public meeting at the Campbell County Library announcing the impairments and soliciting ideas for addressing the concern. On February 27, 2003, another public meeting was hosted to inform local landowners of their options in addressing the impaired segment of the Little Powder River. The Little Powder River Steering Committee was

formed at this February 27 meeting. The first Steering Committee meeting for watershed planning was held April 7, 2003. The Steering Committee met on a regular basis after that to develop the first Little Powder Watershed Plan (2006).

The Little Powder River Watershed Steering Committee worked to implement the Little Powder Watershed Plans adopted in 2006 through 2010. During this timeframe, various BMPs were installed to address human and livestock associated sources of *E.coli*. After BMP implementation, CCCD continued to conduct water quality sampling to document any improvements. From 2011 to 2018 BMP efforts continued through assistance from the local landowners and NRCS practices. These efforts included grazing management practices, riparian fencing, and water development and fabricated windbreaks (WACD, 2018). Outreach and education activities were also conducted during that time.

In 2018 the LPRWSC reconvened to create the Little Powder Watershed Restoration Plan in order to further improve the watershed. The LPRWSC met monthly from February 2018 through April 2019. During these meetings, committee members reviewed narrative sections, aided in identifying issues leading to *E.coli* impairments, suggested potential BMPs that could be implemented within the watershed, and established a milestone table to ensure timely progress towards watershed goals.

Watershed Assessment and Conditions

3.1 Subwatershed Characteristics

Subwatershed divisions within the Little Powder River watershed were made based upon boundaries defined by the USGS. Each hydrologic unit, or drainage area, is identified by a unique HUC that ranges from 2-12 digits depending upon the level of division. CCCD used the 10 digit HUCs or 5th level subwatershed divisions, to characterize the Little Powder River Watershed. The Little Powder River Watershed Plan includes five subwatersheds: Horse Creek, Spring Creek, Olmstead Creek, Rawhide Creek, and Cottonwood Creek. Each subwatershed is described according to size, primary land ownership and land uses, and other characteristics (Table 3.1).

3.1.1 Horse Creek

The Horse Creek Subwatershed is the midwestern area of the watershed, and includes Squaw Creek, Buck Creek, Hay Creek, Horse Creek, Road Creek, Calf Creek, Wildcat Creek, Boxelder Creek, Number 1 Creek, Logan Creek, Coal Creek, Short Creek, and South Squaw Creek, encompassing approximately 844 square miles (208,293 acres). This subwatershed contains no water quality sample sites or USGS gauging stations. Land cover is dominated by shrubland and mixed grassland with small amounts of Ponderosa pine/Juniper, hayland and cultivated crops along the westernmost edge (Appendix B).

The Horse Creek Subwatershed is approximately 86.7% private land, with 6.5% State of Wyoming land, and 6.8% federal land under the Bureau of Land Management. The Horse Creek subwatershed is comprised of large rangeland parcels where livestock grazing is the primary land use, with large acreage parcels (greater than 100 acres) making up 98% of the land area and 39% of the total number of parcels. Small acreage parcels (41-100 acres) are estimated to make up 1% of the land area and 14% of the total number of parcels. Ranchette parcels (5-40 acres) are estimated to make up 1% of the land area and 19% of the total number of parcels. Residential parcels (<5 acres) constitute <1% of the land area and 28% of the total number of parcels.

There are two paved highways that transect the Horse Creek subwatershed; US Highway 14/16 runs through the western portion and Wyoming Highway 59 crosses the northeast portion. Collins Road (County Road #23) and Horse Creek Road (County Road #55) are major county roads which run through the subwatershed. There are also numerous smaller county roads, private roads, and oilfield roads throughout the subwatershed. The subwatershed has been subject to gravel mining, oil production, limited Coalbed Natural Gas (CBM) development, pipelines, and an increase in truck traffic on the dirt roads.

3.1.2 Spring Creek

The Spring Creek Subwatershed is the middle and eastern area of the watershed, and includes North Fork Elk Creek, Elk Creek, White Tail Creek, Antelope Creek, ZV Creek, Dry Fork Spring Creek, Horse Creek, Spring Creek, Deep Creek, South Fork Duck Creek, Duck Creek, and North Fork Duck Creek, encompassing approximately 789 square miles (194,808 acres). This subwatershed contains the LPR3 water quality sample site but no USGS gauging stations. Land cover is dominated by shrubland and mixed grassland with small amounts of Ponderosa pine/Juniper and hayland scattered throughout and cultivated crops along the southern edge (Appendix B).

The Spring Creek Subwatershed is approximately 64.6% private land, 6.4% State of Wyoming land, 7.7% federal land under the Bureau of Land Management, 6.3% federal land under National Grasslands, and 15.1% federal land under Bankhead Jones. The Horse Creek subwatershed is comprised of large rangeland parcels where livestock grazing is the primary land use, with large acreage parcels (greater than 100 acres) making up 98% of the land area and 58% of the total number of parcels. Small acreage parcels (41-100 acres) are estimated to make up 1% of the land area and 16% of the total number of parcels. Ranchette parcels (5-40 acres) are estimated to make up 1% of the land area and 20% of the total number of parcels. Residential parcels (<5 acres) constitute <1% of the land area and 7% of the total number of parcels.

Wyoming Highway 59 crosses through the middle of the Spring Creek subwatershed from north to south. Collins Road (County Road #23), Hart Road (County Road #47), Elk Creek Road (County Road #33), Rocky Point Road (County Road #85), and Heald Road (County Road #49) are major county roads which run through the subwatershed. There are also numerous smaller county roads, private roads, and oilfield roads throughout the subwatershed. The subwatershed has been subject to gravel mining, oil production, limited CBM development, pipelines, and an increase in truck traffic on the dirt roads.

3.1.3 Olmstead Creek

The Olmstead Creek Subwatershed is the northern portion of the watershed, and includes Trail Creek, Dry Trail Creek, Dry Creek, Eightyfive Creek, Bell Creek, Cookstove Prong Olmstead Creek, Olmstead Creek, South Fork Olmstead Creek, North Fork Olmstead Creek, and Spring Creek, encompassing approximately 1095 square miles (approximately 174,364 acres). This subwatershed contains the LPR2 water quality sample site as well as a USGS gauging station (#06324970) on the Wyoming/Montana border. Land cover is dominated by shrubland and mixed grassland with small amounts of Ponderosa pine/Juniper on the western and eastern edges, hayland is scattered throughout and cultivated crops occur along the northern edge (Appendix B).

The Olmstead Creek Subwatershed is approximately 77.7% private land, with 7.2% State of Wyoming land, and 15% federal land under the Bureau of Land Management. The Olmstead

Creek subwatershed is comprised of large rangeland parcels where livestock grazing is the primary land use, with large acreage parcels (greater than 100 acres) making up 98% of the land area and 57% of the total number of parcels. Small acreage parcels (41-100 acres) are estimated to make up 1% of the land area and 12% of the total number of parcels. Ranchette parcels (5-40 acres) are estimated to make up 1% of the land area and 25% of the total number of parcels. Residential parcels (<5 acres) constitute <1% of the land area and 6% of the total number of parcels.

Wyoming Highway 59 crosses through the middle of the Olmstead Creek subwatershed from north to south. Olmstead Road (County Road #80), Bowers Ute Road (County Road #15), Bay Horse Road (County Road #7), Hart Road (County Road #47), Trail Creek Road (County Road #98) and Parks Road (County Road #81) are major county roads which run through the subwatershed. There are also numerous smaller county roads, private roads, and oilfield roads throughout the subwatershed. The subwatershed has been subject to oil production, limited CBM development, pipelines, and an increase in truck traffic on the dirt roads.

3.1.4 Rawhide Creek

The Rawhide Creek Subwatershed is the southwestern portion of the watershed, and includes Bull Creek, Cow Creek, Provant Creek, Corral Creek, Dry Fork Little Powder River, Prairie Creek, Little Rawhide Creek, Lone Tree Prong, Nine T Bar Creek, Road Prong, Rawhide Creek, Lower Rawhide Creek, Draw No. 3, Draw No. 6, Red Fox Draw, Moyer Spring Creek, Garner Lake, and East Fork, encompassing approximately 733 square miles (180,952 acres). This subwatershed contains no water quality sample sites or USGS gauging stations. Land cover is dominated by shrubland and mixed grassland with small amounts of Ponderosa pine/Juniper in the eastern portion of the subwatershed. Hayland is scattered throughout and cultivated crops occur along the southern edge. There are also multiple active coal mines, presented as barren land, and developed lands in the central portion of the subwatershed (Appendix B).

The Rawhide Creek Subwatershed is approximately 80.5% private land, 7.0% State of Wyoming land, 11.6% federal land under the Bureau of Land Management, and 0.1% federal land under Bankhead Jones. The Rawhide Creek subwatershed is comprised of large rangeland parcels where livestock grazing is the primary land use, with large acreage parcels (greater than 100 acres) making up 93% of the land area and 5% of the total number of parcels. Small acreage parcels (41-100 acres) are estimated to make up 2% of the land area and 3% of the total number of parcels. Ranchette parcels (5-40 acres) are estimated to make up 4% of the land area and 16% of the total number of parcels. Residential parcels (<5 acres) constitute 1% of the land area and 76% of the total number of parcels.

There are two paved highways that transect the Rawhide Creek subwatershed; US Highway 14/16 runs through the western portion and Wyoming Highway 59 passes through the middle of the subwatershed. McKenzie Road (County Road #74), Echeta Road (County Road #29), Garner Lake Road (County Road #38), Collins Road (County Road #23), and Cow Creek Road

(County Road #26) are major county roads which run through the subwatershed. There are also numerous smaller county roads, private roads, and oilfield roads throughout the subwatershed. The subwatershed has been subject to coal mining, gravel mining, oil production, limited CBM development, pipelines, and an increase in truck traffic on the dirt roads. The Rawhide Creek subwatershed also contains the Campbell County Landfill and the Wyoming Integrated Test Center, a carbon capture research facility.

3.1.5 Cottonwood Creek

The Cottonwood Creek Subwatershed is the southeast portion of the watershed, and includes Lone Tree Creek, North Fork Hay Creek, North Twin Creek, South Twin Creek, Deer Creek, West Fork Cottonwood Creek, Little Mitchell Creek, Cottonwood Creek, and Hope Creek, encompassing approximately 489 square miles (120,763 acres). This subwatershed contains no water quality sample site or USGS gauging stations. Land cover is dominated by shrubland and mixed grassland with small amounts of Ponderosa pine/Juniper on the western and eastern edges, hayland is scattered throughout and cultivated crops occur in the central portion of the subwatershed (Appendix B).

The Cottonwood Creek Subwatershed is approximately 84.8% private land, with 6.7% State of Wyoming land, and 8.5% federal land under the Bureau of Land Management. The Olmstead Creek subwatershed is comprised of large rangeland parcels where livestock grazing is the primary land use, with large acreage parcels (greater than 100 acres) making up 97% of the land area and 36% of the total number of parcels. Small acreage parcels (41-100 acres) are estimated to make up 1% of the land area and 13% of the total number of parcels. Ranchette parcels (5-40 acres) are estimated to make up 2% of the land area and 40% of the total number of parcels. Residential parcels (<5 acres) constitute <1% of the land area and 11% of the total number of parcels.

There are no paved highways within the Cottonwood Creek subwatershed. Adon Road (County Road #1), Cow Creek Road (County Road #26), and Spring Creek Road (County Road #91) are major county roads which run through the subwatershed. There are also numerous smaller county roads, private roads, and oilfield roads throughout the subwatershed. The subwatershed has been subject to oil production, pipelines, and an increase in truck traffic on the dirt roads.

Table 3.1 Summary of Little Powder River Watershed Characteristics

	Horse Creek	Spring Creek	Olmstead Creek	Rawhide Creek	Cottonwood Creek
Size	208,293	194,808	174,364	180,952	120,763
Tributaries	Squaw Creek Buck Creek Hay Creek Horse Creek Road Creek Calf Creek Wildcat Creek Boxelder Creek Number 1 Creek Logan Creek Coal Creek Short Creek South Squaw Creek	North Fork Elk Creek Elk Creek White Tail Creek Antelope Creek ZV Creek Dry Fork Spring Creek Horse Creek Spring Creek Deep Creek South Fork Duck Creek Duck Creek North Fork Duck Creek	Trail Creek Dry Trail Creek Dry creek Eightyfive Creek Bell Creek Cookstove Prong Olmstead Creek Olmstead Creek South Fork Olmstead Creek North Fork Olmstead Creek Spring Creek	Bull Creek Cow Creek Provant Creek Corral Creek Dry Fork Little Powder River Prairie Creek Little Rawhide Creek Lone Tree Prong Nine T Bar Creek Road Prong Rawhide Creek Lower Rawhide Creek Draw No. 3 Draw No. 6 Red Fox Draw Moyer Spring Creek Garner Lake East Fork	Lone Tree Creek North Fork Hay Creek North Twin Creek South Twin Creek Deer Creek West Fork Cottonwood Creek Little Mitchell Creek Mitchel Creek Cottonwood Creek Hope Creek
Sample Sites		LPR3	LPR2		
Landownership	Private 86.7% State 6.5% BLM 6.8%	Private 64.6% State 6.4% BLM 7.7% N. Grasslands 6.3% Bankhead Jones 15.1%	Private 77.7% State 7.2% BLM 15%	Private 80.5% State 7.0% BLM 11.6% Bankhead Jones 0.1%	Private 84.8% State 6.7% BLM 8.5%
Land Uses	Dryland annual crop Residential Rangeland Dry Hay Forestry	Dryland annual crop Residential Rangeland Dry Hay Forestry	Dryland annual crop Residential Irrigated Hay Forestry	Residential Irrigated Hay Rangeland Dry Hay Forestry	Dryland annual crop Residential Rangeland Dry Hay
Land Cover	Shrub Grassland Cultivated Crops Ponderosa/ Juniper Hay land	Shrub Grassland Cultivated Crops Ponderosa/ Juniper Hay land	Shrub Grassland Cultivated Crops Ponderosa/ Juniper Hay land	Shrub Grassland Cultivated Crops Ponderosa/ Juniper Hay land	Shrub Grassland Cultivated Crops Hay land
Residential Parcels (<5 acres) #	90	13	11	1719	22
Ranchette	62	39	48	364	81

Parcels (5-40 acres) #					
Small Acreage (41-100 acres) #	45	30	22	75	26
Large Acreage (>100 acres)	127	111	109	102	73
Subdivisions	Green Valley			Pineview	
Transportation Corridors	Hwy 59 County Roads	Hwy 59 County Roads	Hwy 59 County Roads	Hwy 59 Hwy 14-16 County Roads Railroads	County Roads
Permitted Discharge Points	16	7	13	37	1
Other Activities	Gravel Pit Oil CBM limited activity Pipelines	Gravel Pit Oil CBM limited activity Pipelines	Oil CBM limited activity Pipelines	Coal Mines County Landfill Gravel Pit ITC Facility CBM limited activity Pipelines	Oil Pipelines

3.2 Water Quality Summary

A complete summary of results and statistics for monitoring locations within the Little Powder River Watershed are available in the Little Powder River *E. coli* Source Project Final Report (CCCD, 2016). Only data that has passed quality assurance and quality control review by WDEQ was utilized in this plan. Water quality data from the Little Powder River *E. coli* Source Project indicates that water quality in the Little Powder River watershed meets many of the water quality standards. *E. coli* bacteria concentrations that exceed the Wyoming water quality standards for primary contact recreation are the main concern within the Little Powder River watershed. Although numeric standards for sediment/turbidity have not been established, Little Powder River contains high levels of sediment (>25 NTU), which may contribute to *E. coli* bacteria concerns. Within portions of the watershed, water temperatures were recorded in excess of 20°C, generally in the warmer summer months. The Little Powder Watershed Restoration Plan will not directly address water temperature because of the many factors affecting water temperature (e.g. weather, water quantity, channel geometry, and turbidity). However, it is anticipated that activities to address bacteria and sediment concerns would also reduce water temperature.

CCCD collected 17 *E. coli* samples between June 2015 and August 2016 at each of the two monitoring sites on the Little Powder River, which resulted in three geometric means for each sample site. Exceedances of the WDEQ's primary recreational standard for *E. coli* (126 colony forming units (cfu)/100ml) occurred at both sample sites within the Little Powder River

watershed, during 2015 and 2016. The geometric mean for the downstream site, within the Olmstead Creek subwatershed, exceeded the primary contact recreation *E.coli* standard in the spring of 2015, while the geometric mean for the upstream site, within the Spring Creek subwatershed, exceeded the primary contact recreation *E.coli* standard in the spring and fall of 2015. Samples were taken into the month of October in 2015, but these samples were not used in calculating the geometric mean for the primary recreation season (May-September).

Individual sample results concluded that 17 of the 34 chemical parameter samples (50% of the samples) recorded an *E.coli* concentration greater than 126 cfu/100ml. *E. coli* results were also compared to the primary contact recreation season concentrations to WDEQ-WQD's "lightly used full body contact" single sample maximum concentration of 410 cfu/100 ml. Results concluded that 9 of the 34 chemical parameter samples (26.5% of the samples) surpassed the single sample maximum concentration of 410 cfu/100 ml. All of the samples that surpassed the single sample maximum concentration were collected during the spring and fall of 2015. The greatest *E. coli* concentration of 6130 cfu/100 ml was measured on July 2, 2015 at the upstream sample site within the Spring Creek subwatershed. Concentrations of *E. coli* fluctuated greatly during the 2015 and 2016 monitoring seasons. *E. coli* concentrations at the upstream sample site within the Spring Creek subwatershed were much higher during the 2015 monitoring season than the previous 2010-2013 monitoring project recorded. However, *E. coli* concentrations during the 2016 monitoring season were slightly lower than the 2010-2013 project (Figure 2).

Correlation between field parameters and *E. coli* concentrations were relatively minor, with discharge rate and turbidity demonstrating the strongest correlations. The strongest correlation between turbidity and *E. coli* occurred at the upstream sample site and suggests there may be an association between *E. coli* concentrations and turbidity at this site. Discharge rate and *E.coli* concentrations were also found to have a positive correlation at both sample sites during the 2015-2016 monitoring project. Concentrations of total dissolved solids (TDS) were slightly greater in 2015-2016 at the upstream sample site when compared to the previous 2010-2013 data. However, all other constituents were lower at both sites when compared to concentrations from the 2010-2013 monitoring data.

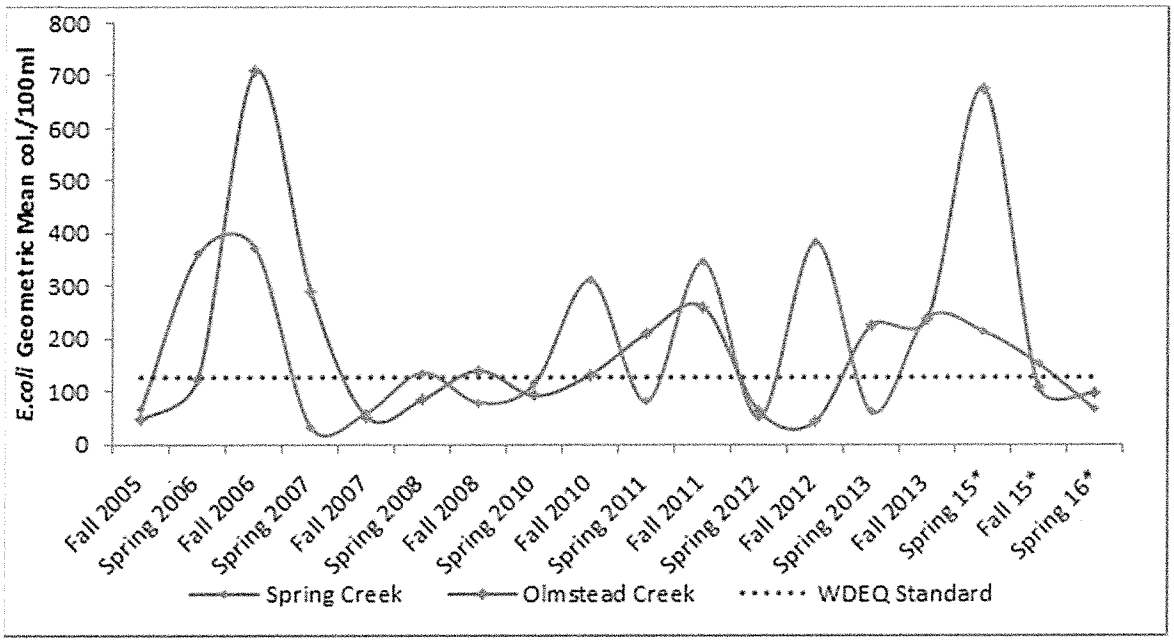


Figure 2. Historic *E. coli* geometric means from sample sites located within the Spring Creek and Olmstead Creek Subwatersheds of the Little Powder River with the WDEQ *E.coli* Standard for comparison.

Pollutant Loads and Source Identification

4.1 Estimated Load Reductions

Load reductions were estimated using the load duration curve method (Appendix C) as this is the most frequently used method in developing EPA Watershed Plans; the method also has the ability to quantify water quality parameters at various flow regimes. CCCD used information and examples from "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA 2007), the "DRAFT Handbook for Developing Watershed TMDLs" (USEPA, 2008), the "Handbook for Developing Watershed Plans to Restore and Protect Our Waters" (USEPA, 2008a), and other approved TMDLs and watershed plans. The primary limitation of using the load duration curve method within the Little Powder River Watershed is limited *E. coli* concentration data. The USEPA (2008) acknowledges that some TMDLs have been developed with limited amounts of data, in which case the recommendation is that TMDL development use the "best available data" (USEPA, 2008). *E. coli* load estimates and reduction estimates within the Little Powder Watershed Restoration Plan were developed with the data available from previous sampling and will be updated in the future as additional data are collected.

Load duration curves provide visual representation of the relationship between stream flow and *E. coli* load capacity at various flow conditions. These curves plot collected data against the water quality standard for various flow rates and aid in identifying flow conditions where exceedances of that water quality standard occur. The Little Powder Watershed Restoration Plan breaks flow conditions into three categories; moist condition flows (10-40% of flows exceeded), midrange flows (40-60% of flows exceeded) and dry condition flows (60-90% of flows exceeded). High flow (flood) and low flow (drought) conditions (<10% and >90% of flows exceeded) are excluded from load reduction estimates (USEPA, 2007). High and low flow conditions are considered the extreme situations and efforts to reduce bacteria loads would likely be ineffective.

The critical flow condition for an individual sample site is the flow condition which requires the greatest reduction in *E. coli*. Critical flow conditions correspond to different runoff and/or precipitation events and provide insight into potential pollutant sources (Table 4.1).

Table 4.1 Potential Load Sources Under Given Critical Flow Conditions.

Contributing Source Area	Duration Curve Zone		
	Moist Condition Flows	Mid-Range Flows	Dry Condition Flows
Point Source			M
On-site Wastewater (Septic) Systems		H	H
Riparian Areas	H	H	H
Upland Stormwater Runoff	H	M	
Bank Erosion	M		

Note: H: High Priority; M: Medium Priority. Adapted from "An Approach for Using Load Reduction Curves in the Development of TMDLs" (USEPA, 2007).

CCCD has collected water quality data for 13 years within the Little Powder River Watershed; these data can be used in developing load duration curves. While there are other samples that have been collected, they are not credible for inclusion in these curves. The data available allows for characterization and estimation of *E. coli* impairment relative to the water quality standard. Continued data collection within the Little Powder River Watershed will provide a stronger representation of this relationship and allow for adjustments to the reductions required to meet the water quality standard. Incorporating further *E. coli* data will enable CCCD and the LPRWSC to continually evaluate load reduction efforts to better address the observed patterns within the watershed.

Load duration curves were developed for each sample site within the Little Powder River Watershed. These curves show individual data points in relationship to the water quality standard at various flow conditions; the curves were used to determine critical flow conditions, critical areas, and show how daily *E. coli* loads correspond to various flow conditions. Within the Spring Creek subwatershed, the sample site was moved a short distance downstream in 2015 and *E. coli* loads and reduction requirements for both sites were averaged.

E. coli load reduction estimates required to achieve the Wyoming water quality standard for primary contact recreation of 126 cfu/100 mL were calculated for each sample site as well as

each subwatershed based on *E. coli* data collected between 2005 and 2016 (Table 4.2). For the purpose of this plan, instantaneous loads were converted to a daily load and compared to the daily load at the water quality standard (USEPA, 2007). The daily loads were completed using the following calculation:

$$\textit{GIGA E. coli}\ \text{cfu/day} = \frac{(\textit{E. coli}\ \text{cfu/100 ml} * \text{discharge ft}^3\text{/s} * 24{,}465{,}525\ \text{ml*s / ft}^3\ \text{*day})}{1{,}000{,}000{,}000}$$

For simplicity, CCCD used GIGA cfu/day to represent *E. coli* loads. For example, 126 GIGA is equivalent to 126,000,000,000 cfu/100ml. Daily load was calculated by multiplying the cfu/100 ml by the discharge (ft^3/s) and a conversion factor of 24,465,525 which corresponds to ml/day (USEPA, 2007). The primary contact standard for, the, five samples in 60-days, geometric means (126 cfu/100 ml) was used rather than the single sample maximum identified in Chapter 1, Wyoming Water Quality Standards (WDEQ, 2007). Single sample maximums may be used in advisory postings but not for the purpose of "listing a water body on the State 303(d) list or development of a TMDL or watershed plan" (WDEQ, 2007). Values presented in the load duration curves are averages of all instantaneous samples collected at each site and the flow conditions at the time of sample collection.

4.1.1 Spring Creek

Load reduction estimates were developed for the Spring Creek subwatershed for sample sites LPR1 and LPR3, which are located at the furthest upstream sampling location. Sample site LPR1 was abandoned in 2015 and was moved approximately 1.6 miles (stream miles) upstream, as a result of this change in sample location, the new sample site was named LPR3. The load reduction estimates are shown graphically as load duration curves in Figure 3 and Figure 4. The data is then summarized in Table 4.2 and includes observed loads by flow zones, daily load capacity, and reduction requirement to meet standard. Observed loads exceed the primary recreation standard in all three flow zones. As a result reductions are needed across all flow zones, except the very dry zone.

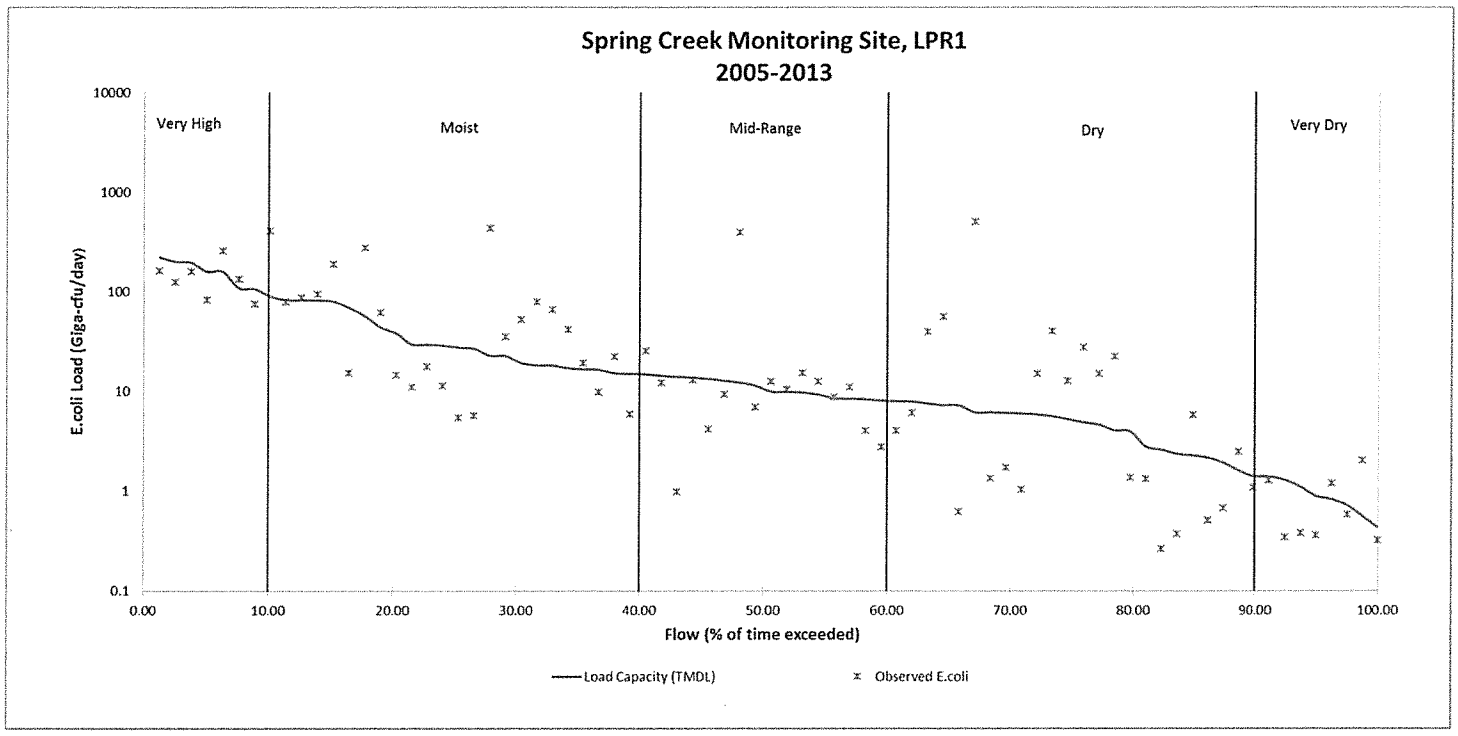


Figure 3. Load duration curve – LPR1

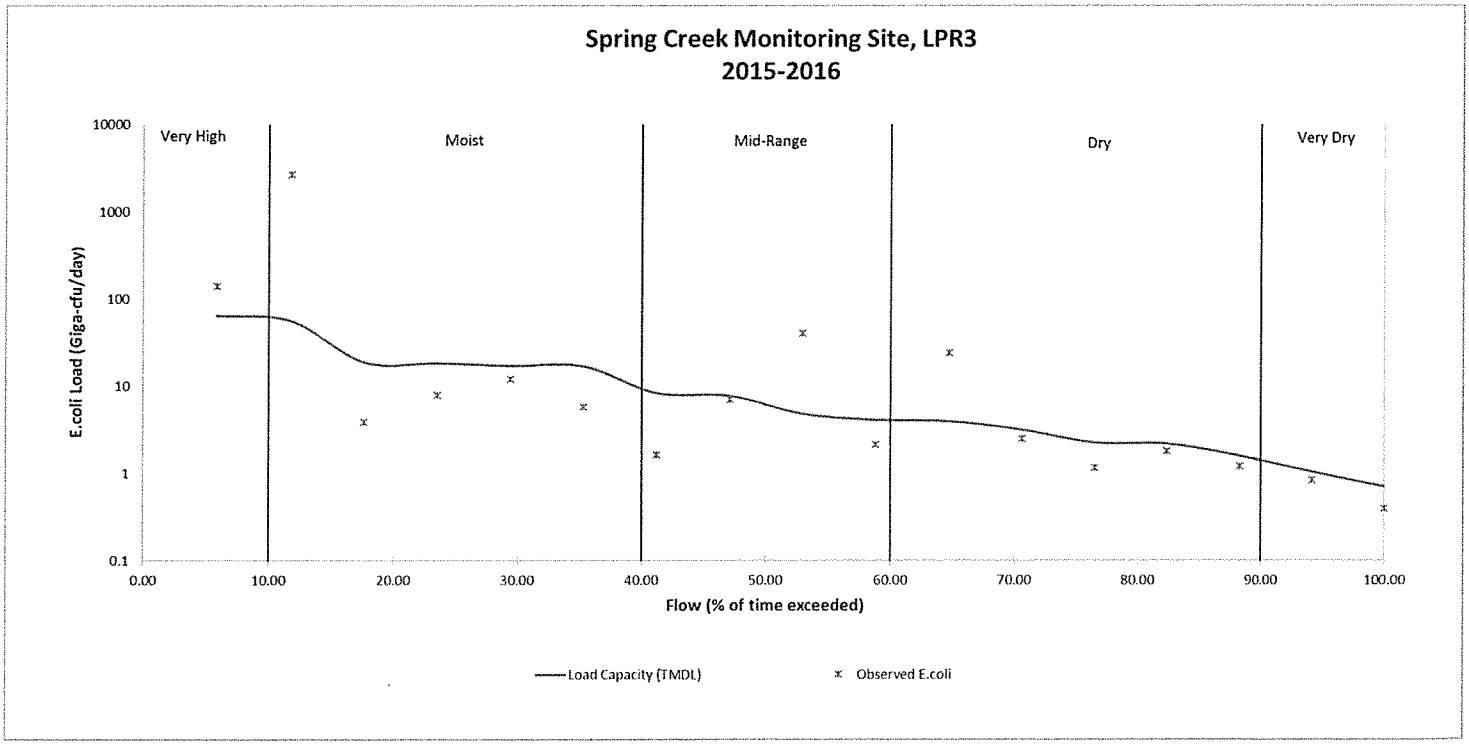


Figure 4. Load duration curve – LPR3

Table 4.2 Average daily load capacity, observed flows, and reductions for LPR1 and LPR3 (in Giga-cfu/day)

Flow Condition	Very High	Moist	Mid-Range	Dry	Very Dry
Duration Interval	0-10	10-40	40-60	60-90	90-100
E. coli load sampled (GIGA cfu/day)	**142**	**165**	**30**	**27**	**1**
E. coli daily load capacity	**152**	**37**	**10**	**4**	**1**
Reduction required	-7.4%	**77.5%**	**65.8%**	**84.0%**	-15.9%

*Bold conditions indicate the critical flow condition for the watershed.

[1] Values represent the average of two sample sites, one historical and one current sample site. The historic sample site was sampled from 2005-2013 and the current sample site was sampled from 2015-2016.

4.1.2 Olmstead Creek

Load reduction estimates were developed for the Olmstead Creek subwatershed at sample site LPR2, which is located at the furthest downstream sampling location. The load reduction estimates are shown graphically as load duration curves in Figure 5. The data is then summarized in Table 4.3 and includes observed loads by flow zones, daily load capacity, and reduction requirement to meet standard. Observed loads exceed the primary recreation standard in all three flow zones. As a result reductions are needed across the flow zones.

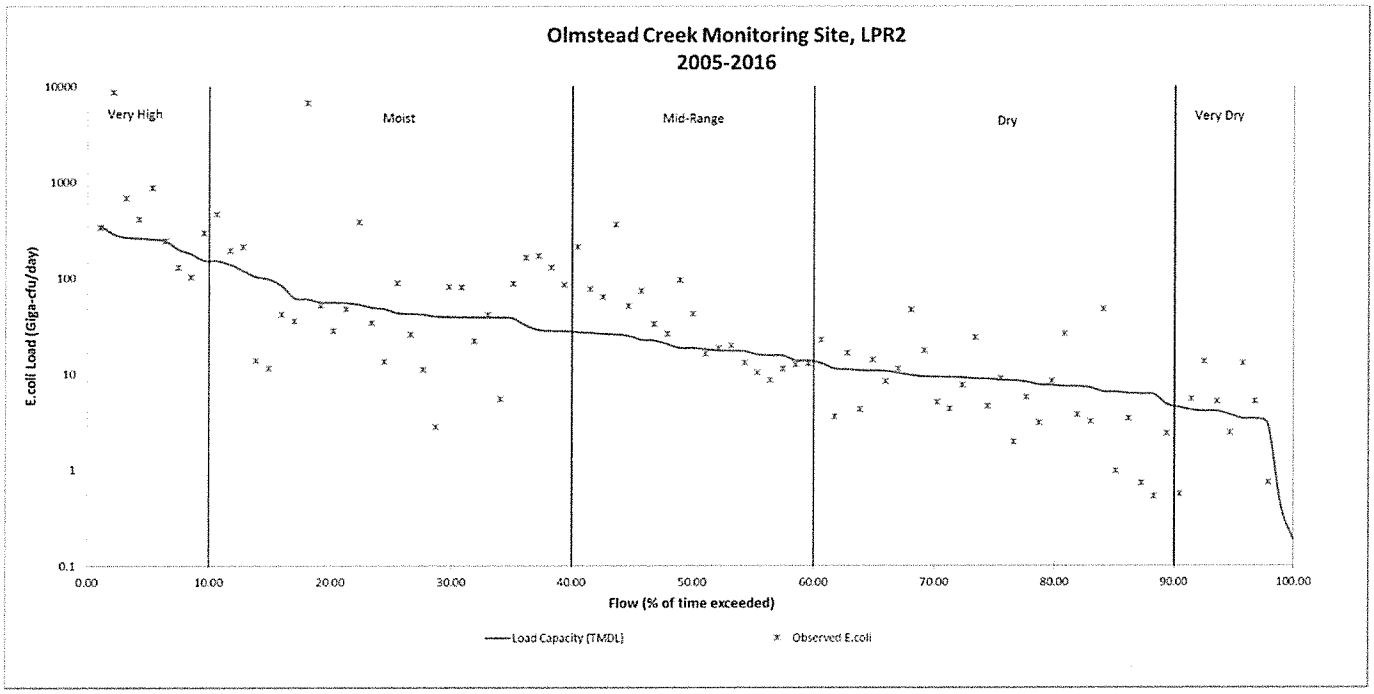


Figure 5. Load duration curve- LPR2

Table 4.3 Average daily load capacity, observed flows, and reductions for LPR2 (in Giga-cfu/day)

Flow Condition	Very High	Moist	Mid-Range	Dry	Very Dry
Duration Interval	0-10	10-40	40-60	60-90	90-100
E. coli load sampled (GIGA cfu/day)	**1307**	**329**	**61**	**11**	**5**
E. coli daily load capacity	**246**	**59**	**20**	**9**	**3**
Reduction required	**81.2%**	**82%**	**67.3%**	**21.3%**	**32.6%**

*Bold conditions indicate the critical flow condition for the watershed.

4.2 Impaired Segments and Critical Areas

E. coli and flow data from previous water quality sampling were used to develop load duration curves and identify Critical Flow Conditions for each sample site (USEPA, 2007). Identification of Critical Flow Conditions assisted in assessing potential sources of *E. coli* contamination within

the watershed and identifying possible mitigation efforts that may be implemented to reduce the potential for contamination.

Critical areas for *E. coli* bacteria load reduction were evaluated and established to identify areas within the watershed that would benefit most from mitigation efforts. These critical areas were determined by CCCD through considering water quality data, necessary load reductions, critical flow conditions, and land use within the watershed. *E. coli* bacteria concentrations were generally higher in the northern portion of the watershed, with bacteria concentrations increasing from the upstream sampling site to the downstream site. There are potential contributors to *E. coli* loads in the southern portion of the watershed as well.

4.3 Potential Pollutant Sources

Nonpoint source pollution problems are difficult to trace back to a single source or point of origin. Pollution from nonpoint sources, including bacteria, may enter waterbodies through surface water runoff. Due to the uncertainty of pollutant sources and variability in timing of runoff events, it is difficult to accurately quantify pollutant sources for a given area based on watershed characteristics and land uses. Results of calculations or other quantitative approaches to identify pollutant sources need to be reviewed and adjusted as necessary to reflect the qualitative assessment of the watershed residents. Evaluating all potential pollutant sources may provide information on their relative contributions and aid in directing funds and resources appropriately.

The LPRWSC identified septic systems, domestic animals and livestock from large and small acreages, ranchettes, and wildlife as the more direct bacteria contributors in the watershed. To estimate the relative contribution and priority for each pollutant source, CCCD gathered information from NRCS, Wyoming State Engineer's Office, Wyoming Agriculture Statistics, Wyoming Game and Fish Department, and local knowledge of the watershed from landowners, residents, and others. The estimated values for pollutant sources are based on the best available data. While microbial source tracking studies were conducted beginning in 2015 they were not comprehensive in nature and only examined human and general bacteroides. No other studies have been conducted to determine the actual contribution of each pollutant source to bacteria loads within the Little Powder River Watershed.

Small Wastewater Systems

Small wastewater systems (septic systems) have the potential to contribute *E. coli* bacteria and other pollutants to the streams within the Little Powder River Watershed. Systems with the potential for contributing to bacteria loads are those that discharge directly into the Little Powder River or its tributaries, those that are improperly maintained, improperly installed due

to insufficient size or treatment capacity (leachfield too small, system overloads, insufficient treatment media), inadequate or outdated design (systems lacking leachfields, septic system too small for current demand), poorly or improperly installed (leachfield not on grade, leachfield above tank elevation, system installed in flood prone area), or systems installed where interactions with seasonal groundwater or subterranean flows may occur.

To examine potential human influences in the watershed the CCCD conducted a study in 2015-2016 that utilized new technologies in source identification. With the use of quantitative polymeric chain reaction (qPCR) CCCD was able to examine individual water samples for the presence of human associated bacteroides. CCCD collected a total of 32 microbial source tracking (MST) field samples from June 2015 - July 2016. Each sample was analyzed for 4 different indicators of fecal contamination: General Bacteroidetes (GenBac) and Human Bacteroidetes (HEPA1, HEPA2, and HF183). General Bacteroides provides a count of the total bacteroides from all host detected in the sample. This aids in determining if the specific host is a major or minor contributor. The study resulted in none of the MST samples collected in detecting a human associated Bacteroidetes concentration above the detection limit; however, General Bacteroides were detected in 100% of the qualified samples. Due to the fact that no Human Bacteroidetes were detected in any of the MST field samples, this study suggests that there is not a human associated fecal contamination issue in the Little Powder River Watershed, at this time. The high percentage of MST field samples that detected measurable levels of General Bacteroides would suggest that wildlife, domestic animals, or some combination of warm blooded animal are contributing to the elevated level of General Bacteroidetes (CCCD, 2016). Although this study provided valuable information to aid in prioritizing potential sources and future projects it is not intended to be definitive, as small wastewater facilities can fall into disrepair or fail and cause water quality concerns in the future.

In order to analyze all potential future sources CCCD estimated potential load contributions from small wastewater systems determining the number and location of domestic wells and assumed that each domestic well serviced a residence that was also connected to a small wastewater system. Small wastewater systems within 500 feet of the Little Powder River or its tributaries were considered potential contributors (Table 4.4). The 500-foot distance is based on the WDEQ requirement for systems to be considered eligible for funding assistance. Small wastewater systems greater than 500 feet from surface waters are considered to be less of a contributor "due to infiltration, UV radiation exposure, and residence time in an inhospitable environment (WDEQ, 2015)." Potential contribution from small wastewater systems was calculated by multiplying the number of systems within the 500 foot buffer by 6.6 GIGA cfu/day.

Table 4.4 Potential *E.coli* contributions from small wastewater systems in the Little Powder River Watershed

Subwatershed	Area (acres)	Total Systems	System Density (#/acre)	Systems within 500' (%)	Systems within 500' (#)	Potential Contribution (GIGA cfu/day[1])
Horse Creek	208,293	109	0.0005	17%	18	119
Spring Creek	194,808	34	0.0002	65%	22	145
Olmstead Creek	174,364	39	0.0002	38%	15	99
Rawhide Creek	180,952	285	0.0016	13%	37	244
Cottonwood Creek	120,763	89	0.0007	22%	20	132

[1] The potential contribution from the septic systems is based on 2.5 persons per household at 265 liters/day (Horsley and Witten 1996 in Indian Department of Environmental Management 2004).

Within the Little Powder River Watershed, the density of small wastewater systems with 500 feet of the Little Powder River or its tributaries is greatest in the northern (downstream) portion of the watershed. This area has many large acreage parcels where most dwellings are built near waterways. Campbell County has been delegated authority for small residential waste water systems permitting since the mid 1970's. Additional information on the process can be obtained by contacting the Campbell County Planning and Zoning Division.

Greywater systems may also contribute to *E. coli* bacteria and other pollutant contributions to surface waters. These systems are used to treat household water (i.e. sinks, showers, and laundry) separately from the primary small wastewater system. Water that has passed through these systems may be used to irrigate pastures, but is not to be used for irrigating recreational turf or food crops. Currently there are no greywater systems permitted within the Little Powder River Watershed. Future development of greywater systems must be permitted through the Campbell County Planning and Zoning Division and comply with WDEQ-WQD Chapter 25, Section 17 Rules and Regulations.

Domestic Animals and Livestock

Animal waste from domestic animals, including livestock and pets, has the potential to contribute *E. coli* bacteria through direct discharge to surface water or through runoff from uplands and confinement facilities. Prolonged use by livestock on areas adjacent to streams, especially those without vegetative buffers, stock water gaps, corrals and containment areas with inadequate runoff mitigation, winter feed areas, and upland areas with significant runoff may all be sources or contributors of *E. coli* within the watershed. Accumulation of pet waste near surface water, due to high use or close proximity of homes to surface water, or on upland areas with significant runoff may also contribute *E. coli* to the surface water within the watershed.

E.coli contributions from domestic animals within the Little Powder River Watershed are difficult, and in many cases impossible, to quantify as accurate information on the number of any species of livestock and domestic pets specific to the watershed are not available. Residents within the watershed may have cattle, horses, sheep, llamas, goats, hogs/pigs, chickens, dogs, cats, and others domestic animals. The number of livestock and domestic animals owned by each resident within the watershed varies greatly. For the purposes of this plan, CCCD used the 2012 Wyoming Agriculture Statistics to estimate a per acre density for only beef cattle (0.026/acre), sheep (0.009/acre), and horses (0.001/acre). There are no documented numbers for other types of livestock or domestic animals. Estimates of livestock density within the watershed were used to calculate the potential loads from those sources using documented loading rates for cattle, sheep, and horses (Table 4.5). Because the loading rates were for fecal coliform instead of *E. coli*, CCCD used 63% of the referenced rate (126 cfu/day E. coli is 63% of 200 cfu/day of fecal coliform). *E. coli* is a subset of fecal coliform and site-specific correlation among the two parameters can be made; an *E. coli* value of 126 cfu/day and a fecal coliform value of 200 cfu/day are expected to result in approximately 8 illnesses/1000 swimmers at freshwater beaches (USEPA, 1986).

CCCD used the areas for different sized parcels in each subwatershed, defined as follows:

- Large Acreages are parcels of land greater than 100 acres;
- Small Acreages are parcels of land between 40 and 100 acres;
- Ranchettes are parcels between 5 and 40 acres; and
- Residential parcels are smaller than 5 acres.

Table 4.5 Potential *E.coli* contributions from domestic animals, excluding pets, in the Little Powder River Watershed.

Subwatershed	Acres	Beef Cattle Concentration (.026/acre)		Sheep Concentration (.009/acre)		Horse Concentration (.001/acre)	
		Estimated Number[1]	Potential Contribution 69.3 GIGA *E.coli* cfu/day[2]	Estimated Number[1]	Potential Contribution 7 GIGA *E.coli* cfu/day[3]	Estimated Number[1]	Potential Contribution .3 GIGA *E.coli* cfu/day[4]
Large Acreage Parcels (>100 acres)							
Cottonwood	107,171	2784	192919	964	6750	159	48
Spring	190,883	4958	343609	1718	12023	283	85
Olmstead	169,560	4404	305226	1526	10680	252	76
Horse	203,980	5298	367185	1835	12847	303	91
Rawhide	168,409	4375	303154	1515	10607	250	75
Small Acreage Parcels (40- 100 acres)							
Cottonwood	1858	48	3345	17	117	3	1
Spring	1780	46	3204	16	112	3	1
Olmstead	1427	37	2569	13	90	2	1
Horse	2848	74	5127	26	179	4	1
Rawhide	4134	107	7442	37	260	6	2
Ranchette Acreage Parcels (5-40 acres)							
Cottonwood	1759	46	3166	16	111	3	0.8
Spring	1221	32	2198	11	77	2	0.5
Olmstead	1253	33	2256	11	79	2	0.6
Horse	1341	35	2414	12	84	2	0.6
Rawhide	6500	169	11701	58	409	10	2.9

[1]Animals per acre estimated from information in the 2012 Wyoming Agricultural Statistics (USDA NASS, 2012)

[2]The potential *E. coli* contribution from beef cattle is based on 63% of 110 fecal coliform GIGA cfu/day per cow (ASAE 1998 in USEPA, 2001).

[3]The potential *E. coli* contribution from sheep is based on 63% of 12 fecal coliform GIGA cfu/day per sheep (ASAE 1998 in USEPA, 2001).

[4]The potential *E. coli* contribution from horses is based on 63% of 0.42 fecal coliform GIGA cfu/day per horse (ASAE 1998 in USEPA, 2001).

Acreage by parcel size was estimated by applying the percentage of different sized parcels within each subwatershed to the total acres in the subwatershed. Parcels less than five acres were considered rural residential and it is assumed that these acreages do not contain livestock, though this may not always be the case. These smaller parcels do not provide sufficient space to support livestock use without careful management and often have less vegetative cover and more bare ground than larger parcels. When compared to landowners of larger parcels, a larger proportion of small acreage landowners may be less knowledgeable and/or less dependent on basic natural resource processes. Small acreages tend to have higher concentrations of animals than large acreages. The size and type of BMPs will vary depending on the size of parcel.

Due to the variability and unreliability of the livestock estimates, CCCD converted numbers of individual animals to animal units (Table 4.6). Animal units from cattle, sheep, and horses are used to represent all domestic animals, excluding pets, within the watershed. The animal units presented are based on the combined individual numbers for cattle, horses, and sheep where a cow/calf pair is equivalent to 1.0 AU, a horse is equivalent to 1.25 AU, and a sheep is equivalent to 0.2 AU (NRCS, 1997). Reporting animal units in allows CCCD and the LPRWSC to recommend watershed improvements to address other domestic livestock including llamas, swine, goats, etc.

Table 4.6 Conversion from number of Cattle, Sheep, and Horses to animal units within the Little Powder River Watershed.

Subwatershed	Acres	Beef Cattle		Sheep		Horses		Total Animal Units
		Estimated Numbers	Animal Units (@ 1.0 for 7 months)	Estimated Numbers	Animal Units (@ 0.15 for 9 months)	Estimated Numbers	Animal Units (@ 1.8 for 6-9 months)	
Large Acreage Parcels (>100 acres)[1]								
Cottonwood	107171	2784	19488	964	1301.40	159	2003.40	22792.80
Spring	190883	4958	34706	1718	2319.30	283	3565.80	40591.10
Olmstead	169560	4404	30828	1526	2060.10	252	3175.20	36063.30
Horse	203980	5298	37086	1835	2477.25	303	3817.80	43381.05
Rawhide	168409	4375	30625	1515	2045.25	250	3150.00	35820.25
Small Acreage Parcels (40-100 acres)[2]								
Cottonwood	1858	48	336	17	22.95	3	48.60	407.55
Spring	1780	46	322	16	21.60	3	48.60	392.20
Olmstead	1427	37	259	13	17.55	2	32.40	308.95
Horse	2848	74	518	26	35.10	4	64.80	617.90
Rawhide	4134	107	749	37	49.95	6	97.20	896.15
Ranchette (5-39 acres)[3]								
Cottonwood	1759	46	322	16	21.60	3	32.40	376.00
Spring	1221	32	224	11	14.85	2	21.60	260.45
Olmstead	1253	33	231	11	14.85	2	21.60	267.45
Horse	1341	35	245	12	16.20	2	21.60	282.80
Rawhide	6500	169	1183	58	78.30	10	108.00	1369.30

(Holechek, Pieper, and Herbel 1998); Carrying Capacity based on local NRCS field office averages.

[1]. Horses on large acreage parcels will be carried for 7 months.

[2]. Horses on small acreage parcels will be carried for 9 months.

[3]. Horses on ranchettes will be carried for carried for 6 months.

Wildlife

There is a variety of small and large mammals and birds, including waterfowl, whose habitat is within the Little Powder River Watershed (Table 4.7). Wildlife species are potential contributors of *E. coli* bacteria as they are warm blooded animals. Riparian areas often provide the best habitat (i.e. food and shelter) for wildlife; therefore the majority of wildlife is concentrated in relatively close proximity to streams. CCCD attempted to estimate contributions from wildlife, but encountered several difficulties. Some population estimates for wildlife numbers are available through Wyoming Game and Fish, but these estimates are not confined to the watershed boundary. The available information is presented on a statewide or hunt area/herd unit basis. Species included in these estimates covering the Little Powder River Watershed include pronghorn antelope and mule deer as these are the most likely wildlife species to contribute to the bacteria load within the watershed. There are active sage grouse leks and sage grouse core habitat within the Little Powder River Watershed as identified by the Northeast Wyoming Sage Grouse Local Working Group. Core area habitat and leks occur throughout the watershed; however counts of sage grouse numbers are not available for the watershed (The Northeast Wyoming Sage-grouse Working Group, 2014). In addition to larger wildlife species, the watershed is home to a variety of small mammals and other wildlife for which there are no population estimates. Birds and waterfowl are potential contributors to *E. coli* bacteria; however the data available containing bird counts do not accurately reflect the number of birds present within the Little Powder River Watershed. CCCD and the LPRWSC recognize that wildlife and bird species are potential contributors, but cannot accurately determine potential *E. coli* load contributions from these sources.

Table 4.7 Wildlife species present in the Little Powder River Watershed

Big Game/ Large Mammal	Birds	Small Mammal
Pronghorn	Mallards Ducks	Skunk
Mule Deer	Canada Geese	Raccoon
White-tailed Deer	Pheasant	Beaver
Elk	Sage-Grouse	Muskrat
Black Bear, non-resident	Sharp-tailed Grouse	Rabbits
Mountain Lion	Heron	Prairie Dog, ground squirrels and gophers
Wolves, non-resident	Hawks	Badgers
	Owls	Coyote
	Eagles and other raptors	Fox
	Migrant and Resident Birds	Bobcat
	Water Fowl	Porcupine
	Hungarian Partridge	Mink, Weasels
	Turkey Vulture	Mice, Shrews

Wildlife species have the potential to contribute to bacteria concentrations in the Little Powder River Watershed, however there is little that can be done to impact wildlife populations and their behavior. Projects aimed to increase vegetation cover, water filtration, off-stream water development, and decreasing runoff will likely reduce wildlife impacts on water quality.

Small Acreages

Bacteria contributions from septic systems, domestic animals, and runoff return flows can come from parcels of any size, see table 4.3. However, small acreages may increase contributions, especially in areas where there is a high density of small acreage parcels. In some cases the

owners of these small acreage parcels have full-time jobs and may have limited experience with agricultural practices and management of natural resources. A common problem associated with small acreages is that there is often not enough room for proper grazing management or to provide adequate forage for even a few animals. Improper grazing management on small acreages often results in increased bare ground that contributes to potential runoff concerns. Although small acreages will not be considered a separate category for funding and programs, CCCD and the LPRWSC recognize the need for education and outreach opportunities for small acreage landowners to inform them of the potential issues and BMPs and assistance with implementation of BMPs.

Sediment

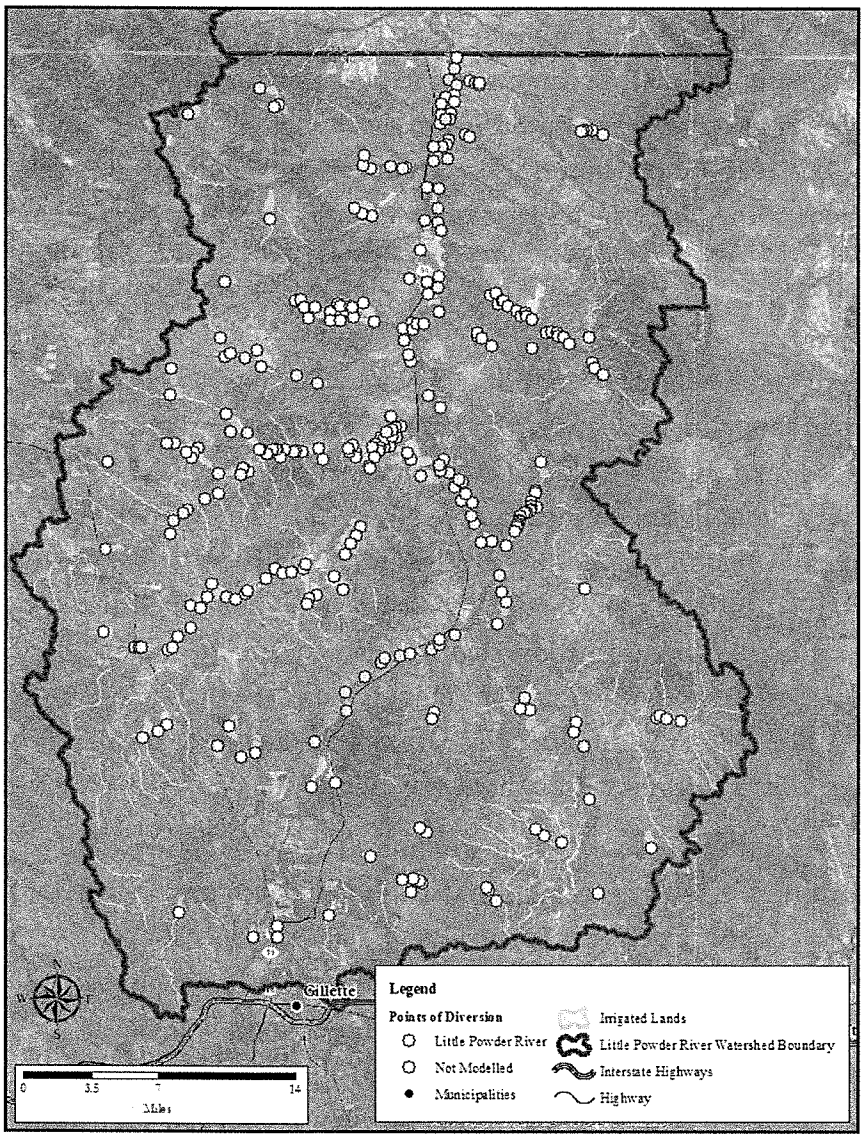
The relationship between sediment and bacteria concentrations is not well understood, but there are indications that increased sediment in streams may be associated with greater bacterial loads. Sediment and suspended solids are able to trap heat, increase water temperatures, and decrease solar radiation through the water column. This can improve the conditions for bacteria reproduction within the water as bacteria reproduce better under warm conditions with low light (Oram, 2014). Studies have shown that bacteria are able to persist longer in streambed sediments, including one study from rangeland streams in Idaho that showed *E. coli* concentrations were 2-270 times greater in streambed sediment than in the water (Stephenson and Rychert, 1982). The CCCD and LPRWSC consider sediment to be a contributing factor to the elevated bacteria levels within the watershed.

Erosion of streambanks is likely the most direct source of in-stream sediment within the Little Powder River Watershed. Streambank erosion can result from a variety of conditions including: unstable streambanks and natural changes to stream course, lacking riparian vegetation, overutilization by livestock, and manipulation or disturbance of stream channels. Streambed sediment is another source of sediment through re-suspension of the sediment, and may occur from natural or human caused activities. Excessive runoff from rain or snowmelt, discharge from point sources, streambed disturbance, and natural changes to channel shape or alignment may lead to increased streambed sediment being suspended in the water, see table 3.1 and Appendix E.

The Little Powder River Watershed contains roads (paved and unpaved), railroads, housing developments, limited areas of dry cropland, coal mining, oil and gas development, pipelines, and the county landfill, all of which have the potential to be a sediment source during periods of excessive runoff.

Irrigation

Map 4.1 Irrigated Lands and Points of Diversion- Little Powder River Watershed



(Wyoming State Engineers Office 2007)

According to Wyoming Water Development, irrigated lands make up less than 2% of the Little Powder River Watershed (Map 4.1). However some in-stream structures from prior irrigation activities do exist that may impact flow. The active irrigation systems, when in use, may reduce stream flow and have the potential to increase sediment through excess runoff as a result of improper irrigation management. Irrigation systems also have the potential to transport bacteria and other pollutants to surface water through runoff, especially in areas where animal waste is present. Retired irrigation systems, although no longer in use, may still impact water quality and stream flow if in-stream structures still exist. In total the Wyoming State Engineers Office, estimates that there are 22 diversions present on the Little Powder River and an additional 306 diversions on other streams within the watershed (Map 4.1). It is not known how many of these diversions are still in use, however the potential for sediment contributions from erosion of these in-stream structures may cause impacts to water quality (Wyoming State Engineers Office 2007). Also, these structures may have been built in a way that alters the natural stream channel or diverts water from the stream. Proper irrigation management and removal of retired

irrigation infrastructure may result in improvements to water quality and overall stream function.

4.4 Prioritization of Pollutant Sources

The purpose of quantifying and identifying potential pollutant sources in a TMDL or watershed restoration plan is to ensure that financial and technical resources are being allocated in the most effective manner. While prioritizing management efforts may be difficult for a non-point source pollutant, such as *E. coli*, there is value to giving priority to various sources within each subwatershed given all available information and good judgment. For example, in watersheds where the most likely source may be related to small wastewater systems, it's not practical to direct all available resources to addressing livestock management. However, if there is an obvious, contribution from livestock or a septic system, both should be addressed regardless of the source prioritization.

To estimate the potential contribution of *E. coli* sources within the Little Powder River Watershed, CCCD and the LPRWSC used a variety of quantitative and qualitative information to characterize and prioritize the potential sources in each subwatershed, including:

- the potential load calculations for septic systems and domestic animals (cattle, horse, and sheep);
- the number and size of parcels within each subwatershed;
- critical flow conditions and measured bacteria loads; and
- other information including land cover, soil types, grazing patterns, and precipitation.

Within each subwatershed, source categories were assigned a high, medium, or low priority based on the potential contribution of that source to the overall pollutant load (Table 4.8). This process is similar to the method used for development of TMDLs for Total Dissolved Solids in Utah (UDEQ, 2007). Additionally, a numeric priority ranking was assigned to the top seven priorities within the entire watershed. Individual projects will be considered based on their potential to benefit water quality, regardless of their prioritization. Thus, a well-developed project with greater potential for improving water quality in a medium or low priority area or category may be done prior to a marginal or poor project in a high priority area.

Table 4.8 Summary Table of Pollutant Sources and Priority Ranking

Subwatershed	Critical Condition[1]	Pollutant Source	Priority
Olmstead Creek			
	Moist	Large Acre Livestock	High-2
		Small Acre Livestock	Low
		Septic Systems	Low
		Stormwater Runoff	High
		Sediment- Streambank	High-5
		Wildlife	Medium
Spring Creek			
	Dry	Large Acre Livestock	High-3
		Small Acre Livestock	Low
		Septic Systems	Low
		Stormwater Runoff	Medium
		Wildlife	Medium
Horse Creek			
		Large Acre Livestock	High- 1
		Small Acre Livestock	Low
		Septic Systems	Low
		Stormwater Runoff	High
		Wildlife	Medium
Rawhide Creek			
		Large Acre Livestock	Low
		Small Acre Livestock	Medium
		Ranchette Livestock	Medium
		Septic Systems	High-4
		Stormwater Runoff	High

		Domestic Animals	Medium
		Wildlife	Medium
Cottonwood Creek			
		Large Acre Livestock	Low
		Small Acre Livestock	High-6
		Ranchette Livestock	High-7
		Septic Systems	Medium
		Stormwater Runoff	High
		Wildlife	Medium

[1]Critical Condition is not available for the Horse Creek, Rawhide Creek, and Cottonwood Creek subwatersheds due to a lack of sample sites within these watersheds.

Potential sources of *E. coli* in the Little Powder River Watershed are primarily from natural background and nonpoint sources; implementation of this watershed plan and BMPs is voluntary for participating partners. While the opportunity for financial and technical assistance is available, there will likely be instances where improvements will be made by individuals on their own. CCCD, NRCS, and the LPRWSC will continue to provide information on potential BMPs to address pollution sources (Table 4.9).

Table 4.9 Potential Best Management Practices (BMPs) to address pollutant sources.

Potential Contributor	Issue	Potential BMPs[1, 2]
Small Wastewater Systems	No tank/leachfield; discharge to stream	Permit and install system
	System located too close to stream	Replace system
	System located within groundwater table	Replace system
	System not functioning	Maintain or replace system
	System not maintained	Provide information/education Maintain system
Domestic Animals, Livestock and Wildlife	Corrals/feed grounds located on stream	**Relocate or buffer facilities** **Provide off-channel water**
	Run-off from corrals and/or feed grounds discharges to stream	Divert run-off to filtration area Retain run-off (ponds) Maintain vegetative buffer
	Poor grazing distribution	Develop grazing management plans (i.e. deferred or rotational grazing, etc.) Riparian buffers Provide offstream water development/stockwater development/fencing Provide fabricated windbreaks Develop stream crossings Provide information/education
In-Stream Structures	Erosion/cutting around structures	Replace or remove structures Bank stabilization
Bank/Channel Erosion	Unstable channel dimensions	Structural enhancements Bank shaping/revegetation
	Increased suspended solids	Settling areas to reduce sediment
Run-off	Rural and residential stormwater run-off	Maintain vegetative buffers Divert run-off to filtration areas Provide information/education

[1]The above list of BMPs is not intended to be comprehensive of all BMPs that may be used to implement this watershed plan. BMPs and conservation practices that are listed in WDEQ NPS Program BMP manuals or United States Department of Agriculture (USDA) technical guides, manuals, or handbooks will be considered. BMPs will be evaluated on a case-by-case basis based on impact to water quality, landowner needs, and other factors.

[2] The BMP's bolded above are the priority practices for implementation. These BMP's primarily focus on grazing and livestock management issues, however all other BMP's will be considered based on their potential to improve water quality. Livestock and grazing management BMP's will be evaluated based upon the scale of the project, potential changes to livestock and grazing management, and proximity to either an ephemeral or intermittent stream.

Watershed Improvement Actions and Recommendations

5.1 NPS Management Measures/Action Items

This section outlines several factors that have been organized into broad categories that may directly or indirectly impact the overall health of the Little Powder River Watershed. For each of the areas identified, the LPRWSC has developed specific objectives and action items to help achieve those objectives. The action items identified include providing a voluntary incentive-based program for implementing BMPs to improve water quality and information and education activities to raise awareness of the issues and opportunities for involvement. For each action item, the LPRWSC has identified the responsible entities, funding needed, and possible funding sources needed to complete the actions.

Quantifying water quality improvements following implementation of individual BMPs or educational activities may not be achieved in the short term. Bacteria concentrations that are negatively impacting water quality likely come from a variety of sources including humans, domestic animals and livestock, and wildlife, making it important to address the impairment from as many sources as possible. By providing a voluntary incentive-based program to encourage participation from landowners and residents, there is greater potential to get projects and practices completed to address water quality. In addition to project implementation, the education opportunities that result from successful implementation of BMPs may provide additional benefits in the long term than can be demonstrated by short term monitoring.

In order to achieve the WDEQ primary contact recreation standard, bacteria levels within the Little Powder River would need to be reduced by over 70% (Table 4.2 and Table 4.3). This level of reduction is not achievable within a five year period; therefore a realistic reduction target of 5% every five years was determined by the LPRWSC (Table 5.2). This will require incremental improvements within the watershed annually (Table 5.1). The CCCD and LPRWSC will meet annually to evaluate progress and action items. This will allow the LPRWSC to assess whether they are attaining their 5% reduction goals or if adjustments should be made. The LPRWSC acknowledges that due to the nature of non-point source pollution a 5% reduction may not be realized every five year or may be exceeded in other years, thus the overall goals of a 70% reduction will be the long term focus.

The LPRWSC recognizes the limitations in the reduction estimates presented within this plan. To gain more insight into the long-term trend in water quality, CCCD will continue to monitor water quality to better understand the dynamics of the watershed, especially for bacteria, across different flow and climatic conditions. The LPRWSC will continue to adjust bacteria load and load reduction estimates as additional data becomes available.

Table 5.1 Little Powder River Watershed Plan Implementation Timeline

Year	Targeted percent reduction	Interim monitoring/evaluation (Years)	Begin Watershed Plan Update (Year)
2024	*5%*	2020-2023	2023
2029	*10%*	2026-2029	2028
2034	*15%*	2031-2034	2033
2039	*20%*	2036-2039	2038
2044	*25%*	2041-2044	2043
2049	*30%*	2046-2049	2048
2054	*35%*	2051-2054	2053
2059	*40%*	2056-2059	2058
2064	*45%*	2061-2064	2063
2069	*50%*	2066-2069	2068
2074	*55%*	2071-2074	2073
2079	*60%*	2076-2079	2078
2084	*65%*	2081-2084	2083
2089	*70%*	2086-2089	2088

Table 5.2 Estimated contribution reductions needed to meet 5% *E. coli* load reduction

Subwatershed	Spring Creek	Olmstead Creek	Horse Creek	Rawhide Creek	Cottonwood Creek
Critical Condition	Dry	Moist	NA	NA	NA
Reduction required to meet standards at critical condition	75%	75%	NA	NA	NA
Phase I targeted reduction	5%	5%	5%	5%	5%
Direct contributions					
Small wastewater systems to be addressed (5%)[1]	1	1	1	2	1
Large Acre animal units to be addressed (5%)[2]	2029	1803	2169	1791	1139
Small Acre animal units to be addressed (5%)[2]	19	15	31	45	20
Rural Ranchette animal units to be addressed (5%)[2]	13	13	14	68	19
Indirect contributions					
In-Stream Structures	TBD	TBD	TBD	TBD	TBD
Bank erosion and channel instability	TBD	TBD	TBD	TBD	TBD
Riparian corridors	TBD	TBD	TBD	TBD	TBD

[1] Number of small wastewater systems and animal units to be addressed are derived from Tables 4.3 and 4.5.

[2]Animal units to be addressed for each parcel size refer to the number of animal units to mitigate, not the number of acres or number of parcels where load reductions need to occur.

5.1.1 Watershed Plan Implementation

The LPRWSC and CCCD intend to implement the action items outlined within this plan to achieve the corresponding objectives. To fully implement this watershed plan, technical assistance and resources may be required from outside agencies, including USDA-NRCS, Campbell County government, University of Wyoming Cooperative Extension, and the private sector. Establishing and maintaining partnerships with these outside entities will aid in providing technical assistance and/or engineering services for implementation of BMPs and conservation planning.

As implementation of the watershed plan proceeds, some action items may not be necessary or may not be able to be implemented as planned. There may also be other items that have not yet been considered within this plan and may need to be addressed in the future. In addition to potential changes in implementation of the plan, there may be a need for CCCD to update pollutant load information and reduction estimates as more data becomes available. This plan will remain dynamic and adjustments will be made as needed, with input from the LPRWSC, to address changing needs within the watershed.

OBJECTIVE: Implement strategic BMPs through a voluntary/incentive-based program(s) to decrease *E. coli* and improve overall water quality.

Action 1. Seek funding and create a voluntary incentive based program(s) aimed at improving overall water quality.

i. Responsible party: CCCD, LPRWSC
ii. Funding needed: $1,000
iii. Funding sources: Section 319 of the CWA, NRCS, Wildlife NGO's, WDA, matching funds from private landowners

Action 2. Engage watershed steering committee on ways to encourage landowners participation in BMPs.

i. Responsible party: CCCD, LPRWSC, Landowners
ii. Funding needed: $1,000
iii. Funding sources: CCCD

Action 3. Conduct follow up assessment of BMPs to evaluate effectiveness of water quality improvement projects and provide reports to LPRWSC.

i. Responsible party: CCCD, LPRWSC, Landowners, with assistance from NRCS
ii. Funding needed: No funding will be needed during the duration of this plan. Evaluation of previous BMP's was conducted in 2014. In the future, projects will be evaluated 5 years post-implementation for their effectiveness.
iii. Funding sources: CCCD, WDEQ, WDA

OBJECTIVE: Assess and maintain Little Powder River Watershed Plan throughout the course of implementation.

Action 4. Maintain the watershed steering committee for the Little Powder River Watershed to provide leadership, project oversight, and review of BMPs.

i. Responsible party: CCCD, LPRWSC
ii. Funding needed: $5,000
iii. Funding sources: CCCD

Action 5. Annually meet with watershed steering committee to review and assess the Little Powder River watershed-based plan and amend as needed.

i. Responsible party: CCCD, LPRWSC
ii. Funding needed: $1,000
iii. Funding sources: CCCD, Section 319 of the CWA

5.1.2 Water Quality

Bacteria concentrations are the primary concern for water quality within the Little Powder River Watershed as they are above WDEQ water quality standards and have the potential to impact human health. The LPRWSC and CCCD are committed to determining the sources and reducing contributions of bacteria, where possible, from various sources in the watershed through a voluntary, incentive-based program to implement BMPs for water quality improvement. While meeting the Wyoming water quality standard may not be attainable in the short term, there is still the potential for reducing bacteria contributions within the watershed. Many of the bacteria contributions within the watershed likely come from non-point pollutant sources, however there are three municipal point sources in the watershed including Rawhide School, Gillette Campbell County Airport, Peabody Caballo Mining, LLC. and a mobile home park. All of these municipal point sources have permits through the Wyoming Pollutant Discharge Elimination System (WYPDES) and discharge into tributaries of the Little Powder River. Non-point sources with the potential for contributing bacteria include small wastewater systems, livestock, domestic animals, and wildlife. In 2018, there were 27 facilities (with associated outfalls) with WYPDES permits for discharge related to energy development activities including coal, oil, and CBM production, (Appendix D and Appendix E). Although these point sources are not likely to contribute to bacteria concentrations, they may contribute sediment and other materials that can negatively impact water quality. Although sediment is not a regulatory concern, it may facilitate bacteria survival and negatively impact overall water quality (USDA-ARS 2011, South Dakota State University 2017). Other potential sediment sources include seasonal runoff and streambank erosion. Given the potential relationship between sediment and bacteria populations, the LPRWSC will address sediment reductions and bank stabilization where appropriate.

OBJECTIVE: Collect and analyze credible water quality data in an effort to continue to gain insight into the natural and anthropogenic influences on bacteria concentrations.

Action 6. Seek funding to assess water quality for the Little Powder River Watershed

i. Responsible party: CCCD
ii. Funding needed: $5,950
iii. Funding sources: Section 319 of the CWA, WDA

Action 7. Collect water quality samples to assess *E. coli* impairment and source identification under an approved sampling analysis plan (SAP).

i. Responsible party: CCCD
ii. Funding needed: $79,500
iii. Funding sources: Section 319 of the CWA, WDA

Action 8. Review additional monitoring methods (i.e. MIM, photo points) to conduct in addition to or in place of *E. coli* water quality monitoring for assessing stream health.

i. Responsible party: CCCD, LPRWSC
ii. Funding needed: $6,665
iii. Funding sources: CCCD base funding

Action 9. Annually review the SAP for adequacy and compliance with WDEQ standard operating procedures.

i. Responsible party: CCCD, WDEQ
ii. Funding needed: $3,500
iii. Funding sources: CCCD base funding

Action 10. Maintain water quality certification of CCCD staff.

i. Responsible party: CCCD, WACD
ii. Funding needed: $6,000
iii. Funding sources: WDA-Lab funds, CCCD 1% funding

Action 11. Analyze water quality data and identify trends/correlations and compliance with WDEQ standards.

i. Responsible party: CCCD, WDEQ
ii. Funding needed: $25,000
iii. Funding sources: Section 319 of the CWA, WDA

Action 12. Develop and conduct *E.coli* sediment sampling project.

i. Responsible party: CCCD
ii. Funding needed: $17,726
iii. Funding sources: Section 319 or 205(j) of the CWA, WDA

OBJECTIVE: Reduce bacteria concentrations in the Little Powder River Watershed by 5% within five years (of plan approval).

Action 13. Provide financial and technical assistance to address failing small wastewater systems within 500 feet of surface water.

i. Responsible party: CCCD, NRCS, Campbell County
ii. Funding needed: $120,000

iii. Funding sources: Section 319 of the CWA, WDA, matching funds from private landowners

Action 14. Provide financial and technical assistance for livestock management and distribution to improve water quality.

i. Responsible party: CCCD, NRCS
ii. Funding needed: $675,000
Funding need based on previous BMP project cost within the watershed.
iii. Funding sources: Section 319 of the CWA, NRCS, Wildlife NGO's, WDA, matching funds from private landowners

OBJECTIVE: Reduce sediment contributions from within stream channel/banks, riparian areas, and upland areas.

Action 15. Through landowner participation, identify reaches, where bank stabilization efforts may improve overall water quality.

i. Responsible party: CCCD, LPRWSC, Landowners
ii. Funding needed: $1,000
iii. Funding sources: CCCD 1% funding, Section 319 of the CWA

Action 16. Provide technical and financial assistance to stabilize stream banks and remediate existing in stream structures that may cause negative effects to stream hydrology.

i. Responsible party: CCCD, NRCS, Landowners
ii. Funding needed: Unknown this is contingent upon what is determined in 3.a.
iii. Funding sources: Section 319 of the CWA, NRCS, Wildlife NGO's, WDA, matching funds from private landowners

5.1.3 Awareness and Education

To successfully improve water quality over the long term, there must be support and participation from many landowners within the watershed. In order for a watershed improvement program to be effective, there needs to be awareness of the existing water quality issues, educational materials and activities highlighting potential and existing improvement practices, and opportunities for involvement in these practices. Through the completion of successful BMPs, there is the potential for additional participation from other landowners, as neighbor-to-neighbor conversations are an effective method for gathering further support and involvement. With increased education and awareness of the water quality issues and opportunities available for improvement, there will likely be more motivation to be involved in the improvement efforts. Although some landowners may not be interested in

or qualify for financial assistance programs, education activities can ensure they are aware of the water quality issues and practical solutions that they can implement on their own.

Growth and development within the Little Powder River Watershed has continued as small acreage parcels become more appealing. This has led to an increase in the number of small acreage landowners within the watershed. Small acreage parcels are typically more difficult to manage, especially for those landowners with limited land management experience. These parcels do not have sufficient room for large numbers of livestock which often leads to improper grazing management. In addition to livestock, small acreage subdivisions may result in an increased density of small wastewater systems. Awareness and education efforts tailored specifically toward small acreage landowners will be critical for addressing the unique issues that they face and how those issues may be addressed to improve water quality.

OBJECTIVE: Educate the public about current water quality issues facing the Little Powder River Watershed.

Action 16. Develop and distribute an annual watershed-focused newsletter to promote participation and provide an update on progress and publicize completed projects to appropriate and interested parties.

i. Responsible party: CCCD
ii. Funding needed: $4,000
iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 17. Provide educational materials and staff at events within the watershed to update residents on water quality issues and BMPs.

i. Responsible party: CCCD, LPRWSC
ii. Funding needed: $5,000
iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 18. Update and maintain the water quality information on the CCCD website.

i. Responsible party: CCCD
ii. Funding needed: $3,000
iii. Funding sources: CCCD 1% Funding

OBJECTIVE: Encourage landowner participation in practices and enhancements to decrease bacteria contribution, and improve overall water quality within the Little Powder River Watershed, through education and outreach.

Action 19. Host watershed tour(s) following implementation of practices and enhancement to increase landowners' awareness and participation.
   i. Responsible party: CCCD, LPRWSC, NRCS, Landowners
   ii. Funding needed: $4,000
   iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 20. Provide information on the benefits of vegetative buffers and bank stabilization, for addressing impacts of stormwater runoff.
   i. Responsible party: CCCD
   ii. Funding needed: $3,000
   iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 21. Provide information on the benefits of upland and range management techniques for addressing *E. coli* concerns.
   i. Responsible party: CCCD
   ii. Funding needed: $5,000
   iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 22. Educate residents on proper installation and maintenance of individual small wastewater systems.
   i. Responsible party: CCCD, Campbell County
   ii. Funding needed: $3,000
   iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 23. Inform agricultural producers of positive impacts of properly installed/ located AFO/CAFO and possible remediation practices.
   i. Responsible party: CCCD, NRCS
   ii. Funding needed: $3,000
   iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

Action 24. Provide information and education to small acreage landowners on water quality and land management principles.
   i. Responsible party: CCCD, UW Extension
   ii. Funding needed: $3,000
   iii. Funding sources: Section 319 of the CWA, WDA, CCCD 1% Funding

5.2 Technical and Financial Assistance

The estimated amount needed to implement this plan is $948,341 over the next five years. This is based on cost estimates of previous projects completed. The CCCD currently has a grant through section 319 of the CWA for $264,000 to be used on the Little Powder River and Donkey Creek watersheds. Additional funding will need to be secured, either through additional 319 grants, WDA, landowner match or other sources to fully implement this plan. Additional funding sources may include:

- Grants from the US EPA/WDEQ through section 319 or 205 (j) of the CWA
- Grants from the WDA
- USDA Program Funds, including Environmental Quality Incentives Program (EQIP), Agriculture Management Assistance (AMA), and RCPP
- Grants from the Wyoming Game and Fish Department
- Grants from the Wyoming Wildlife and Natural Resource Trust
- Agreements with Federal Partners including BLM and the USFS
- Grants from NGO's
- Local assistance and appropriations from Campbell County and others.

Often, a combination of funding sources will aid to address each project. These outside funding sources make projects more feasible for landowners to implement and encourages additional participation. Each funding source comes with its own set of limitations, but in combination, they can complement one another to create a robust program that encourages voluntary conservation and practice implementation. Grants administered through CCCD can be more flexible, especially in terms of projects that do not fit within sign-up dates/timelines of USDA programs. State and local grants and appropriations, as well as contributions from landowners, provide the non-federal match necessary for the federal grant funds provided through US EPA and WDEQ.

In the past, funding has not been a limiting factor in implementing watershed improvement projects. However, as funding becomes more and more competitive, it will be imperative to have high quality projects to compete. One of the most limiting factors will be access to technical assistance. NRCS has partnered with CCCD in the past to provide some technical assistance, but may have other priorities, and outside assistance may be needed. This will limit funding for on the ground projects that would instead be used on contracted technical assistance.

5.3 Information and Education

In order to inform landowners of water quality issues and encourage participation in a voluntary incentive-based program for implementing BMPs, CCCD and the LPRWSC will need to promote and increase awareness about the program within the watershed. One of the most effective strategies for encouraging participation is discussions among landowners following the successful completion of BMPs. CCCD will continue to raise awareness of water quality and available programs through a variety of sources, including digital and print. The Little Powder Watershed Restoration Plan includes a variety of specific information and education activities that have been successful within other watersheds, including information on the CCCD website and in quarterly newsletters providing water quality updates and improvement opportunities.

Schedule of Completion

6.1 Implementation Schedule

The LPRWSC has developed this plan with the intent to reduce bacteria concentrations by 5% over a five year period. This 5% estimated reduction is necessary for the Little Powder River to progress toward meeting the primary contact recreation standard for the State of Wyoming. The LPRWSC developed a timeline for completion of the objectives and action items intended to achieve this goal (Table 6.1).

6.2 Interim Milestones

Changes in water quality over short time periods may not be a useful indicator of overall water quality improvement, therefore the LPRWSC created interim milestones and tasks to be completed for each of the action items within this plan (Table 6.1). The process for evaluating progress toward meeting the established milestones is described in Section 7.

Table 6.1. Little Powder River Watershed Interim Milestone Table

Objective: Implement strategic BMPs through a voluntary, incentive-based program(s) to decrease *E. coli* and improve overall water quality.					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 1. Seek funding and create a voluntary incentive based program(s) aimed at improving overall water quality					
Develop program materials for an incentive based program.	June	Continue	Continue	Continue	Continue
Apply for WDA Water Quality Grant	July		July		July
Apply for WDEQ 319 Funding	July			July	
Action 2. Engage watershed steering committee on ways to encourage participation in BMPs					
Annual meeting		January	January	January	January
Action 3. Conduct follow up assessment of BMPs to evaluate effectiveness of water quality improvement projects and provide reports to LPRWSC					
Annual meeting		January	January	January	January
Photo documentation of projects	TBD	TBD	TBD	TBD	TBD
Interim water quality monitoring report	December	December	December	December	December

Table 6.1 (continued). Little Powder River Watershed Interim Milestone Table

Objective: Assess and maintain Little Powder Watershed Plan throughout the course of implementation.					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 4. Maintain the watershed steering committee for Little Powder River Watershed to provide leadership, project oversight, and review of BMPs					
Annual meeting		January	January	January	January
Review BMP applications	TBD	TBD	TBD	TBD	TBD
Action 5. Annually meet with watershed steering committee to review and assess the Little Powder Watershed Restoration Plan and amend as needed					
Track interim milestones		January	January	January	January
Plan amendments - as needed		January	January	January	January
Update/renew watershed plan				November	Continue
Objective: Collect and analyze credible water quality data in an effort to gain insight into the influences on bacteria concentrations.					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 6. Seek funding to assess water quality of the Little Powder River Watershed					
Apply for WDA Water Quality Grant	July		July		July
Apply for WDEQ 319/ 205(j) Funding	July			July	
Action 7. Collect water quality samples to assess *E. coli* impairment and source identification under an approved sampling analysis plan (SAP)					
Sample collection	May-Sept	May-Sept	May-Sept	May-Sept	May-Sept
Interim data reports	December	December	December	December	December
Action 8. Review additional monitoring methods (i.e. MIM, photo points) to conduct in addition to or in place of *E. coli* water quality monitoring for assessing stream health.					
Investigate methods	Fall	Continue	Continue	Continue	Continue
Identify potential monitoring locations	Fall	Continue	Continue	Continue	Continue
Action 8. Annually review the SAP for adequacy and compliance with WDEQ standard operating procedures					
Update sampling analysis plan	March	March	March	March	March
Action 9. Maintain water quality certification of CCCD staff					
Water quality continuing education for staff	TBD	TBD	TBD	TBD	TBD
Field audits - as required	TBD	TBD	TBD	TBD	TBD

Table 6.1 (continued). Little Powder River Watershed Interim Milestone Table

Action 10. Analyze water quality data and identify trends/ correlations, and compliance with WDEQ standards					
Internal QA/QC	October	October	October	October	October
Data analysis	October	October	October	October	October
Action 11. Develop and conduct *E.coli* sediment sampling project					
Develop program and sampling protocol	April				
Conducting *E.coli* sediment sampling			May-Sept	TBD	TBD
Objective: Reduce bacteria concentrations in the Little Powder River Watershed by 5% within five years (of plan approval).					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 12. Provide financial and technical assistance to address failing small wastewater systems within 500 feet of surface water, see Table 5.2					
Projects - TBD (# of systems)	1	1	1	2	1
Action 13. Provide financial and technical assistance for livestock management and distribution to improve water quality, see Table 5.2					
Projects - TBD (AUs treated)	0	2297	2297	2297	2297
Objective: Reduce sediment contributions from within stream channel and upland areas.					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 14. Through landowner participation, identify reaches where bank stabilization efforts may improve overall water quality					
Develop education and outreach material specific to bank stabilization	November				
Develop priority areas with LPRWSC		January			
Action 15. Provide technical and financial assistance to stabilize stream banks and remediate in stream structures that may cause negative effects to stream hydrology					
Projects - to be determined	TBD	TBD	TBD	TBD	TBD
Objective: Educate the public about current water quality issues facing the Little Powder River Watershed.					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 16. Develop and distribute an annual watershed focused newsletter to promote participation and provide an update on progress and publicize completed projects to appropriate and interested parties					
Develop and distribute newsletter		February	February	February	February

Table 6.1 (continued). Little Powder River Watershed Interim Milestone Table

Action 17. Provide educational materials and staff at events within the watershed to update residents on water quality issues and BMPs					
Attend one community event within the watershed annually	Fall	Fall	Fall	Fall	Fall
Action 18. Update and maintain the water quality information on the CCCD website					
Annually update LPR water quality information		February	February	February	February
Annually upload water quality focused newsletter to website		February	February	February	February
Maintain information about BMP and cost-share opportunities		Spring	Continue	Continue	Continue
Objective: Encourage landowner participation in practices and enhancements to decrease bacteria contribution and improve overall water quality within the Little Powder Watershed, through education and outreach.					
Action Item/Interim Item	**2019**	**2020**	**2021**	**2022**	**2023**
Action 19. Host watershed tour(s) following implementation of practices and enhancement to increase landowners' awareness and participation					
Host tour	NA	NA	TBD	TBD	TBD
Action 20. Provide information on the benefits of vegetative buffers and bank stabilization, for addressing impacts of stormwater runoff					
Article in watershed focused newsletter			January		
Develop material for website	Fall	Continue	Continue	Continue	Continue
Action 21. Provide information on the benefits of upland and range management techniques, for addressing *E. coli* concerns					
Article in watershed focused newsletter			January		
Develop material for website	Fall	Continue	Continue	Continue	Continue
Action 22. Educate residents on proper installation and maintenance of individual small wastewater systems					
Article in watershed focused newsletter		January			
Develop material for website	Fall	Continue	Continue	Continue	Continue

Table 6.1 (continued). Little Powder River Watershed Interim Milestone Table

Action 23. Inform agricultural producers of positive impacts of properly installed/located AFO/CAFO and possible remediation practices					
Article in watershed focused newsletter				January	
Develop material for website	Fall	Continue	Continue	Continue	Continue
Action 24. Provide information and education to small acreage landowners on water quality and land management principles					
Article in watershed focused newsletter					January
Develop material for website	Fall	Continue	Continue	Continue	Continue

Monitoring and Evaluation Plan

7.1 Criteria for Evaluation

Changes in water quality may not be significant in the short term; therefore the LPRWSC will review progress toward completion of the watershed plan and meeting water quality standards on a regular basis.

The LPRWSC will meet annually and review the action items and interim milestones outlined in the watershed plan. If the action items or interim milestones are not yet completed, the LPRWSC will discuss possible reasons and take one of the following actions:

a) extend the action item or milestone into the next year or adjust the timeline;
b) abandon the action item or milestone completely if not achievable; or
c) modify the action item or milestone to make it achievable.

The LPRWSC will evaluate the types and number of improvement projects being proposed, initiated, and/or completed annually in conjunction with the review of the watershed plan. If the desired numbers or types of projects are not being proposed and/or completed, the LPRWSC will discuss possible reasons and take one of the following actions:

a) if certain types of projects are not being proposed, the LPRWSC will consider additional information and education;
b) if certain types of projects are not being proposed, but the LPRWSC feels outreach and education is adequate, the group may consider adjusting the desired number of a certain type of project; or
c) if certain types of projects are being proposed but are not being initiated or completed in a timely manner, the LPRWSC will consider whether this is from a lack of technical or financial assistance and look for sources to get the projects completed.

CCCD will collect additional water quality samples during and following the implementation of this plan. The LPRWSC expects to see a minimum 5% reduction within five years of plan implementation. If this reduction is not observed, the LPRWSC will consider the following actions during future plan revisions:

a) increase the number of improvement projects in areas not meeting the plan goals, which may require additional information and education; or
b) adjust the intended percent reduction and/or load estimates.

If minor modifications to the plan are necessary, the LPRWSC will make these changes and notify watershed residents, landowners, and WDEQ. Minor modifications include adjusting the number of projects, information and education activities, and changes to the schedule within the 5 year timeline of this plan. If more extensive changes are required, such as changes to the pollutant loads and reduction estimates, potential sources, and the overall timeline, the revised plan will be subject to the 45 day public comment period and submitted to WDEQ for approval.

7.2 Monitoring Plan

The LPRWSC recognizes that changes in water quality may take several years to occur, especially given the fluctuation in bacteria concentrations, as measured historically. Long term monitoring will aid in strengthening bacteria load estimates and required reductions. To better understand the dynamics of the Little Powder River Watershed, especially for bacteria, more years of sampling data encompassing varying flows and climate conditions are needed. The LPRWSC will continue to adjust the bacteria load and load reduction estimates as additional data are collected. The additional monitoring will enable the LPRWSC to evaluate long term trends in water quality within the watershed.

CCCD currently conducts water quality monitoring throughout the primary recreation season on an annual basis within the Little Powder River Watershed. This interim monitoring focuses on bacteria, turbidity, and field parameters (discharge, pH, electrical conductivity, dissolved oxygen, and temperature). From previous water sampling data, the LPRWSC has observed a correlation between turbidity and the *E. coli* levels and intends to investigate this further. *E.coli* may be coming from overland flow but may also be trapped in streambed sediment and released during increased flows. In order to investigate this further, CCCD will develop a study methodology for sampling *E.coli* in streambed sediment to determine if the sediment may be contributing to the elevated *E. coli* levels within the watershed. The sampling methods for this study will be adapted from similar studies addressing this specific question (Pandey and Soupir, 2014). CCCD and the LPRWSC will also evaluate alternative monitoring methods to implement in addition to, or in place of, current water quality monitoring methods. These alternative methods may include, but are not limited to: Multiple Indicator Monitoring (Burton et al. 2011) and photo points.

Water quality monitoring will be conducted throughout the duration of this plan. Prior to each monitoring season, CCCD will develop a detailed Sampling Analysis Plan (SAP) for approval by WDEQ. Follow up monitoring will be conducted at the end of this plan to document any changes in water quality. At this time, the timeframe and sampling parameters have not been determined but will likely be similar to those used in interim monitoring. This additional monitoring will be coordinated with other water quality monitoring projects conducted by CCCD.

Another area that will need to be monitored throughout the course on this plans implementation is BMP monitoring. BMP monitoring can be performed in a number of ways depending on the type of BMP implemented and availability of additional funding for monitoring. The CCCD has previously monitored implemented BMPs five years post installation. This was done to ensure that the implemented BMPs were still in place and in good repair. This was documented through a written report and photo documentation. This procedure also provided a way to assist landowners, should maintenance need to be performed on the BMP to maintain or improve the projects function. The LPRWSC will consider other project specific monitoring technics based on the applied for practices and landowners voluntary participation. These monitoring techniques may include but are not limited to: range monitoring, photo points, Multiple Indicator Monitoring (Burton et al. 2011), water sampling, and collecting grazing management data. These monitoring methods may help assess the

health and function of the stream and adjacent riparian areas and the effectiveness of BMPs on overall stream health.

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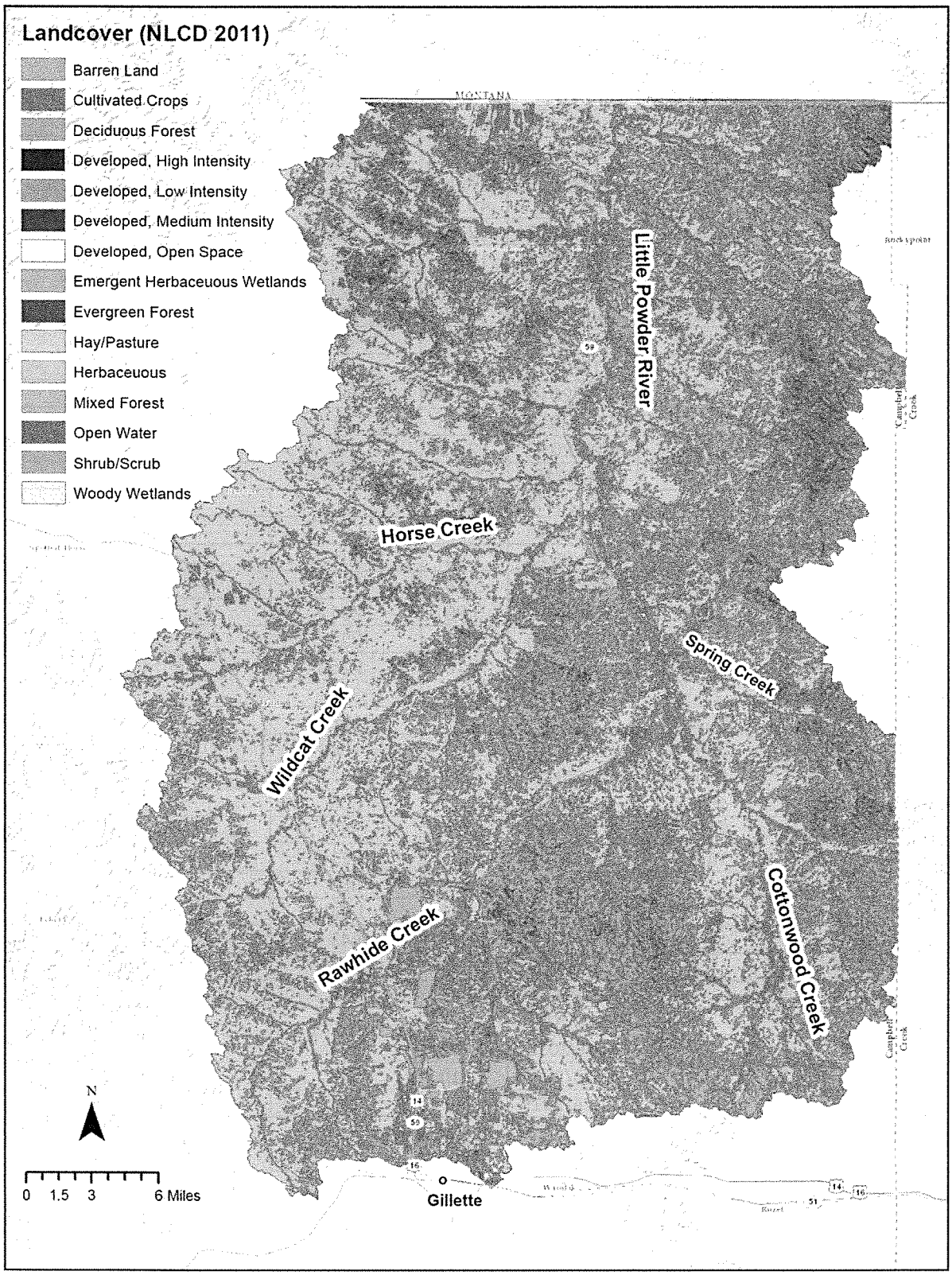
Appendix A. Stream Flow Data

LPR1			LPR2			LPR3		
Date	cfs	*E. coli* cfu/100 ml	Date	cfs	*E. coli* cfu/100 ml	Date	cfs	*E. coli* cfu/100 ml
10/17/2005	0.266	185	9/22/2005	0.135	14	6/22/2015	20.636	276
10/19/2005	0.232	102	9/27/2005	0.060	9	7/2/2015	18.032	6130
10/20/2005	0.286	52	10/17/2005	2.386	64	7/13/2015	5.431	44
10/31/2005	0.415	34	10/19/2005	1.097	192	7/23/2015	6.043	26
11/1/2005	0.354	44	10/20/2005	1.313	160	8/3/2015	1.319	66
4/3/2006	1.927	22	4/3/2006	2.314	57	8/13/2015	1.270	770
4/5/2006	1.273	44	4/5/2006	1.995	15	9/10/2015	0.726	65
4/10/2006	2.421	670	4/10/2006	9.284	750	9/21/2015	0.703	104
4/18/2006	1.809	910	4/18/2006	2.461	140	10/1/2015	1.553	1050
4/19/2006	1.983	10400	4/19/2006	2.876	340	10/13/2015	1.017	101
9/26/2006	3.936	4100	9/26/2006	19.504	14000	10/26/2015	2.493	115
10/2/2006	1.690	310	10/2/2006	3.286	140	5/12/2016	2.682	24.9
10/12/2006	0.899	60	10/12/2006	2.386	450	5/23/2016	5.900	55
10/17/2006	0.453	98	10/17/2006	1.097	480	6/2/2016	5.491	88.6
10/23/2006	2.335	980	10/23/2006	1.313	420	6/13/2016	0.511	95.9
4/11/2007	4.509	9	4/11/2007	17.754	110	6/23/2016	0.335	101.4
4/17/2007	0.759	20	4/17/2007	9.034	590	7/5/2016	0.227	71.7
4/24/2007	3.667	77	4/24/2007	10.333	650			
4/26/2007	1.957	36	4/26/2007	8.030	260			
5/1/2007	0.138	95	5/1/2007	7.182	190			
10/1/2007	0.616	45	10/1/2007	2.998	70			
10/3/2007	0.693	30	10/3/2007	2.672	88			
10/10/2007	0.836	13	10/24/2007	2.748	29			
10/15/2007	1.301	700	4/23/2008	13.47	34			
10/24/2007	2.569	64	4/24/2008	12.53	18			
4/23/2008	4.40	120	4/29/2008	12.83	9			
4/24/2008	4.82	50	5/5/2008	93.24	3800			
4/29/2008	5.30	76	5/15/2008	38.68	225			
5/5/2008	28.92	580	9/16/2008	3.51	50			
5/15/2008	14.15	180	9/23/2008	5.03	70			
9/16/2008	3.19	160	9/25/2008	5.15	82			
9/23/2008	3.13	200	10/1/2008	4.44	119			
9/25/2008	3.18	134	10/2/2008	5.01	92			
10/1/2008	2.74	131	10/10/2008	2.969	60			
10/2/2008	2.55	98	10/15/2008	3.661	40			
5/4/2009	12.32	48	5/4/2009	31.51	15			
5/7/2009	9.26	50	5/7/2009	26.799	64			
5/12/2009	7.29	200	5/12/2009	19.942	73			
5/18/2009	4.60	108	5/18/2009	18.055	117			
5/27/2009	2.68	62	5/27/2009	13.709	77			
5/3/2010	22.20	28	5/3/2010	33.28	17			
6/1/2010	63.41	103	6/1/2010	114.70	120			
6/2/2010	51.36	205	6/2/2010	84.60	201			
6/7/2010	25.68	299	6/7/2010	44.88	178			
8/5/2010	18.40	613	8/5/2010	13.93	261			

8/11/2010	4.11	93	8/11/2010	5.62	143			
8/12/2010	2.98	172	8/12/2010	5.58	96			
8/26/2010	1.49	411	8/26/2010	3.46	99			
8/30/2010	1.57	727	8/30/2010	4.45	115			
5/3/2011	71.69	93	5/3/2011	79.13	127			
5/4/2011	64.58	79	5/4/2011	82.54	435			
5/5/2011	51.45	66	5/5/2011	64.31	83			
6/30/2011	35.04	156	7/5/2011	86.03	326			
7/5/2011	26.49	135	7/6/2011	48.93	387			
7/6/2011	26.58	121	7/7/2011	49.20	248			
7/7/2011	26.41	148	8/17/2011	12.70	261			
8/17/2011	5.50	308	8/22/2011	12.27	291			
8/22/2011	6.22	345	8/23/2011	12.63	261			
8/23/2011	4.89	186	8/24/2011	12.56	135			
8/24/2011	5.87	548	5/8/2012	57.67	73			
5/8/2012	34.40	89	6/16/2012	15.92	88			
6/16/2012	9.45	77	6/20/2012	17.96	64			
6/20/2012	9.54	47	6/21/2012	15.35	36			
6/21/2012	8.85	25	6/25/2012	12.59	72			
6/25/2012	4.29	40	8/1/2012	1.55	63			
8/1/2012	0.51	197	8/2/2012	2.49	51			
8/2/2012	0.73	326	8/8/2012	2.02	70			
8/8/2012	0.18	461	8/13/2012	1.44	16			
8/13/2012	0.45	116	5/6/2013	5.84	114			
5/6/2013	8.62	27	5/9/2013	5.99	291			
5/9/2013	2.60	44	5/13/2013	3.03	236			
5/13/2013	2.32	11	5/14/2013	4.16	225			
5/14/2013	1.98	28	5/21/2013	8.66	365			
5/21/2013	7.35	2420	7/29/2013	3.49	166			
7/29/2013	1.89	326	7/30/2013	2.95	106			
7/30/2013	2.71	166	8/6/2013	7.33	411			
8/6/2013	5.85	461	8/7/2013	8.46	308			
8/7/2013	4.78	219	8/13/2013	9.00	387			
8/13/2013	5.36	147	7/2/2015	17.107	921			
			7/13/2015	8.815	980			
			7/23/2015	8.311	1780			
			8/3/2015	5.996	649			
			8/13/2015	5.633	135			
			9/10/2015	2.085	19			
			9/21/2015	1.963	11			
			10/1/2015	2.102	921			
			10/13/2015	3.119	613			
			10/26/2015	2.793	131			
			5/12/2016	2.860	66.3			
			5/23/2016	3.591	187			
			6/2/2016	6.591	163.1			
			6/13/2016	1.354	166.4			
			6/23/2016	1.209	82.2			
			7/5/2016	0.955	31.8			

Appendix B. Landcover



Appendix C. Load Duration Curves Methodology

Load Duration Curve Methodology

The load duration curve methodology was used in this plan both because of the preference for its use in developing EPA Watershed Plans, but also for its ability to quantify water quality parameters at varied flow regimes. A key benefit of this method is the visual representation it provides of the relationship between stream flow and *E. coli* load capacity. Methodologies for the development of load duration curves used in developing this watershed restoration plan are provided in "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA, 2007).

Flow Duration Curve. The load duration curve methodology begins with the development of a flow duration curve for each water quality sample site. This graph plots stream flow in cubic feet per second (cfs) on the vertical 'y' axis, against a ranked flow percentage on the horizontal 'x' axis. The ranked flow percentage is derived from the measured stream flows ranked highest to lowest, by dividing an individual rank by the total number of ranked measured flows, to create a percentage of the time that the stream flow exceeded a given measurement. Thus, a ranked flow percentage of 0 would indicate that 0 percent of the measured flow exceeded this measurement, and a ranked flow percentage of 100 would indicate than 100 percent of the measured flow exceeded this measurement.

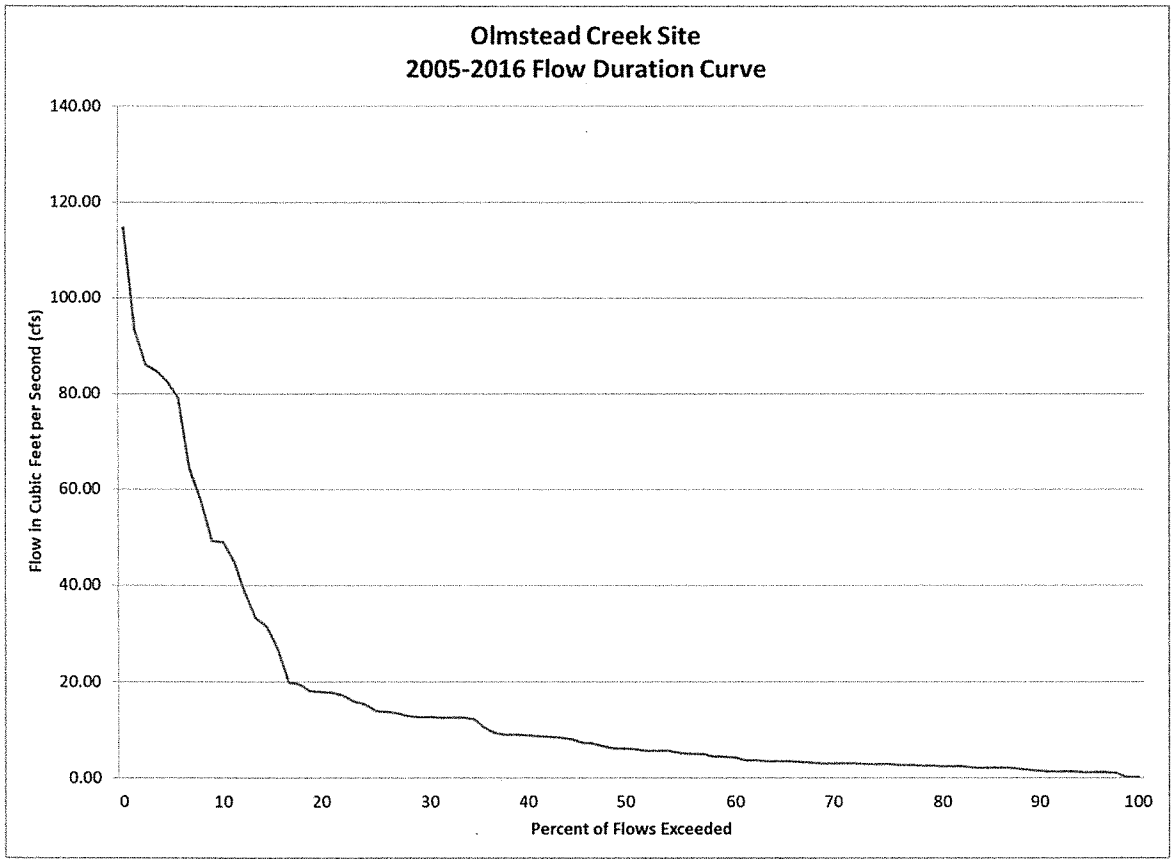


Figure C.1 Flow Duration Curve for Olmstead Creek Sample Site

Load Duration Curve. From the flow duration curve, a load duration curve is developed to quantify the allowable *E. coli* load under the state water quality standard. The load duration curve is developed in the same way as the flow duration curve, plotting the ranked flow percentage on the horizontal 'x' axis, and the water quality standard's allowable *E. coli* load on the vertical 'y' axis. The values for the water quality standard's allowable *E. coli* load is determined using the water quality standard of 126 (for primary contact recreation) colony forming units (cfu) multiplied by the flow in cubic feet per second (cfs) multiplied by a conversion factor that converts the water quality standard into a daily load.

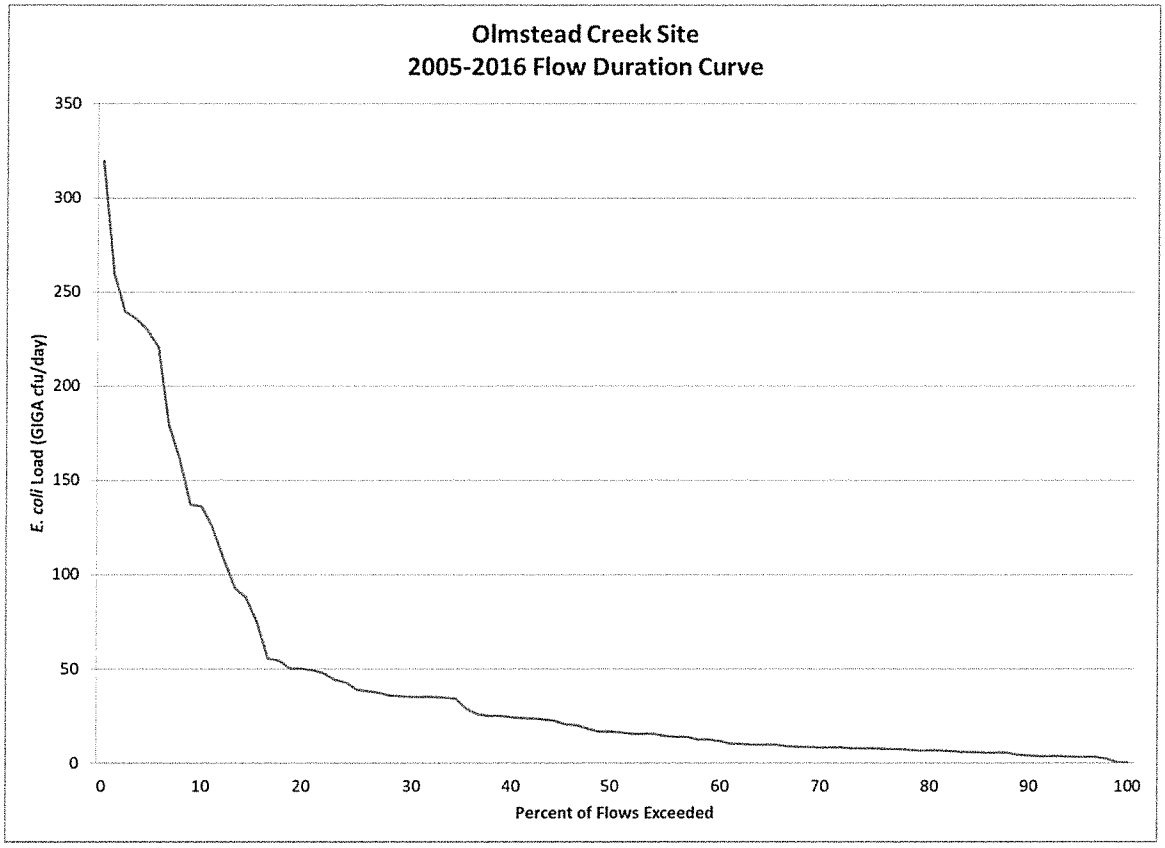


Figure C.2 Load Duration Curve for Olmstead Creek Sample Site

Measured pollutant loads. The load duration curve becomes most useful in determining the state of the existing *E. coli* load in a stream when the measured *E. coli* load is plotted on the load duration curve graph. This allows for a visual representation of both the water quality standard as well as the existing *E. coli* measurement at the time the sample was taken. Those samples where the actual *E. coli* concentration is in compliance with the water quality standard fall below the load duration curve line representing the water quality standard. Similarly, those samples with *E. coli* concentrations exceeding the water quality standard are plotted above the load duration curve line representing the water quality standard. Thus, the sampled *E. coli* concentrations are shown relative to the water quality standard, allowing for easy visual determination of where the actual *E. coli* load falls relative to the water quality standard.

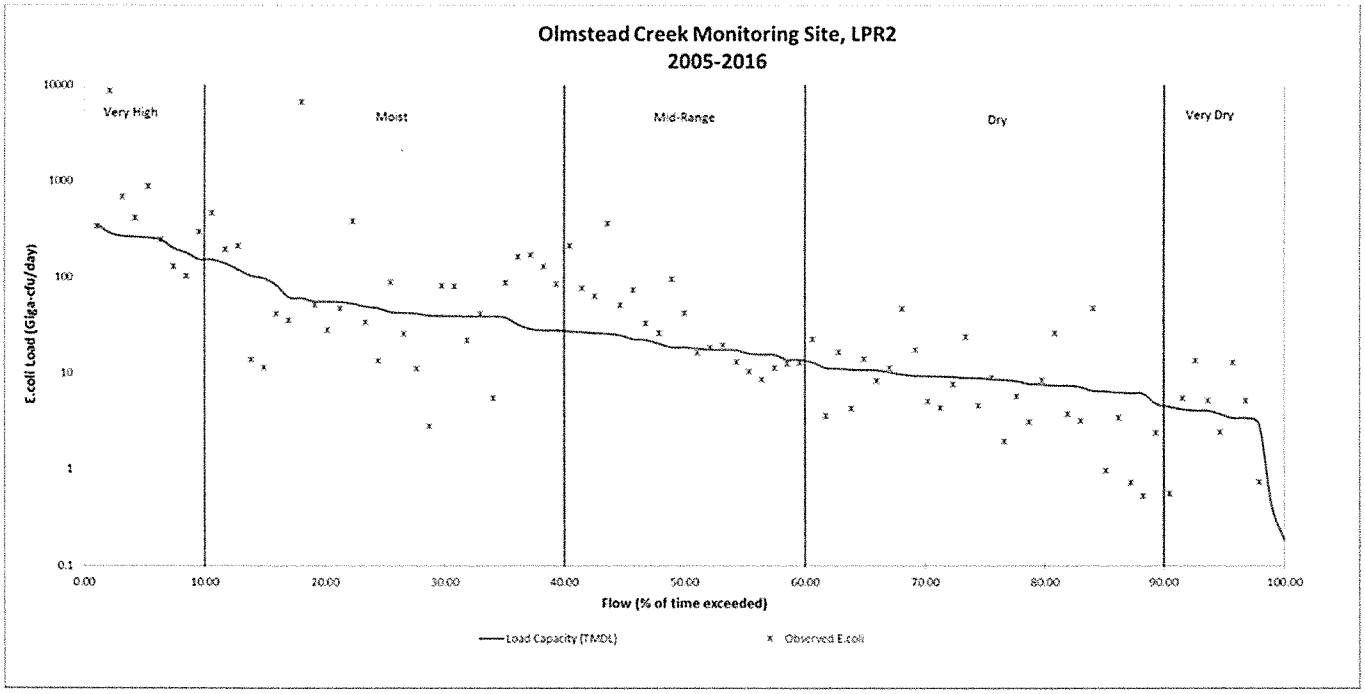


Figure C.3 Load Duration Curve and Sampled *E. coli* Data for Olmstead Creek Sample Site

Critical Flow Conditions. Once the *E. coli* load is plotted on the load duration curve graph, it becomes possible to determine the critical flow condition where the majority of the water quality standard exceedances occur in addition to estimating the reduction in *E. coli* load required to meet the water quality standard. The critical flow condition for a sample site is the flow condition requiring the greatest *E. coli* load reduction to meet the water quality standard. The flow condition categories used in this plan are divided into five categories; very high (0-10% of flows exceeded), moist condition flows (10-40% of flows exceeded), midrange flows (40-60% of flows exceeded), dry condition flows (60-90% of flows exceeded), and very dry (90-100% of flows exceeded). The very high flow (flood/spring) and very dry (drought/late summer) conditions (<10% and >90% of flows exceeded) are excluded from load reduction estimates (USEPA, 2007). These are considered the extreme conditions where load reduction efforts would be least effective.

The critical flow conditions correspond to types of run-off and/or precipitation scenarios and provide information about the potential pollutant sources. Moist condition flows correspond with snowmelt and heavy precipitation runoff conditions. The moist flow critical condition suggests primarily overland flow-type *E. coli* load sources that can originate in areas outside the immediate stream channel. Mid-range flow conditions correspond with normal stream flows and average precipitation. The mid-range flow critical condition suggests a combination of both overland flow-type *E. coli* load sources and more continuous contributions such as point sources. Dry condition flow conditions correspond with lower than normal stream flows and periods of lower precipitation. The dry condition flow critical condition suggests a direct and

continuous load source that is able to occur even when stream flows are below normal and run-off is minimal or absent.

The critical flow condition is suggestive of the potential sources of *E. coli* loading as well as the types of mitigation activities that may have the most effect. Those stream segments with dry condition critical flow condition suggest that point source or direct contributions may be a primary source of *E. coli* loading. Conversely, stream segments with moist condition critical flow condition suggests that non-point source contribution may be a likely source for *E. coli* loading (Table C.1).

Table C.1. Potential Load Sources Under Given Critical Flow Condition

Contributing Source Area	Duration Curve Zone		
	Moist Condition Flows	Mid-Range Flows	Dry Condition Flows
Point Source			M
On-site Wastewater (Septic) Systems		H	H
Riparian Areas	H	H	H
Upland Stormwater Runoff	H	M	
Bank Erosion	M		

Note: H=High Priority; M=Medium Priority

Adapted from "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA 2007).

Load reduction estimates. Load reduction estimates for each sample site are based on the measured *E. coli* load within each of the three flow condition categories and the percent reduction required for each sample to meet the water quality standard at a measured flow. The mean *E. coli* load reduction percent is calculated for each of the flow condition categories. The flow condition with the greatest *E. coli* load reduction to meet the water quality standard is determined to be the critical flow condition for that sampling site.

Appendix D. Permitted Point Source Discharges in the Little Powder River Watershed

The following list of permitted discharges was obtained from James Eisenhauer, point Inspection Program Coordinator on October 22, 2018.

WY Permit Number	Permittee	Facility Name	Outfall Number	Permit Type
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	UPR	Coal Bed Methane
WY0034983	True Oil, LLC	Hilda State #1 & #2	DMP1	Oil Treaters
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	009	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	DPR	Coal Bed Methane
WY0095443	L and J Operating, Inc.	Kluver Field	SUM	Coal Bed Methane
WY0032522	Gillette-Campbell County Airport	Gillette Campbell County Airport	001	Sanitary Wastewater
WY0047384	Storm Cat Energy Corporation	South Jamison	DLPR	Coal Bed Methane
WY0047384	Storm Cat Energy Corporation	South Jamison	AZTE	Coal Bed Methane
WY0028479	Buckskin Mining Company	Buckskin Mine	014	Coal Mine
WY0038326	Storm Cat Energy Corporation	Longhorn Lease CBM Wells	TRIB	Coal Bed Methane
WY0026018	Blackjewel, LLC	Eagle Butte Mine	014	Coal Mine
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	005	Coal Mine
WY0047384	Storm Cat Energy Corporation	South Jamison	ULPR	Coal Bed Methane
WY0053937	Skinner Oil and Gas, LLC	State 6-36R	DMP1	Oil Treaters
WY0034193	Ranch Oil Company	Sawgrass Federal 42-32 Battery	DMP1	Oil Treaters

WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	001	Coal Mine
WY0024031	Peabody Caballo Mining, LLC	Rawhide Mine	008	Coal Mine
WY0038326	Storm Cat Energy Corporation	Longhorn Lease CBM Wells	DPR	Coal Bed Methane
WY0038326	Storm Cat Energy Corporation	Longhorn Lease CBM Wells	ULPR	Coal Bed Methane
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	014	Coal Mine
WY0026310	True Oil, LLC	Government 6-1 Lease	001	Oil Treaters
WY0024031	Peabody Caballo Mining, LLC	Rawhide Mine	002	Coal Mine
WY0047376	Storm Cat Energy Corporation	North Jamison	TG2	Coal Bed Methane
WY0036234	CKT Energy, LLC	Big Ute Discharge Facility	001	Oil Treaters
WY0047376	Storm Cat Energy Corporation	North Jamison	TRB1	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW4	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW3	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW5	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW2	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW1	Coal Bed Methane
WY0034193	Ranch Oil Company	Sawgrass Federal 42-32 Battery	001	Oil Treaters
WY0035394	The Termo Company	Rocky Butte Separation	001	Oil Treaters
WY0034304	TAQA USA, Inc.	Rocky Point #1-4 Federal	001	Oil Treaters
WY0034304	TAQA USA, Inc.	Rocky Point #1-4 Federal	001	Oil Treaters

WY0047376	Storm Cat Energy Corporation	North Jamison	DLPR	Coal Bed Methane
WY0047384	Storm Cat Energy Corporation	South Jamison	TRB1	Coal Bed Methane
WY0094510	Petrox Resources, Inc.	Hunter Ranch Water Transfer Station	DMP1	Oil Treaters
WY0026018	Blackjewel, LLC	Eagle Butte Mine	019	Coal Mine
WY0024031	Peabody Caballo Mining, LLC	Rawhide Mine	013	Coal Mine
WY0036234	CKT Energy, LLC	Big Ute Discharge Facility	BBCP	Oil Treaters
WY0035394	The Termo Company	Rocky Butte Separation	BBCP	Oil Treaters
WY0047384	Storm Cat Energy Corporation	South Jamison	DIV3	Coal Bed Methane
WY0096296	BTA Oil Producers, LLC	Baytown 21-27 Discharge Facility	DMP1	Oil Treaters
WY0035513	McClure Enterprises	Homestead A Discharge Facility	BBCP	Oil Treaters
WY0094391	Merit Energy Company	Galion North	DMP1	Oil Treaters
WY0096121	H.D. & Carolyn B. Adams dba Don Adams & Associates	Camp Creek Surface Disposal	DMP1	Oil Treaters
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	TRB1	Coal Bed Methane
WY0096130	BTA Oil Producers, LLC	Anvil 33-1 Discharge Facility	DMP1	Oil Treaters
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	R13	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	R27	Coal Bed Methane
WY0095443	L and J Operating, Inc.	Kluver Field	ULPR	Coal Bed Methane
WY0095443	L and J Operating, Inc.	Kluver Field	DLPR	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	R26	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	R32	Coal Bed Methane

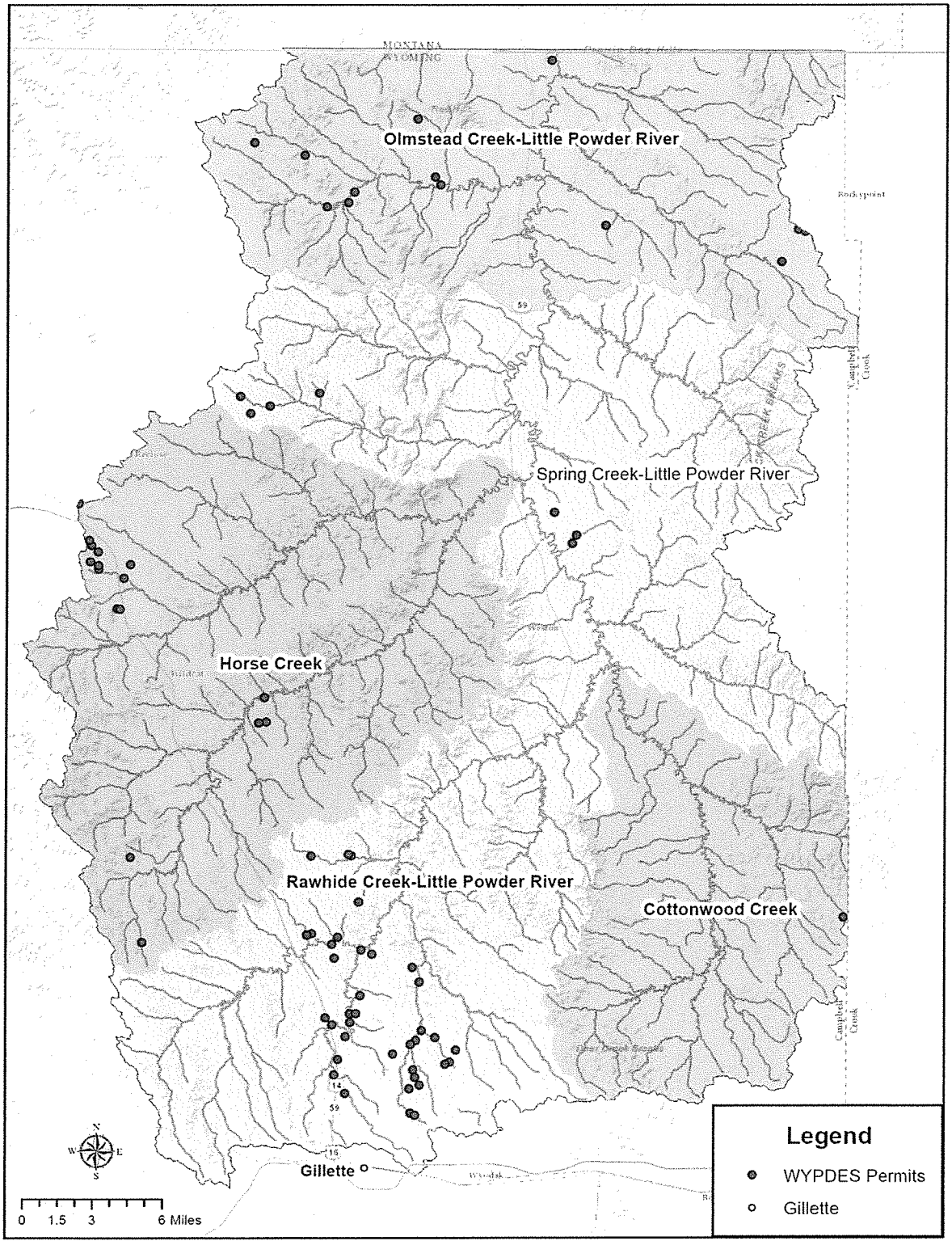
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW6	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW7	Coal Bed Methane
WY0034304	TAQA USA, Inc.	Rocky Point #1-4 Federal	DMP1	Oil Treaters
WY0035394	The Termo Company	Rocky Butte Separation	DMP1	Oil Treaters
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW12	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW14	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW9	Coal Bed Methane
WY0034304	TAQA USA, Inc.	Rocky Point #1-4 Federal	DMP1	Oil Treaters
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW13	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	STR1	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW10	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	STR3	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW11	Coal Bed Methane
WY0047376	Storm Cat Energy Corporation	North Jamison	ULPR	Coal Bed Methane
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	MW8	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	R09	Coal Bed Methane
WY0095443	L and J Operating, Inc.	Kluver Field	TRIB	Coal Bed Methane

WY0095761	BTA Oil Producers, LLC	Baytown 32-29 Discharge Facility	001	Oil Treaters
WY0095621	Apex Companies, LLC	Horse Creek: Ag Monitoring Network	STR2	Coal Bed Methane
WY0095753	BTA Oil Producers, LLC	Baytown 32-28 Discharge Facility	001	Oil Treaters
WY0053937	Skinner Oil and Gas, LLC	State 6-36R	001	Oil Treaters
WY0026018	Blackjewel, LLC	Eagle Butte Mine	018	Coal Mine
WY0024031	Peabody Caballo Mining, LLC	Rawhide Mine	004	Coal Mine
WY0095761	BTA Oil Producers, LLC	Baytown 32-29 Discharge Facility	BBCP	Oil Treaters
WY0028479	Buckskin Mining Company	Buckskin Mine	010	Coal Mine
WY0028479	Buckskin Mining Company	Buckskin Mine	001	Coal Mine
WY0028479	Buckskin Mining Company	Buckskin Mine	009	Coal Mine
WY0028479	Buckskin Mining Company	Buckskin Mine	007	Coal Mine
WY0026433	Alpha Wyoming Land Company, LLC	Rawhide School	001	Sanitary Wastewater
WY0095753	BTA Oil Producers, LLC	Baytown 32-28 Discharge Facility	BBCP	Oil Treaters
WY0026018	Blackjewel, LLC	Eagle Butte Mine	013	Coal Mine
WY0000264	TAQA USA, Inc.	Rocky Point Field, Central Tank Battery	001	Oil Treaters
WY0000264	TAQA USA, Inc.	Rocky Point Field, Central Tank Battery	001	Oil Treaters
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	008	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	007	Coal Bed Methane
WY0034142	Legacy Reserves Operating, LP	Galion Separation Facility	001	Oil Treaters

WY0028479	Buckskin Mining Company	Buckskin Mine	011	Coal Mine
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	002	Coal Mine
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	010	Coal Mine
WY0035513	McClure Enterprises	Homestead A Discharge Facility	001	Oil Treaters
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	013	Coal Mine
WY0034983	True Oil, LLC	Hilda State #1 & #2	001	Oil Treaters
WY0024031	Peabody Caballo Mining, LLC	Rawhide Mine	001	Coal Mine
WY0026018	Blackjewel, LLC	Eagle Butte Mine	031	Coal Mine
WY0026018	Blackjewel, LLC	Eagle Butte Mine	029	Coal Mine
WY0026018	Blackjewel, LLC	Eagle Butte Mine	021	Coal Mine
WY0094510	Petrox Resources, Inc.	Hunter Ranch Water Transfer Station	BBCP	Oil Treaters
WY0028479	Buckskin Mining Company	Buckskin Mine	013	Coal Mine
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	020	Coal Mine
WY0096121	H.D. & Carolyn B. Adams dba Don Adams & Associates	Camp Creek Surface Disposal	001	Oil Treaters
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	023	Coal Mine
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	021	Coal Mine
WY0094391	Merit Energy Company	Galion North	001	Oil Treaters
WY0094510	Petrox Resources, Inc.	Hunter Ranch Water Transfer Station	001	Oil Treaters
WY0096130	BTA Oil Producers, LLC	Anvil 33-1 Discharge Facility	001	Oil Treaters
WY0024031	Peabody Caballo Mining, LLC	Rawhide Mine	014	Coal Mine

WY0096296	BTA Oil Producers, LLC	Baytown 21-27 Discharge Facility	001	Oil Treaters
WY0034142	Legacy Reserves Operating, LP	Galion Separation Facility	BBCP	Oil Treaters
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	022	Coal Mine
WY0026018	Blackjewel, LLC	Eagle Butte Mine	033	Coal Mine
WY0095443	L and J Operating, Inc.	Kluver Field	002	Coal Bed Methane
WY0095443	L and J Operating, Inc.	Kluver Field	001	Coal Bed Methane
WY0038164	Carbon Creek Energy, LLC	Carson and Reed	022	Coal Bed Methane
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	019	Coal Mine
WY0028479	Buckskin Mining Company	Buckskin Mine	017	Coal Mine
WY0032964	Western Fuels-Wyoming, Inc.	Dry Fork Mine	018	Coal Mine
WY0028479	Buckskin Mining Company	Buckskin Mine	016	Coal Mine
WY0047384	Storm Cat Energy Corporation	South Jamison	004	Coal Bed Methane
WY0048488	Hoy, Philip	Hoy Mobile Home Park	001	Sanitary Wastewater
WY0047376	Storm Cat Energy Corporation	North Jamison	003	Coal Bed Methane

Appendix E. Map of Permitted Point Source Discharges in the Little Powder River Watershed



Appendix F. Responses to Public Comments