Mailing Address:
Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:
Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651
Fax: (307) 766-3785

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FINAL REPORT

BELLE FOURCHE RIVER WATERSHED STUDY

SUBBASIN ABOVE KEYHOLE RESERVOIR

WATERSHED MANAGEMENT PLAN

Topical Report RSI-2512

prepared for

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, Wyoming 82002

March 2015

RESPEC

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SUBBASIN ABOVE KEYHOLE RESERVOIR

WATERSHED MANAGEMENT PLAN

Topical Report RSI-2512

by

RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

and

Anderson Consulting Engineers, Inc.
375 Horsetooth Road, Building #5
Fort Collins, Colorado 80525

prepared for

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, Wyoming 82002

March 2015

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES
(Continued)

FIGURE **PAGE**

1.0 INTRODUCTION

In 2012, the Crook County Natural Resources District (CCNRD), Campbell County Conservation District (CCCD), and Crook County Irrigation District (CCID) requested that the Wyoming Water Development Commission (WWDC) conduct a comprehensive study of the Belle Fourche River Watershed and its water resources. The local sponsors requested that the Level I watershed study evaluate watershed function; assess wetland and riparian conditions; develop geomorphic classifications; and identify resource concerns and water development opportunities on irrigated lands, rangelands, wetlands, and streams. The WWDC approved funding for the watershed study and then contracted with RESPEC and Anderson Consulting Engineers, Inc. (ACE), to provide technical or professional services for the watershed study.

The Belle Fourche River Watershed Study, Level I, is a comprehensive evaluation and an initial inventory of the water and land resources within the study area. This Level I watershed study provides important information that the CCNRD, CCCD, and CCID (the study's local sponsors) and the WWDC (the study's sponsor), could use in developing water resources and implementing conservation practices that address water and land resource concerns within the study area. This watershed study includes in-depth descriptions about needed water development projects that could provide economic, ecological, and social benefits to the state of Wyoming and its citizens.

Because of the size and variability of the study area for the Belle Fourche River Watershed, as shown in Figure 1.1, the final reports for the watershed were separated into this basin wide summary report and a final report was completed for each of the three subareas or subbasins. The terms "watershed" and "study area" are used interchangeably throughout this study and associated reports. The "subarea" and "subbasin" terms are also used interchangeably in these reports. This basin wide summary report was completed for the study area and includes data and information regarding the overall study area along with inclusion of all three of the subbasin reports and watershed management plan and rehabilitation components. Throughout these reports, mention will be made where more specific information can be found within the subbasin reports or the basin wide summary report where appropriate.

This "Subbasin above Keyhole Reservoir Report" was completed for the Belle Fourche River Watershed that occurs above Keyhole Reservoir within the study area. These reports, accompanied by the "digital library" and Geographic Information System (GIS) geodatabase, are intended to provide the results of the Belle Fourche River Watershed Study, Level I. Subbasins were identified based on the U.S. Geological Survey (USGS) 10^{th} order "hydrologic units" classification which has an assigned Hydrologic Unit Code (HUC). The subbasin contains 15 watersheds (HUC-10) and are listed in Table 1.1 and shown in Figure 1.2.

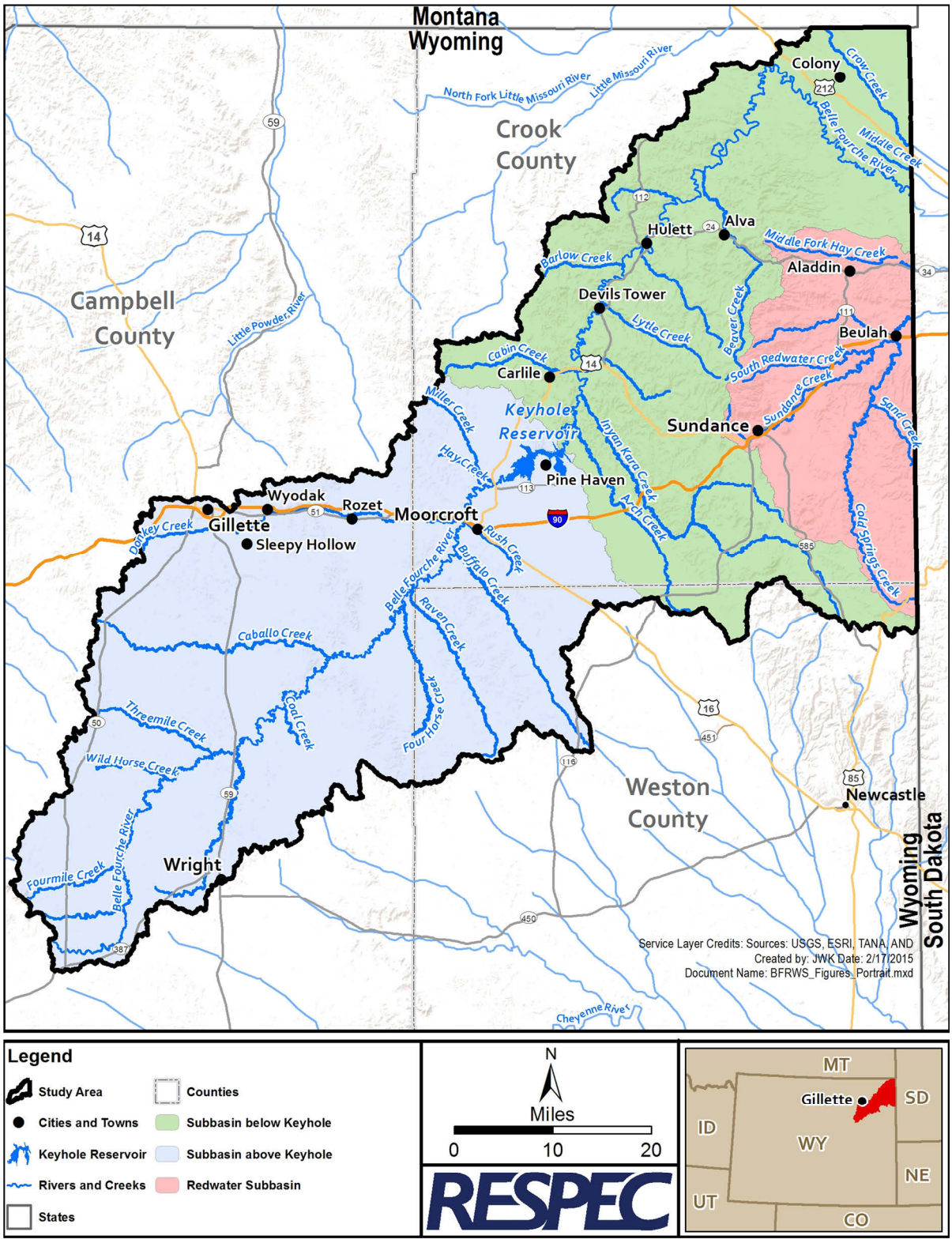


Figure 1.1. Belle Fourche River Watershed and Distinct Subbasins Within the Study Area.

Table 1.1. Watersheds (10th Order Hydrologic Unit Codes) Within the Subbasin Above Keyhole Reservoir

Hydrologic Unit Code	Watershed (HUC-10) Name	Study Subbasin	Acres	Square Miles
1012020101	Mud Spring Creek-Belle Fourche River	Above Keyhole Reservoir	225,640	353
1012020103	Caballo Creek	Above Keyhole Reservoir	166,640	260
1012020106	Donkey Creek	Above Keyhole Reservoir	163,250	255
1012020102	Hay Creek-Belle Fourche River	Above Keyhole Reservoir	180,190	282
1012020104	Buffalo Creek-Belle Fourche River	Above Keyhole Reservoir	299,180	467
1012020105	Wind Creek-Belle Fourche River	Above Keyhole Reservoir	212,050	331
Total			**1,246,950**	**1,948**

1.1 SUBBASIN ABOVE KEYHOLE RESERVOIR

The Belle Fourche River Watershed – Subbasin above Keyhole Reservoir encompasses the drainage area for the Belle Fourche River beginning at the headwaters approximately 18 miles southwest of Wright, and flowing generally northeast where it enters Keyhole Reservoir, which is located on the Belle Fourche River approximately 6 miles northeast of Moorcroft. The subbasin includes the land draining to the Belle Fourche River and tributaries covering approximately 1,948 square miles or 1,246,950 acres. The subbasin is the largest of the three subbasins, encompassing over 50 percent of the study area. The subbasin is situated in Campbell County with portions in Crook and Weston Counties. The subbasin includes the communities of Gillette, Moorcroft, Pine Haven, Rozet, Sleepy Hollow, Wright, and Wyodak.

1.2 STUDY ISSUES AND UNDERSTANDING

This Level I study provides a comprehensive evaluation of the Belle Fourche River Watershed and concludes with the Watershed Management and Rehabilitation Plan, which is included in Chapter 4.0 of the basin wide summary report. The expectation of the local sponsors (CCNRD, CCCD, and CCID) and the WWDC was to identify water development opportunities within the study area. In developing the Watershed Management and Rehabilitation Plan, the consultant worked with the local sponsors, the Wyoming Water Development Office (WWDO) and several study participants to address the following issues within the subbasin including: surface water availability; irrigation system improvements; and rangeland and grazing improvements.

1.3 PURPOSE AND SCOPE

The purpose of this Level I study was to combine the available and relevant data and information with the study-generated inventory data into a GIS geodatabase and digital library. In addition, a Watershed Management and Rehabilitation Plan was to be developed that outlined the potential water development opportunities and alternatives. To accomplish this effort, several objectives were completed and are discussed in the basin wide summary report.

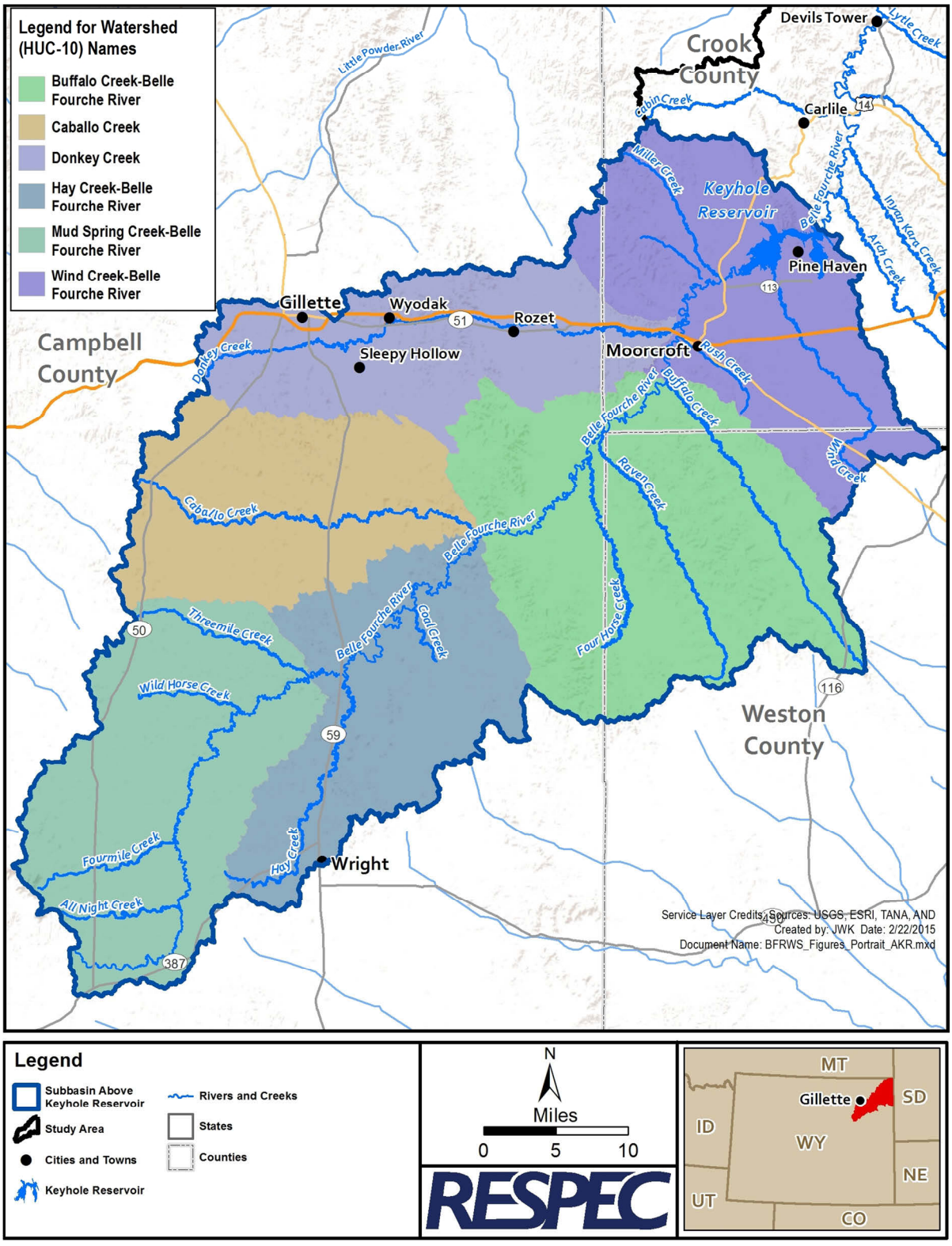


Figure 1.2. Watersheds (HUC-10) Within the Subbasin Above Keyhole Reservoir.

2.0 PROJECT MEETINGS

2.1 SCOPING MEETINGS, OPEN HOUSES, AND LANDOWNER MEETINGS

Public involvement and landowner participation were an important element of the Belle Fourche River Watershed Study effort because of the amount and complexity of the water and land issues and concerns within the study area. Therefore, considerable emphasis and time was placed on this aspect of the study. Scoping meetings, open houses, landowner meetings, and on-site field visits were conducted by RESPEC and ACE staff in cooperation with CCNRD, CCCD, CCID, WWDO, and Natural Resources Conservation Service (NRCS). Scoping meetings, open houses, landowner meetings, and field visits were coordinated by RESPEC with assistance from the CCNRD, CCCD, CCID, WWDO, and NRCS. A detailed description of the scoping meetings, open houses, and project meetings is included in the basin wide summary report.

Within the subbasin, a scoping meeting was held in Gillette on September 16, 2013, where RESPEC representatives made presentations, summarized work, and outlined tasks. Draft maps generated with available GIS data were presented to inform attendees. Questions were answered during the meetings but most discussions occurred between the attendees, local sponsors, and consultants after the scoping meeting. Landowner open houses were held in Moorcroft on April 16, 2014, and in Gillette on April 17 and October 15, 2014. During the open houses, landowners discussed their concerns and potential projects with the consultant and representatives from CCNRD, CCCD, CCID, WWDO, or NRCS. Table 2.1 lists the meetings conducted within the subbasin during the study.

2.2 LANDOWNER MEETINGS AND FIELD VISITS

Following the scoping meetings and open houses, landowners interested in the study contacted the consultant, CCNRD, CCCD, or NRCS staff. Meetings with landowners were then scheduled at their properties where discussions focused on land and water resource concerns and issues specific to the landowner. Usually, the landowner gave a tour of the property to the consultant and was often accompanied by a representative from the CCNRD, CCCD, or NRCS. During these visits, conceptual ideas were discussed for potential water development projects.

Field inventory efforts were often conducted in coordination with planned scoping meetings, landowner open houses, CCNRD and CCCD board meetings, and landowner visits. Field activities focused on irrigation, upland livestock/wildlife water opportunities, riparian and stream channel conditions, dam and reservoir assessment, and hydrologic investigations. Ranchers, irrigators, and residents who visited with the study team to discuss issues and concerns demonstrated extensive knowledge and valuable insight about the watershed.

Table 2.1. Scoping, Landowner, Study, and Coordination Meetings in the Subbasin Above Keyhole Reservoir

Number	Date	Type	Location
2	07/10/13	Local Sponsor Meeting	CCCD Gillette Office
3	07/18/13	Coordination Meeting	Campbell County GIS Gillette Office
6	09/16/13	Coordination Meeting	CCCD Gillette Office
7	09/16/13	Scoping Meeting	Campbell County Rec Center Gillette
8	09/17/13	Project Update/Status	Wyoming Association of Conservation Districts (WACD) Area I Meeting Wright
18	03/10/14	Local Sponsor Meeting	CCCD Gillette Office
20	04/07/14	Local Sponsor Meeting	CCCD/CCNRD Joint Meeting Moorcroft
21	04/16/14	Landowner Open House	Moorcroft Fire Department
22	04/17/14	Landowner Open House	Gillette Fire Department
25	04/22/14	Landowner Meeting	McNally Ranch
26	04/22/14	Landowner Meeting	Bush Ranch
27	04/22/14	Landowner Meeting	Yake Property
28	04/22/14	Landowner Meeting	Brown Property
31	04/24/14	Landowner Meeting	Bishop Ranch
35	05/20/14	Landowner Meeting	Shipwheel Ranch
37	06/17/14	Landowner Meeting	McNally Ranch
43	08/20/14	Local Sponsor Meeting	CCCD Gillette Office
45	08/29/14	Landowner Meeting	Rourke Ranch
50	09/19/14	Landowner Meeting	CCCD Gillette Office
56	10/10/14	Landowner Meeting	Empire Ranch
59	10/15/14	Landowner Open House	CCCD Gillette Office
64	10/25/14	Landowner Meeting	Warbonnet Ranch

3.0 WATERSHED DESCRIPTION AND INVENTORY

3.1 LAND USES AND ACTIVITIES

3.1.1 Land Ownership

The area of the Subbasin above Keyhole Reservoir within the Belle Fourche River Watershed covers approximately 1,948 square miles or 1,246,950 acres. Land management within the subbasin consists of 87.3 percent of parcels or approximately 1,088,840 acres under private ownership, 5.1 percent of parcels or 63,380 acres managed by federal agencies, and 6.9 percent of parcels or 85,660 acres owned by the state of Wyoming. Water covers approximately 9,070 acres (0.7 percent) of the subbasin. Almost 68 percent of the subbasin is located within Campbell County, while 17 percent is located in Crook County, and 15 percent is within Weston County. Table 3.1 lists the generalized categories of surface land ownership within the subbasin and Figure 3.1 displays the land ownership categories.

Table 3.1. Land Ownership Within the Subbasin

Ownership	Area (acres)	Area (square miles)	Area (%)
Private	1,088,840	1,701	87.3
Federal	63,380	99	5.1
Wyoming State Lands	85,660	134	6.9
Water	9,070	14	0.7
Total	**1,246,950**	**1,948**	**100.0**

3.1.2 Irrigated Lands

Irrigation within the subbasin is primarily for agricultural use. Based upon data provided by the WWDO, approximately 7,242 acres of irrigated land comprise 0.58 percent of the subbasin as listed by watershed (HUC-10) in Table 3.2 and shown in Figure 3.2. There are 205 points of diversion associated with these irrigated acres. Several individual ditches convey water to these irrigated acres. The crop grown on irrigated lands within the subbasin is primarily alfalfa with some hay and small grains such as oats and barley.

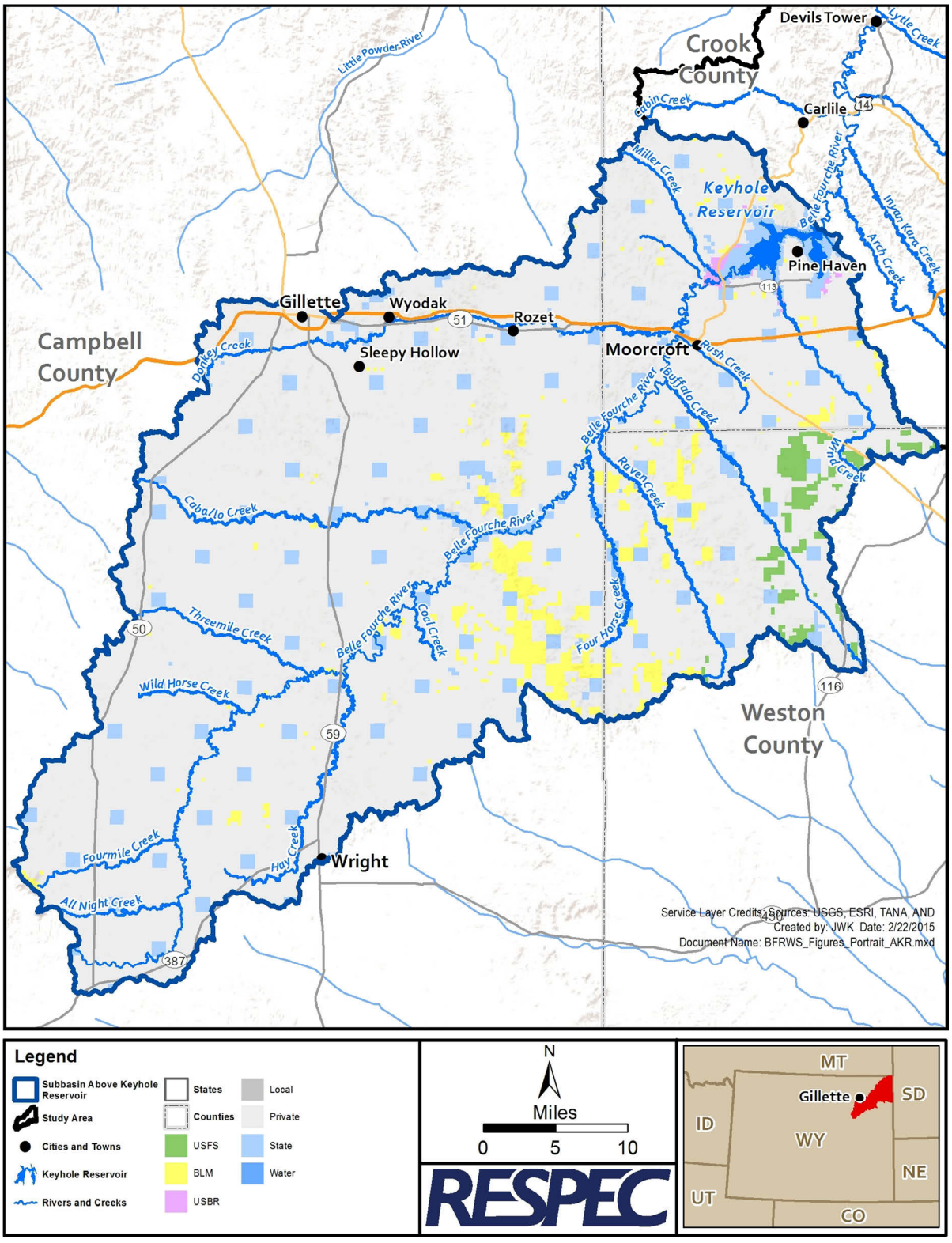


Figure 3.1. Categories of Land Ownership Within the Subbasin.

Table 3.2. Irrigated Lands by Subwatershed (HUC10) Within the Subbasin

Watershed (HUC10)	Estimated Area (acres)	Percent of Subbasin (%)
Mud Spring Creek-Belle Fourche River	1,174	0.09
Caballo Creek	750	0.06
Donkey Creek	1,231	0.10
Hay Creek-Belle Fourche River	483	0.04
Buffalo Creek-Belle Fourche River	1,852	0.15
Wind Creek-Belle Fourche River	1,752	0.14
Total Estimated Acres	**7,242**	**0.58**

3.1.3 Grazing

3.1.3.1 Range and Forest Lands

Approximately 1,190,050 acres of rangeland and forest lands occur within the subbasin and cover more than 95 percent of the subbasin, and approximately 1,173,450 acres of rangelands are within the subbasin (covering approximately 94.1 percent of the subbasin). Private land encompasses approximately 1,026,750 acres (87.5 percent) of the rangelands in the subbasin. The state of Wyoming manages 82,610 acres (7.0 percent), the Bureau of Land Management (BLM) manages approximately 44,980 acres (3.8 percent) and the United States Forest Service (USFS) manages approximately 14,410 acres (1.2 percent) of the rangelands within the subbasin as shown in Table 3.3. The remaining 4,700 acres (0.4 percent) of rangelands within the subbasin are owned by other parcel owners. In addition to the rangelands, forest lands cover approximately 1.3 percent of the subbasin or 16,600 acres with almost 80 percent of these forest lands under private ownership.

3.1.3.2 Federal Grazing Allotments

Grazing on an estimated 59,390 acres of federal rangelands within the subbasin is administered by the BLM and USFS. The BLM manages 73 grazing allotments in the subbasin comprising of approximately 282,253 acres. The BLM Buffalo Field Office administers approximately 93 percent of the BLM allotment acres; the BLM Newcastle Field Office administers the remaining 7 percent of the BLM allotment acres as shown in Figure 3.3 and summarized in Table 3.4. In addition to the BLM grazing allotments, the USFS Douglas Ranger District administers 19 grazing allotments encompassing approximately 44,378 acres consisting of private, state, and federal lands within the subbasin. The USFS grazing allotments within the subbasin are listed in Table 3.5 and also shown in Figure 3.3.

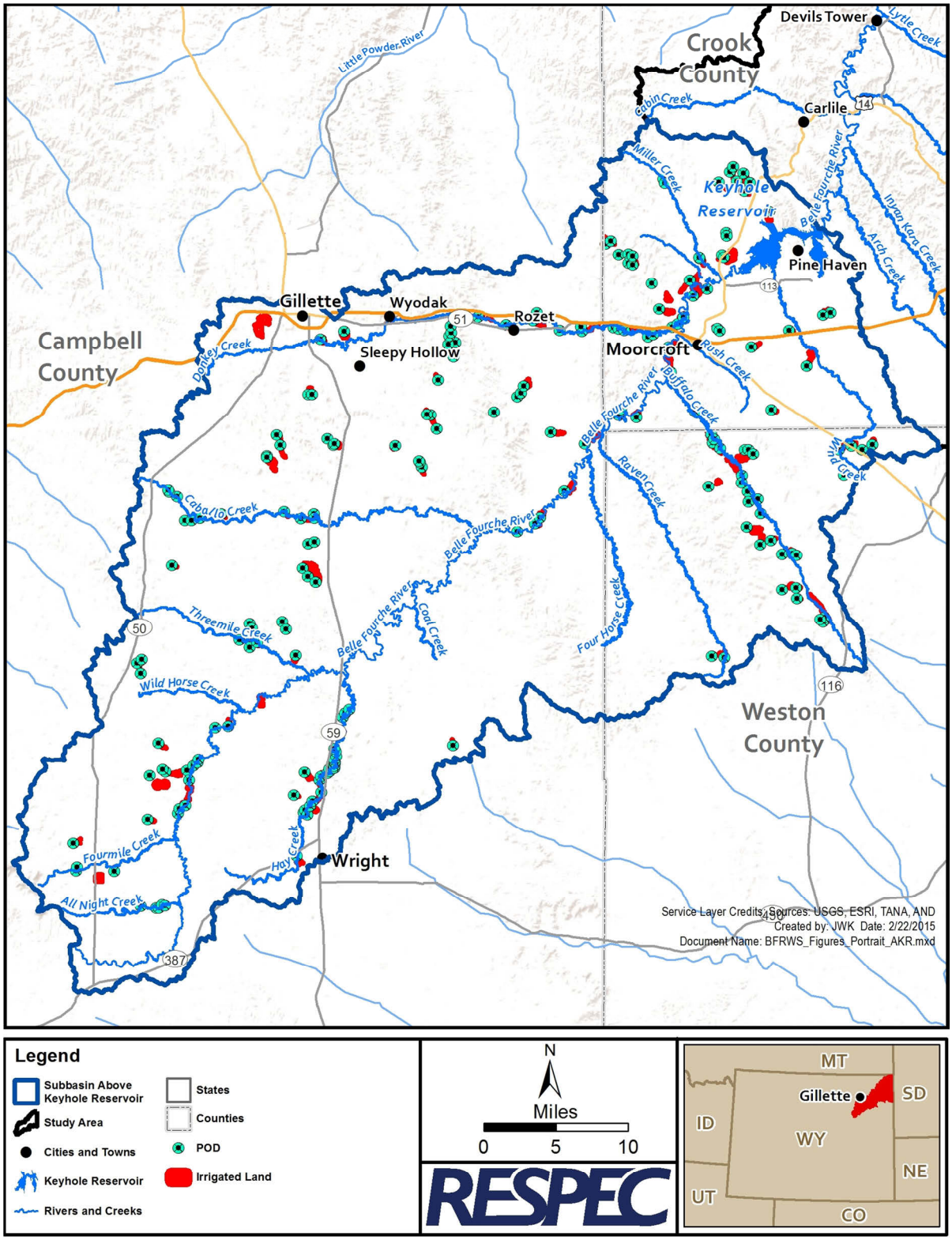


Figure 3.2. Irrigated Lands and Points of Diversion Within the Subbasin.

Table 3.3. Rangelands by Ownership/Management Within the Subbasin

Land Ownership or Management	Rangeland Acres	Percent of Total Rangeland Acres
Private	1,026,750	87.5
State of Wyoming	82,610	7.0
BLM	44,980	3.8
USFS	14,410	1.2
Other (U.S. Bureau of Reclamation, USFWS, etc.)	4,700	0.5
Total	**1,173,450**	**100.0**

3.1.3.3 Range Conditions and Needs

Range conditions depend on a number of factors including, but not limited to, climate and precipitation, soil and water, plants and animals, topography and geology, and natural disturbances. Range condition goals, objectives, and actions for the BLM managed allotments within the subbasin are detailed in the BLM's proposed and approved resource management plans (RMPs) and associated environmental impact statement (EIS) documents for the BLM Buffalo and Newcastle field offices. Range condition goals, objectives, and actions for the USFS grazing allotments are included in the USFS Forest Plan and amendments and associated EIS documents for the USFS Douglas Ranger District and Thunder Basin National Grassland Land.

Grazing permits or leases for a particular allotment, however, are not included within the RMP, Forest Plan, or EIS. Grazing leases and permits frequently include an allotment management plan (AMP), coordinated resource management plan (CRMP), or similar agreement that outlines a grazing plan and is prepared in cooperation with the permittees or operators. These plans often include goals and objectives, management indicators, use patterns, desired conditions, and monitoring techniques to measure progress.

Public land management policies directly affect the management of the private rangelands because public grazing leases and federal grazing allotments are integral components of a typical private grazing operation within the study area. Whether grazing occurs on private or public lands, a system of well-distributed, reliable water sources is a vital component to maintain or improve range conditions. A considerable amount of information regarding soils, hydrology, ecology, production, and vegetation within the study area is available. The ecological site description, which helps landowners and managers evaluate the condition of a range or forest site by comparing the current growth to what the site is capable of growing, can also be a valuable tool for landowners to use in their decision making.

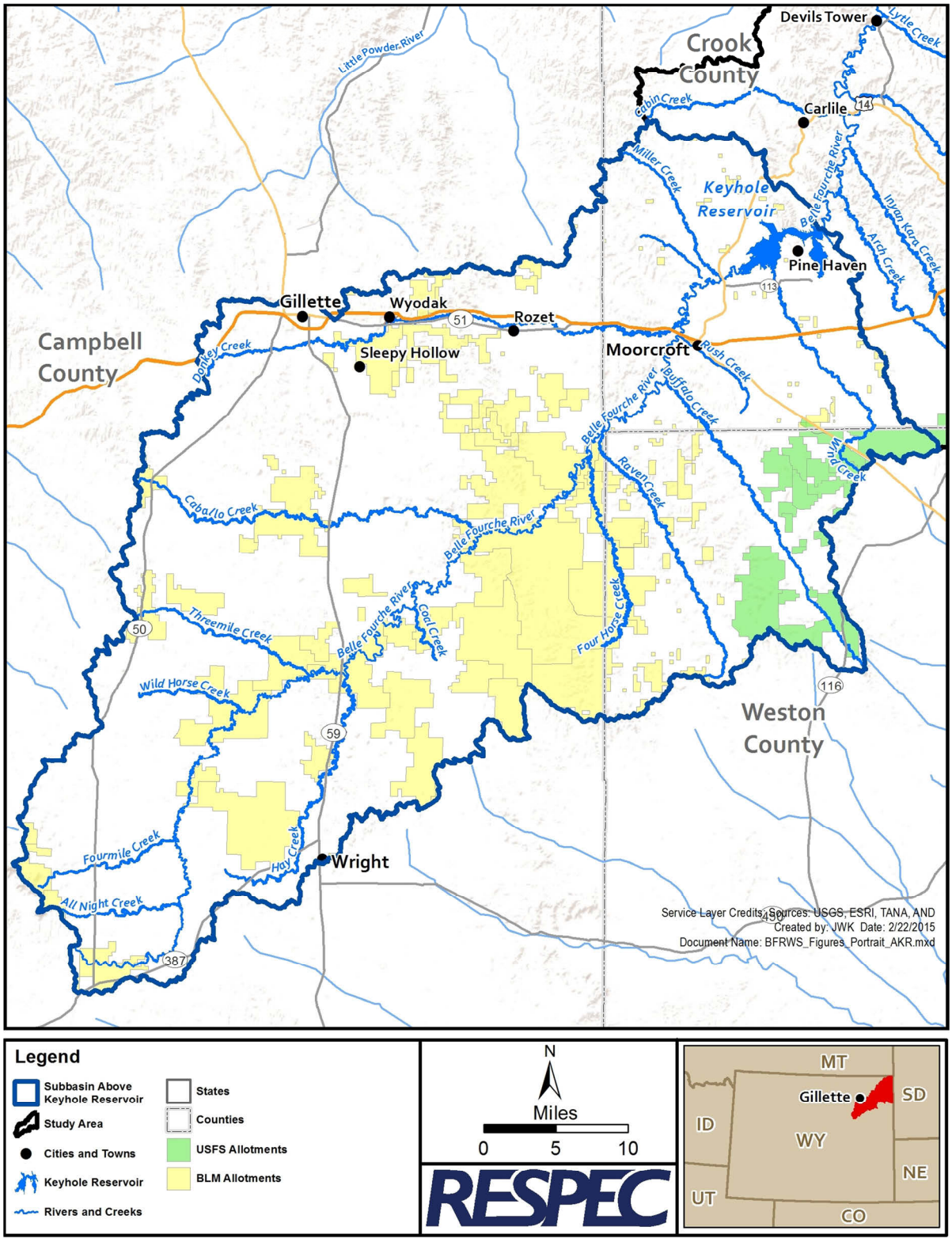


Figure 3.3. Federal Grazing Allotments Within the Subbasin and Study Area.

Table 3.4. Bureau of Land Management Allotment Summary for the Subbasin (Page 1 of 2)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Buffalo Field Office			**Buffalo Field Office**		
2242	Four Horse Creek	6,435	12149	Coal Creek	3,355
2243	Brower Draw	8,950	12150	Yellowhammer	6,101
2248	Coon Track Creek	3,620	12158	Jiggs Reservoir	912
2249	Osborn	3,661	12208	Caballo Draw	2,344
2256	Pinette Draw	7,930	12209	Belle Fourche TR	16,663
2258	Cabin Canyon	15,739	12231	Hilight	7,076
2263	Rozet	872	22021	Bishop	34,611
2272	Sand Rock/Hoe Creek	804	22027	Cordero Allotment	2,833
2280	South Middle Butte	0	22107	Fortin Draw	688
2306	Gardner Lake	204	22123	Lone Tree	19
2309	Mary Straatsma Est	1,968	22126	Four Horse	13,561
2319	Rattlesnake Creek	2,368	22130	Cottonwood Creek E.	94
2320	Jeffers Draw	2,794	22210	Bone Pile Creek	12,081
2321	Stuart, James R.	168	22590	S. Wyodak	7,041
2325	Linch (Iberlin)	5,629	**Newcastle Field Office**		
2329	Rochelle Hills	1,398	4050	Crazy Creek	82
2330	Reel	3,082	4070	Dry Creek III	38
2331	Winter Draw	3,938	4079	Pine Ridge I	538
2349	Three Mile Creek	15,233	4138	Miller Creek	80
2366	Antelope Draw	1,348	4143	Deer Creek	257
2367	Mud Spring Creek	2,011	4162	W Bacon Creek	115
2381	Wagensen Don Et Al	1,151	4164	Pine Ridge II	1,138
2452	S. Gillette Forty	494	4197	Berger Creek	291
2468	Chalk Hills	3,106	4205	Government Draw	326
12023	Lawver	17,144	4223	Four Horse Creek	242
12036	Willow Cr (T Chair)	2,083	4246	Raven Creek III	1,020
12049	Camblin	3,128	4263	Dry Creek S4+5	205
12069	Cook	2,255	4275	Coal Draw	1,194
12080	Dry Creek Ranch Inc.	13,858	4291	Hayworth Draw	325
12082	Wild Horse Cr Bar76	13,159	4304	Trail Creek	3,215
12091	West Timber Creek	2,465	4351	Buck Draw	3,773
12095	Neil Butte	7,353	4353	Edith Creek	499
12103	Threemile Creek Res.	2,381	4357	Raven Wyoming	1,015

Table 3.4. Bureau of Land Management Allotment Summary for the Study Area (Page 2 of 2)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Newcastle Field Office			Newcastle Field Office		
4383	Cottonwood Creek II	83	14009	Raven Creek I	1,357
4384	Antelope Draw	121	14010	Raven Creek II	444
4404	Wind Creek	282	14016	Freda Creek	966
4407	Hay Creek II	40	14018	Pine Ridge III	1,918

Table 3.5. U.S. Forest Service Allotments Within the Subbasin

Medicine Bow-Routt National Forest Ranger District	Allotment Number	Allotment Name	Area (acres)
Douglas	9218	Bacon Creek	2
	9304	Burr	266
	9318	Clyde	1,522
	9337	Cossart	43
	9325	Cranston	687
	9338	Driskell	2,979
	9001	Kara Community	2,120
	9370	Materi	719
	9372	Mirich	3,889
	9359	Pickrel	10,621
	9307	Pine Ridge	9,516
	9388	Rankin	661
	9303	Reynolds	1,864
	9392	Schuette	635
	9376	Shannon	2
	9373	Shepperson	6,944
	9371	Stellwagon	484
	9355	Watt	1,408
	9357	Webster	16

3.1.3.4 Existing Water Supply

A dependable water supply is the foundation for grazing management; it is necessary to provide sufficient amounts of suitable-quality water to animals over private and public rangelands. Numerous upland water sources are currently within the study area. Many rangeland improvements and grazing management projects have developed existing water sources such as springs, wells, and perennial streams. These projects often included storage tanks, ponds, reservoirs, pumping plants, and spring developments with pipelines carrying livestock and wildlife water to remote stock tanks.

Existing water sources on properties of participating landowners and managers were mapped within the watershed study. Mapping was not completed for the majority of private lands in the watershed because many landowners or managers did not participate in the study. The mapping is not a complete account of all viable water sources but serves as a baseline for estimating livestock and wildlife water needs within the subbasin. Mapping viable water sources within the subbasin included the following items:

- Maps of springs were obtained from the BLM Field Offices and USGS topographic maps.
- Maps of stock wells were created by using data obtained from the Wyoming State Engineer's Office (SEO) and WWDO.
- Interviews with landowners were conducted during study meetings and field visits.
- Maps were developed and existing stock ponds and reservoirs were inventoried during landowner field visits and assessed using aerial imagery, infrared imagery, topographic maps, and hydrography datasets.

This mapping effort indicated the existence of 111 stock reservoirs, ponds, lakes, and reservoirs. Digitized locations of springs were included by using BLM and USGS data. Although a detailed field verification of these sites was beyond the scope of this study, an initial review of the existing sources was completed. Recent high-resolution aerial imagery was examined by using the GIS data to determine the status and viability of the water features.

Existing structures containing water and showing no breaches of the dam or spillway were determined to be likely water sources. Some structures showed visible evidence of dam and spillway breaches or filled with sediment and were determined to be nonfunctional. Other structures were dry and designated as potential water sources. An example of the mapping process is shown in Figure 3.4.

The results of this mapping effort are presented in Figure 3.5. Several livestock/wildlife water development projects, which typically include wells, spring developments, pipelines, and stock tanks, have been completed within the subbasin. A 1-mile buffer was delineated around the existing viable water source locations within the subbasin and is presented in Figure 3.6. This figure of mapping results does not include surface water sources such as perennial and intermittent streams, undeveloped springs, or breached or nonfunctional ponds and reservoirs.

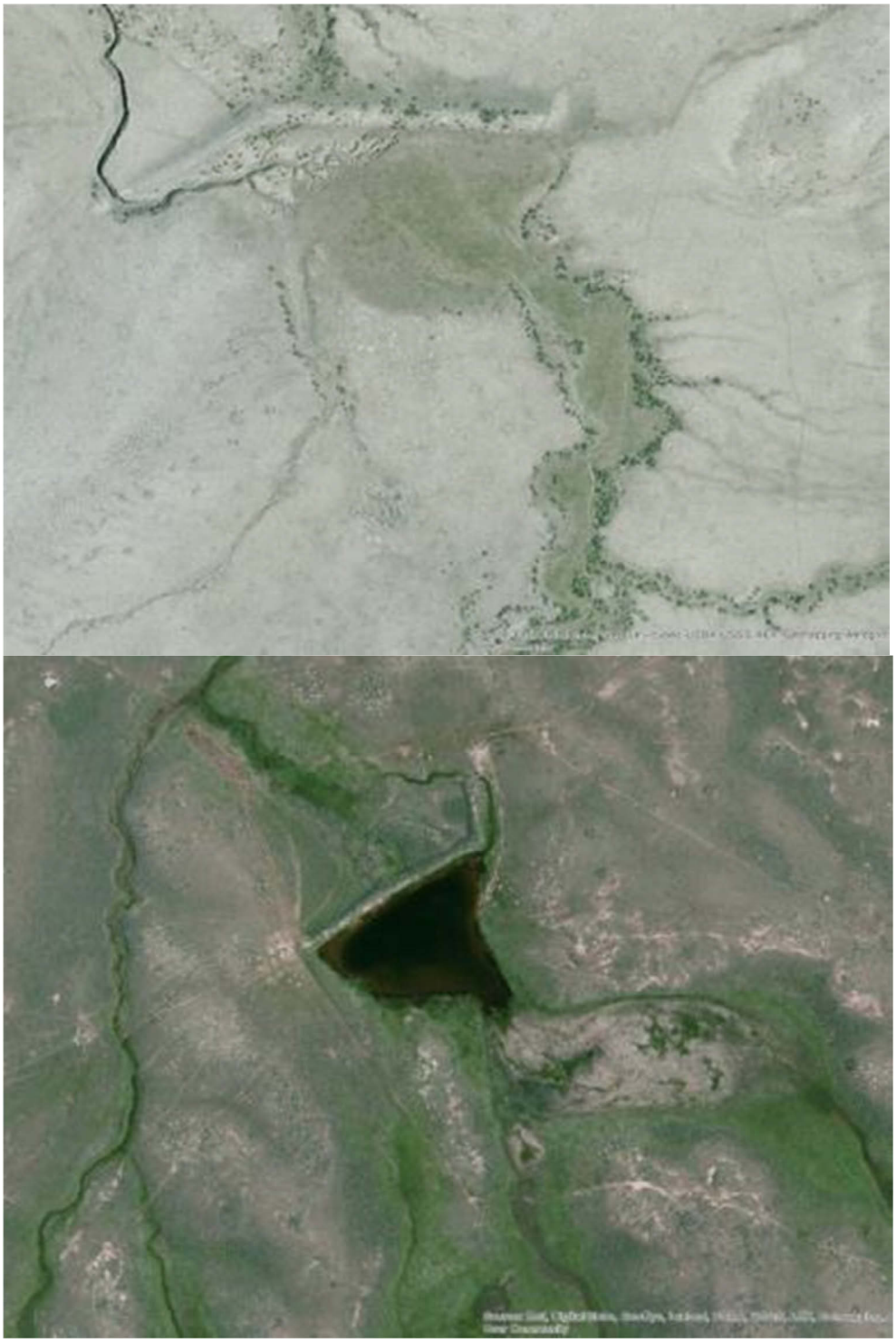


Figure 3.4. Geographic Information System Evaluation of Stock Ponds and Reservoirs Within the Subbasin.

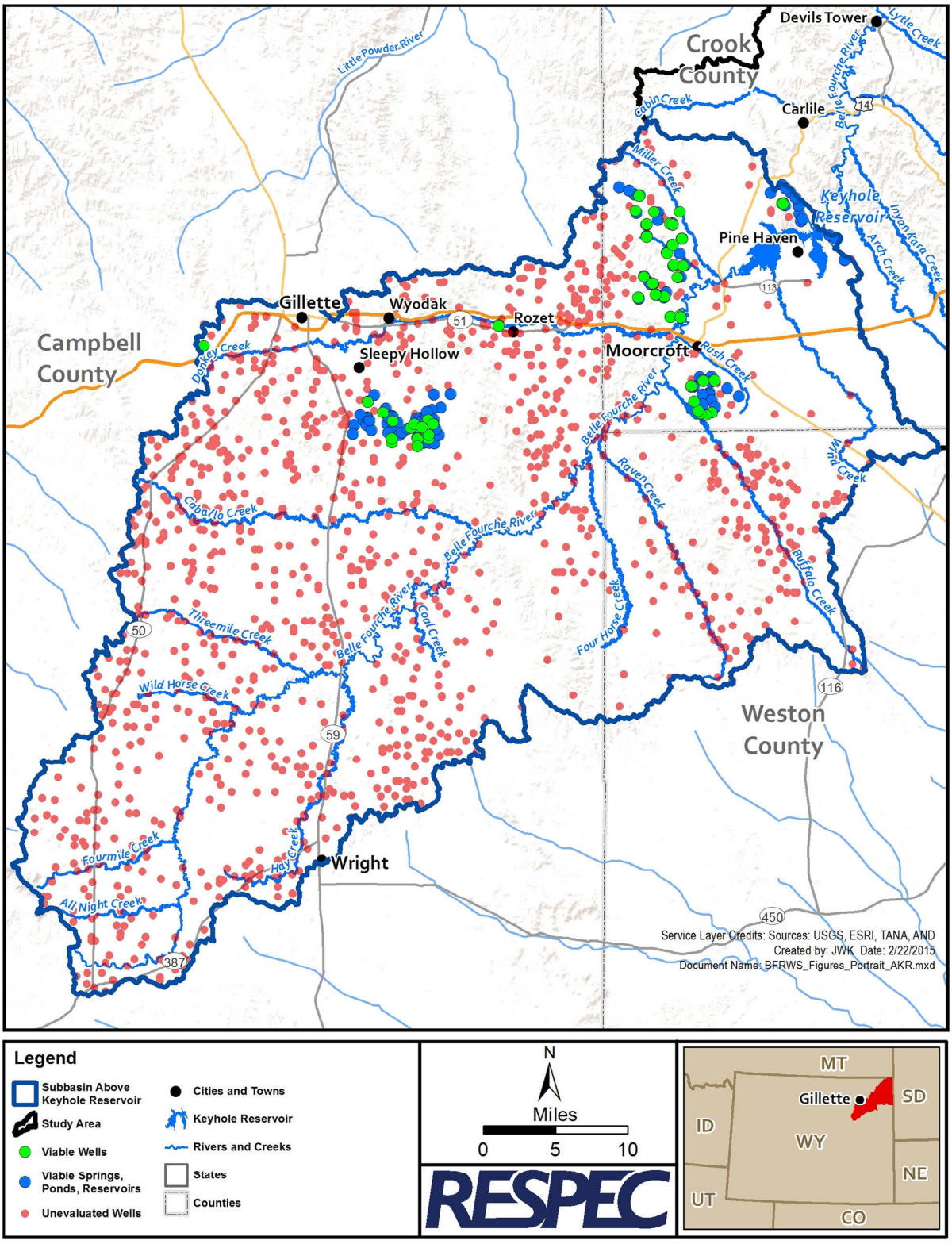


Figure 3.5. Viable Water Sources Within the Subbasin.

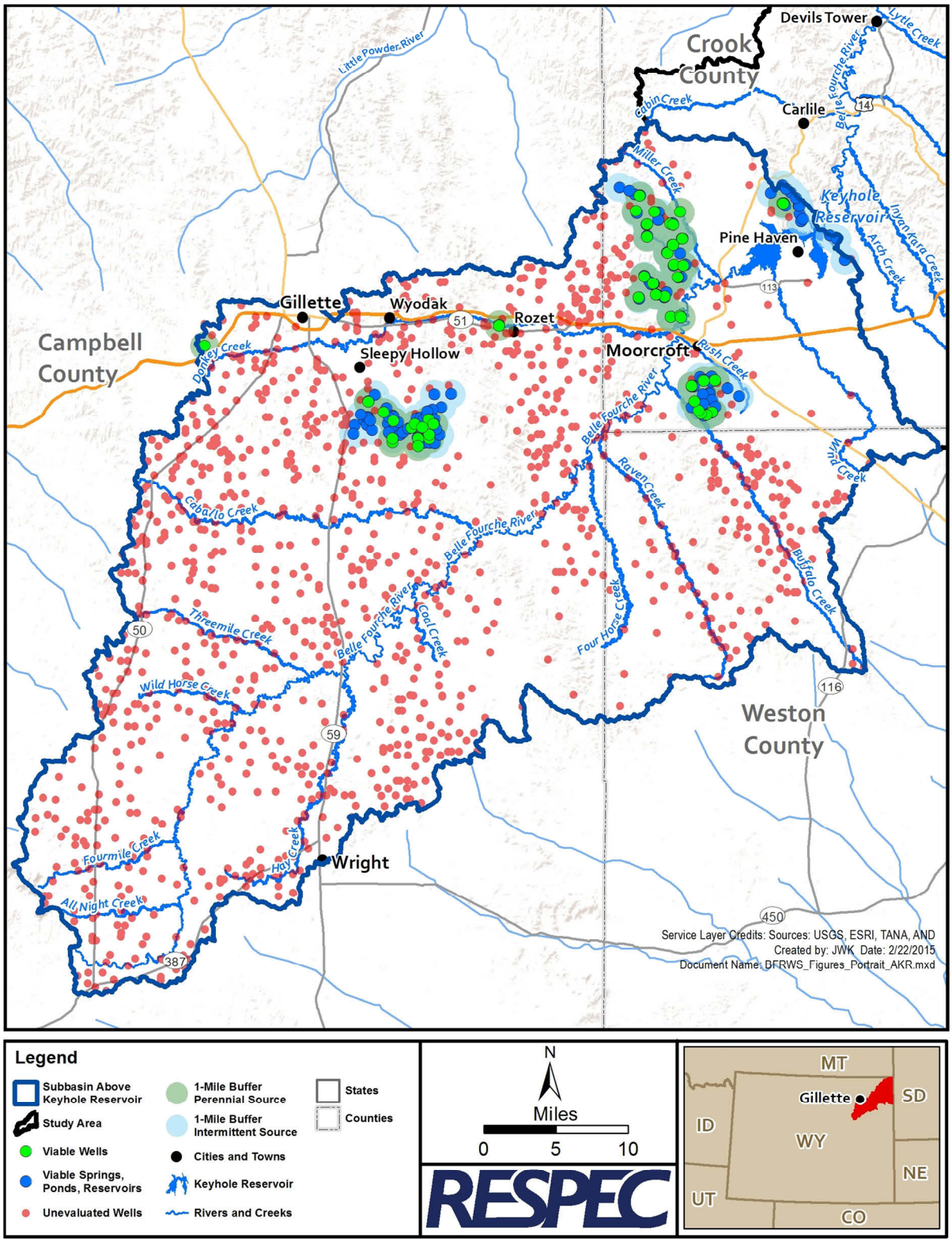


Figure 3.6. Viable Water Sources With a 1-Mile Buffer Within the Subbasin.

3.1.3.5 Ecological Site Descriptions

Rangelands are classified as ecological sites based on soils, topography, and climate that create each site's unique characteristics. An ecological site is a conceptual division of the landscape defined by the BLM, USFS, and NRCS [Caudle et al., 2013] as the following:

> *A distinctive kind of land based on recurring soil, landform, geological, and climate characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its ability to respond similarly to management actions and natural disturbances.*

Ecological sites incorporate environmental factors such as climate, soils, landform, hydrology, vegetation, and natural disturbance regimes that together define the site and its relationships between these factors and how they influence plant community composition [Caudle et al., 2013]. The characteristics differentiating ecological sites and their features are documented as an ecological site description (ESD), which includes the following:

- Data used to define the distinctive properties and characteristics of the sites
- Biotic and abiotic characteristics that differentiate the site (i.e., climate, physiographic, soil characteristics, plant communities)
- Ecological dynamics including how changes in climate, disturbance processes, and management can affect the site.

An ESD includes interpretations about the land uses that a specific ecological site can support along with alternatives for achieving objectives. ESDs are valuable tools that can be used to help landowners and managers make decisions through evaluating the condition or health of a range or forest site and comparing the current vegetation composition to the type of plants the site is capable of growing. The ecological sites and associated descriptions were developed over many years of data collection and range site monitoring and are dependent on the location of a site within defined precipitation zones and existing soil characteristics. ESDs available from the NRCS (*https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD*) describe the following for each ecological site:

- **Site characteristics**—physiographic, climate, soil, and water features
- **Plant communities**—plant species, vegetation states, and ecological dynamics
- **Site interpretations**—management alternatives for the site and its related resources
- **Supporting information**—relevant literature, information, and data sources.

The ESDs and NRCS soil map units are available and have been compiled for approximately 99 percent of the subbasin. There are 33 mapped ESDs covering approximately 90 percent of the subbasin. Figure 3.7 shows the locations of the ecological sites covering more than 2 percent of the acres within the subbasin. Five predominant ESDs cover approximately 56 percent of the subbasin as listed in Table 3.6 and are described in Chapter 4.0. The most predominant

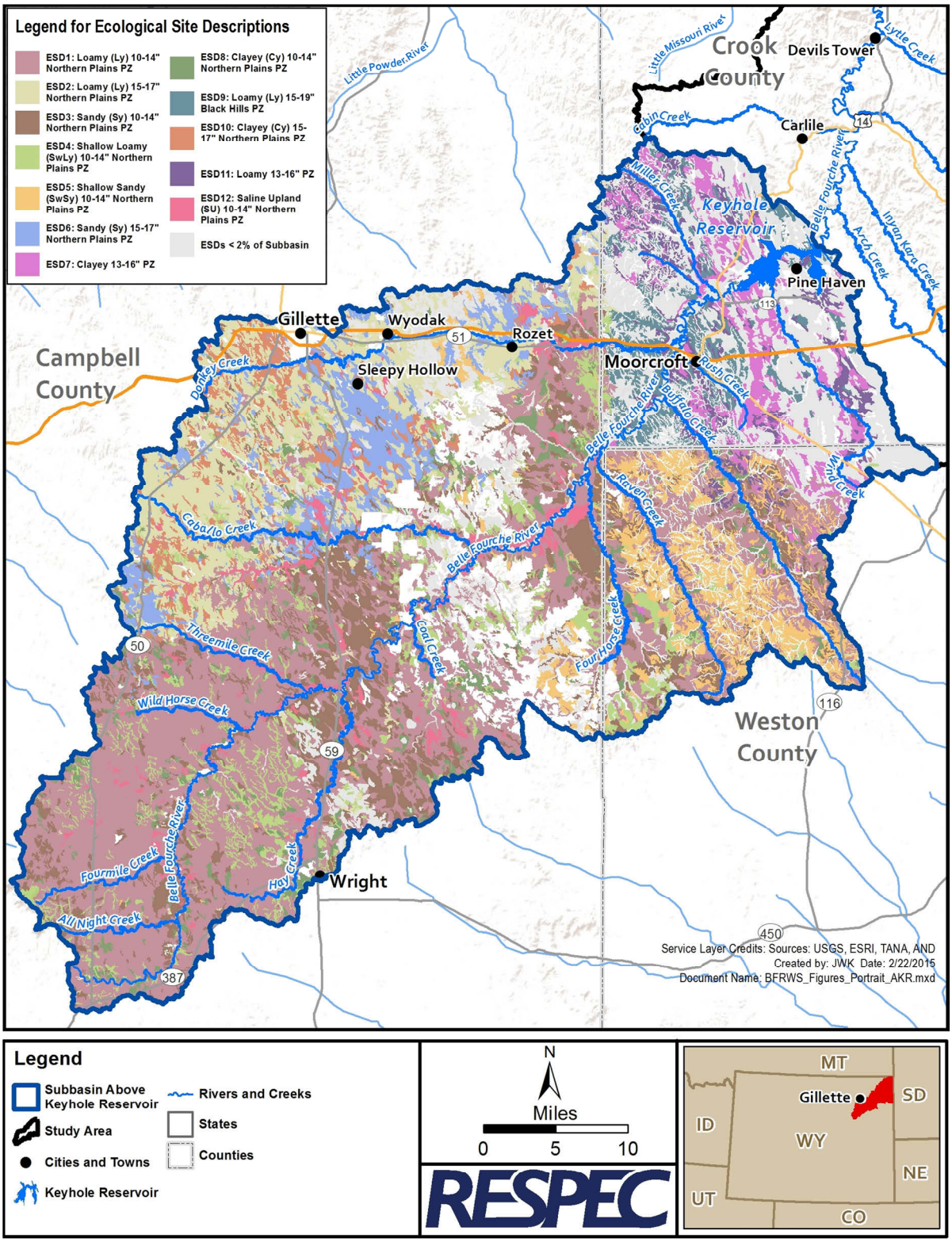


Figure 3.7. Ecological Site Descriptions Within the Subbasin.

ecological site, loamy (Ly) 10 to 14 inch Northern Plains precipitation zone ESD (R058BY122WY) is the largest covering approximately 351,030 acres (28.2 percent) of the subbasin. The ESDs covering more than 1 percent of the subbasin are listed in Table 3.7.

Table 3.6. Predominant Ecological Sites, Descriptions, and Areas Within the Subbasin

Indentifier	Ecological Site I.D.	Description	Area (Acres)	Percent of Subbasin
1	R058BY122WY	Loamy (Ly) 10–14 inch Northern Plains Precipitation Zone (PZ)	351,030	28.2
2	R058BY222WY	Loamy (Ly) 15–17 inch Northern Plains PZ	116,510	9.3
3	R058BY150WY	Sandy (Sy) 10–14 inch Northern Plains PZ	112,530	9.0
4	R058BY162WY	Shallow Loamy (SwLy) 10–14 inch Northern Plains PZ	63,530	5.1
5	R058BY166WY	Shallow Sandy (SwSy) 10–14 inch Northern Plains PZ	58,850	4.7
Total			**702,450**	**56.3**

Rangelands contain numerous ESDs. More than one plant community can occur within an ESD given the site characteristics discussed above. Each range ecological site has a specific plant community that has developed because of these factors and is referred to as reference or Historic Climax Plant Community (HCPC). The HCPC describes the potential plant community and potential productivity of each individual range site. Plant communities have distinct forage production potential; the HCPC usually has the greatest potential. The HCPC can be used to compare the current vegetation growing on a site to the plant community that could be grown on the site. This comparison using the HCPC can be an indicator of potential site productivity.

The descriptions of the HCPC associated with the predominant ESDs within the subbasin were obtained from the NRCS *ESD System for Rangeland and Forestland Data* website that can be accessed online (*https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD*) and are included in Chapter 4.0 of this report.

Table 3.7. Ecological Sites, Descriptions, and Areas for Subbasin

Identifier	Ecological Site I.D.	Description	Area (acres)	Percent of Subbasin
1	R058BY122WY	Loamy (Ly) 10–14 inch Northern Plains PZ	351,030	28.2
2	R058BY222WY	Loamy (Ly) 15–17 inch Northern Plains PZ	116,510	9.3
3	R058BY150WY	Sandy (Sy) 10–14 inch Northern Plains PZ	112,530	9.0
4	R058BY162WY	Shallow Loamy (SwLy) 10–14 inch Northern Plains PZ	63,530	5.1
5	R058BY166WY	Shallow Sandy (SwSy) 10–14 inch Northern Plains PZ	58,850	4.7
6	R058BY250WY	Sandy (Sy) 15–17 inch Northern Plains PZ	54,280	4.4
7	R060AY011SD	Clayey 13–16 inch PZ	36,380	2.9
8	R058BY104WY	Clayey (Cy) 10–14 inch Northern Plains PZ	34,540	2.8
9	R061XY122WY	Loamy (Ly) 15–19 inch Black Hills PZ	29,980	2.4
10	R058BY204WY	Clayey (Cy) 15–17 inch Northern Plains PZ	29,560	2.4
11	R060AY010SD	Loamy 13–16 inch PZ	25,320	2.0
12	R058BY144WY	Saline Upland (SU) 10–14 inch Northern Plains PZ	25,240	2.0
13	R060AY017SD	Shallow Clay	18,290	1.5
14	R058BY176WY	Very Shallow (VS) 10–14 inch Northern Plains PZ	16,610	1.3
15	R060AY012SD	Thin Upland	16,370	1.3
16	R058BY262WY	Shallow Loamy (SwLy) 15–17 inch Northern Plains PZ	14,780	1.2
17	R058BY128WY	Lowland (LL) 10–14 inch Northern Plains PZ	14,620	1.2
18-33	Various ESDs	ESDs covering less than 1 percent of the Subbasin	108,870	8.7
Total			1,127,290	90.4

3.1.4 Mining and Mineral Resources

The subbasin contains 23 operating noncoal mines. Information about the mines was obtained from the Wyoming Department of Environmental Quality (WDEQ) and summarized in Table 3.8 and Figure 3.8. Scoria and sand/gravel mines constitute the majority of permitted mine operations within the project area. Other minerals mined include bentonite and coal gasification. The largest mineral mining operation within the subbasin is the Upton bentonite mine operated by American Colloid Company on a permitted acreage of approximately 19,000 acres. Six active coal mines are located in the western portion of the subbasin near Gillette. Table 3.9 summarizes these operations, which can be seen in Figure 3.8. The largest coal mining operation within the subbasin is the Cordero Rojo Mine operated by Cordero Mining LLC on a permitted acreage of approximately 21,690 acres.

Table 3.8. Current Mineral Resource Mines Within the Subbasin

Permit I.D.	Permitted Mine	Permittee	Commodity	Mine Area (acres)
ET0866	Hitt	Eldridge Excavating Inc.	Sand and Gravel	10.0
ET1150	Durham Ranch	Basic Energy Service LP	Scoria	10.0
ET1193	Shober	Fuller Construction Inc.	Gravel	10.0
ET1265	Fuller Ranch	Magna Energy Service LLC	Scoria	10.0
ET1387	State/Pickrel	Fuller Construction Inc.	Scoria	4.2
ET1415	Greer	Quality Agg & Construction Inc.	Scoria	2.9
ET1418	Ohman	Quality Agg & Construction Inc.	Scoria	6.3
ET1448	Schlautmann	Quality Agg & Construction Inc.	Sand and Gravel	9.6
ET1464	Williams	Earth Work Solutions (WY)	Sand	7.1
ET1475	Swingholm	Dry Creek Trucking LLC	Scoria	3.6
PT0621	Upton	American Colloid Co.	Bentonite	19,016.7
PT0663	Vincent Thar	Fuller Construction Inc.	Scoria	41.6
PT0673	Thar	Magna Energy Service LLC	Scoria	26.3
PT0704	Groves	Groves, Urban H	Sand and Gravel	39.4
PT0709	Shober	Magna Energy Service LLC	Sand and Gravel	34.1
PT0711	Rag Scoria	Hettinger LLC	Scoria	158.7
PT0719	Pickrel Pit	Basic Energy Service LP	Scoria	21.9
PT0731	Durham Ranch Pit	Basic Energy Service LP	Scoria	41.6
PT0745	Iron Mountain	Black Hills Bentonite LLC	Bentonite	1,662.7
PT0745	Iron Mountain	Black Hills Bentonite LLC	Bentonite	1,662.7
PT0770	East Thar	Quality Agg & Construction Inc.	Scoria	83.3
PT0794	Flocchini	Quality Agg & Construction Inc.	Scoria	49.6
RD0001	Hoe Creek Project	U.S. Dept of Energy	Coal Gasification	74.0

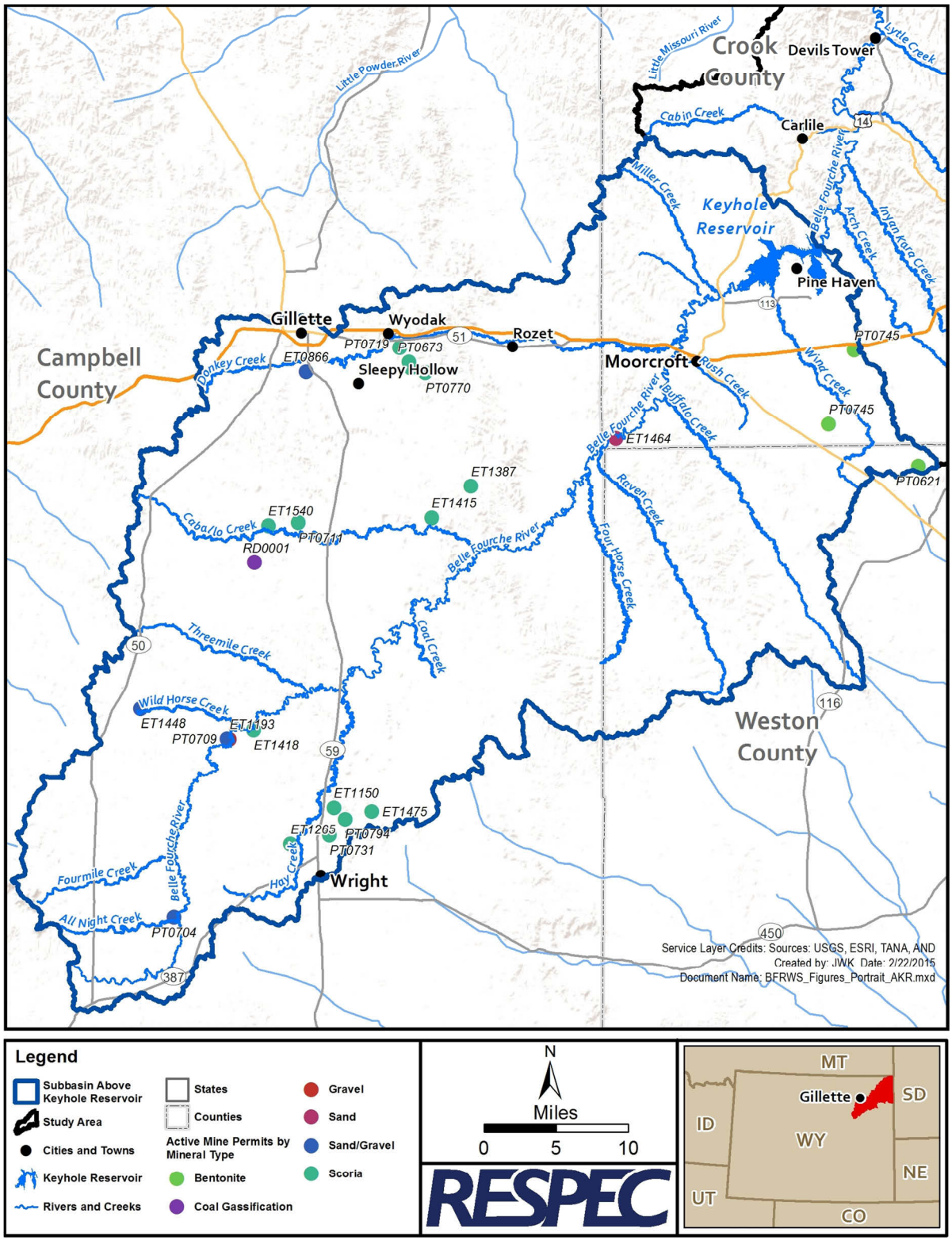


Figure 3.8. Permitted Mines Within the Subbasin.

Table 3.9. Current Coal Resource Mines Within the Study Area

Permit I.D.	Permitted Mine	Permittee	Mine Area (acres)
PT0214	Belle Ayr	Alpha Coal West Inc.	12,090.6
PT0232	WYODAK	WYODAK Resources Development Corp.	6,031.8
PT0237	Cordero Rojo	Cordero Mining LLC	21,685.0
PT0433	Caballo	Peabody Caballo Mining LLC	19,974.7
PT0483	Coal Creek	Thunder Basin Coal Company LLC	9,741.0
PT0676	Izita	Thunder Basin Coal Company LLC	1,831.1

3.1.5 Oil and Gas Production and Resources

Information and data regarding the active and abandoned oil and gas wells within the subbasin was obtained from the Wyoming Oil and Gas Conservation Commission (WOGCC) via their website (*http://wogccms.state.wy.us/*) and by communicating with WOGCC staff. Approximately 2,840 producing gas wells, 1,130 producing oil wells, and 6,290 permanently abandoned wells are within the subbasin. Locations of the active oil and gas wells and permanently abandoned wells are displayed in Figure 3.9.

According to the Wyoming State Geological Survey, the subbasin contains 172,095 acres of oil and gas area. In 2013, oil and gas fields within the subbasin produced approximately 4,544,244 barrels (bbls) of oil, 2,343,823 thousand cubic feet (mcf) of natural gas, and 24,942,131 bbls of water [Wyoming Oil and Gas Conservation Commission, 2014]. Table 3.10 summarizes the 2013 oil and gas production by field for the oil and gas areas within the subbasin. Field locations and pipelines are also shown on Figure 3.9.

3.1.6 Wildlife and Habitat

3.1.6.1 Big Game

The Wyoming Game and Fish Department (WGFD) has recorded, mapped, and analyzed data for big game and developed geodata showing hunt areas, herd units, seasonal range, crucial range, parturition area, and migration routes and barriers for antelope, bighorn sheep, bison, elk, mule deer, moose, Rocky Mountain goat, and white-tailed deer. No areas within the subbasin are considered as parturition area or crucial range for any big game species. Figures 3.10 through 3.13 display the herd units, seasonal range, and critical range for antelope, elk, mule deer, and white-tailed deer. These figures show that the entire subbasin is seasonal range for antelope, elk, mule deer, and white-tailed deer. Approximately 25 percent of the subbasin is seasonal range for elk.

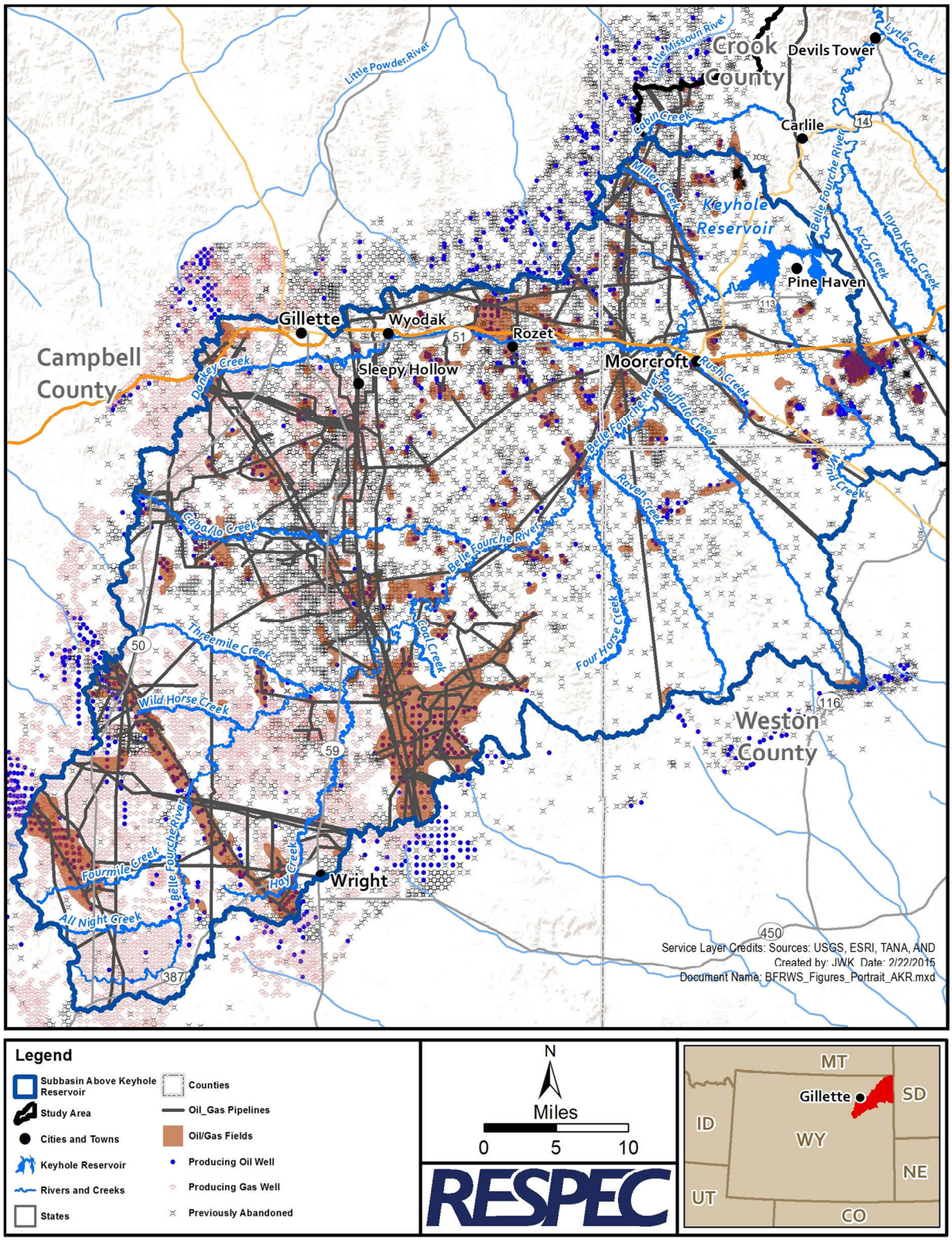


Figure 3.9. Active Oil and Gas Wells Within the Subbasin and Surrounding Area.

Table 3.10. 2013 Oil and Gas Production by Field Within the Subbasin (Page 1 of 3)

Oil or Gas Field	Oil (bbls)[a]	Gas (mcf)[b]	Water (bbls)[a]
Austin Creek	23,617	680,761	1,486
Am-Kirk	12,255	1,265	248,332
Art Creek	8,753	0	46,645
Barton	945	0	80,147
Bethlehem	3,963	0	0
Bigfoot	19,824	0	634,559
Bone Pile	59,485	0	695,161
Buff	3,459	70,268	110
Butte	1,040	0	0
Coyote Creek	20,132	4,412	1,137,584
Coyote Creek South	21,981	9,010	1,295,926
Doe	NDA	NDA	NDA
Donkey Creek North	16,719	0	32,579
Eagle Rock	NDA	NDA	NDA
East Fork	1,481	0	0
Eitel	9,561	0	227,945
FD	44,493	0	943,672
Fiddler Creek	23,370	3,810	193,386
Fiddler Creek East	443	0	46,882
Osage	43,331	0	532,516
Fish	35,590	0	0
Four Horse	0	0	0
Gaither Draw	140,834	24,947	76,654
Hartzog Draw	618,227	148,112	2,446,187
Hawk Point	5,938	0	255,650
Hay Creek	9,459	120,813	504
House Creek	1,994,732	961,671	5,025,241

Table 3.10. 2013 Oil and Gas Production by Field Within the Subbasin (Page 2 of 3)

Oil or Gas Field	Oil (bbls)[a]	Gas (mcf)[b]	Water (bbls)[a]
House Creek West	11,627	2,462	47,589
Kara	1,623	234	56
K-Bar	210,633	171,688	229,723
Keyhole	24	0	0
Kitty	57,480	719,220	11,793
Kummerfield West	14,386	0	403,964
Little Powder	NDA	NDA	NDA
Mill – Gillette	4,199	300	24,830
Napier Road	1,600	0	0
Pinnacle Divide	4,399	0	664
Pleasantville	11,827	0	5,516
Prong Creek	60,573	0	1,380,701
Quest	14,775	40,680	58,377
Rabbit Ears	NDA	NDA	NDA
Rainbow Ranch	14,391	580	493,724
Reel	62,684	0	208,373
Robinson Ranch	13,892	0	1,624,565
Robinson Ranch East	13,191	0	599,727
Robinson Ranch South	9,436	0	153,940
Rock Creek	12,219	0	13,300
Rocky Hill	0	0	0
Rozet	166,748	2,781	1,351,553
Rozet East	27,809	0	217,341
Rozet West	19,300	0	702,147
Rozet South	35,662	0	279,749
S-Bar	24	4	0
Slattery	144,761	6,621	1,602,442

Table 3.10. 2013 Oil and Gas Production by Field Within the Subbasin (Page 3 of 3)

Oil or Gas Field	Oil (bbls)[a]	Gas (mcf)[b]	Water (bbls)[a]
Springen Ranch	12,301	0	88,349
Surprise	NDA	NDA	NDA
Thornton	1,272	0	37
Three Mile	NDA	NDA	NDA
Timber Creek	405,907	234	1,097,641
Timber Creek South	796	0	0
Trava	822	0	2,711
Twenty-One Mile Butte	69,980	34,081	60,495
Wagensen	1,592	10,344	33,310
Wakeman Flats	424	0	422
West Fork	10,177	0	9,779
Widge	13,512	1,114	14,181
Widge North	1,456	0	344
Wood	16,727	9,172	305,108

(a) bbls = One barrel equals 42 (U.S.) gallons of liquid at 60°F at atmospheric pressure.
(b) mcf = One thousand cubic feet of natural gas.
NDA = No Data Available

3.1.6.2 Species of Concern

The Wyoming Natural Diversity Database (WYNDD) records and maintains a list of species in Wyoming that are thought to be rare or sensitive. Table 3.11 lists the tracked or watched species of amphibians, birds, crustaceans, fern and fern ally, fish, insects, mammals, mollusks, and reptiles found within the subbasin [Wyoming Natural Diversity Database, 2014]. The list shows that there is one endangered species: the black-footed ferret (*Mustela nigripes*) and one threatened species: piping plover (*Charadrius melodus*) were known to have occurred in the subbasin. Table 3.11 shows that the sage-grouse is listed as "candidate species; warranted but precluded" because existing information supports a proposal to list the sage-grouse as endangered or threatened, but developing a proposed listing is precluded by higher priority listing activities. In 2011, the Governor of Wyoming issued an executive order to protect and enhance sage-grouse populations and habitat within and outside the core areas. The order requires state agencies to focus management to the greatest extent possible to prevent the sage-grouse from being listed on the endangered species list. The core areas for sage-grouse cover approximately 228,990 acres (18 percent) of the subbasin and are shown in Figure 3.14.

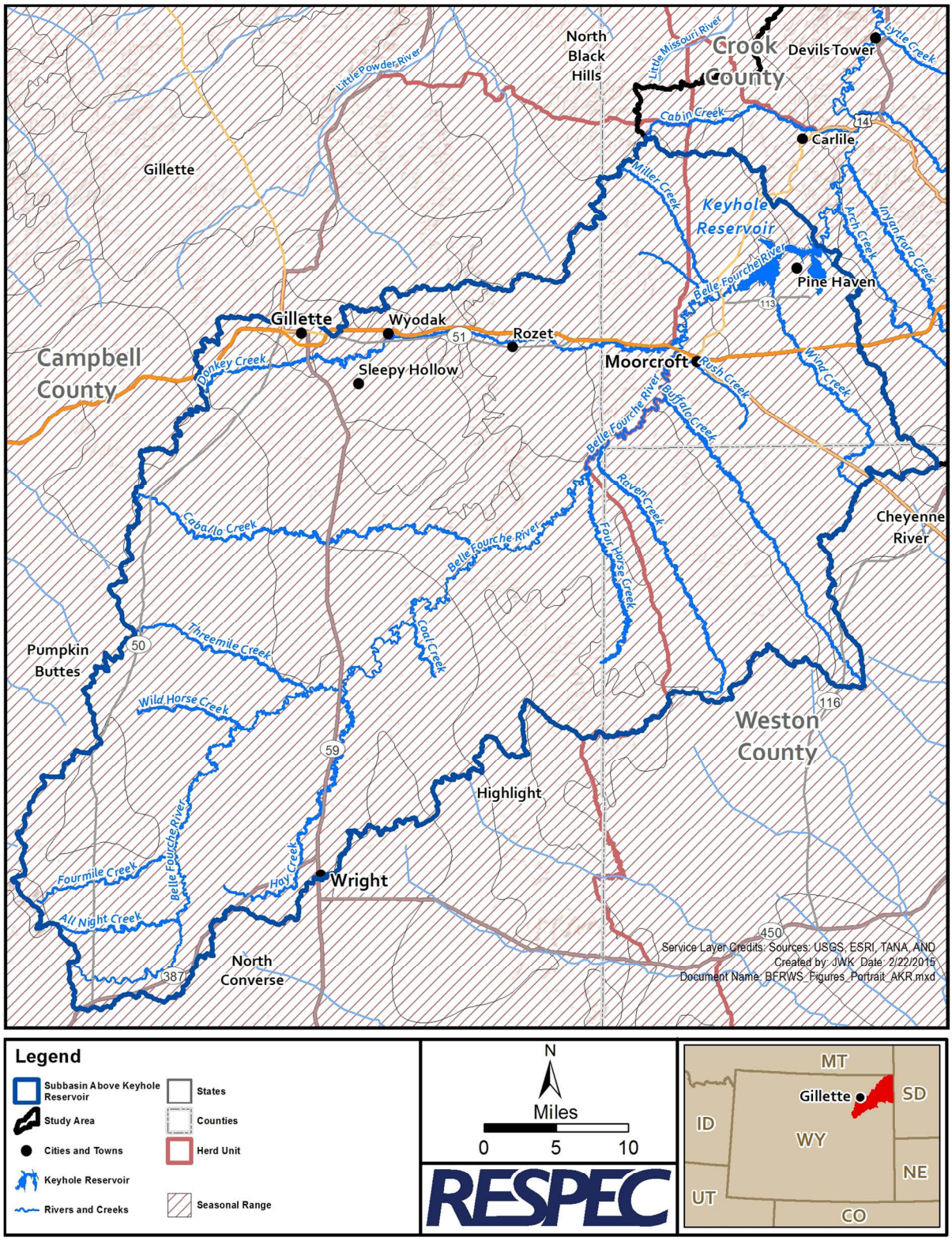


Figure 3.10. Antelope Habitat Within the Subbasin and Surrounding Area.

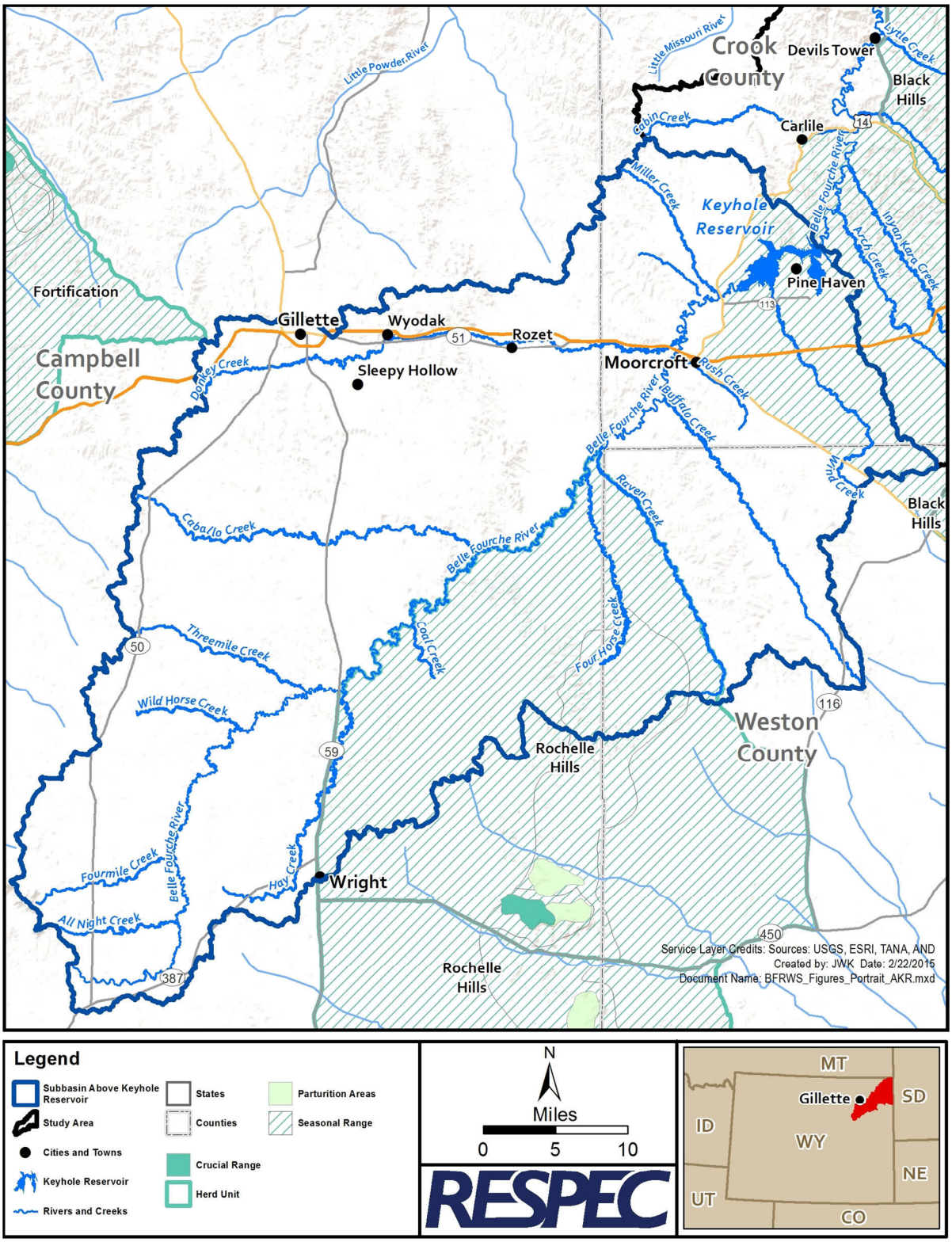


Figure 3.11. Elk Habitat Within the Subbasin and Surrounding Area.

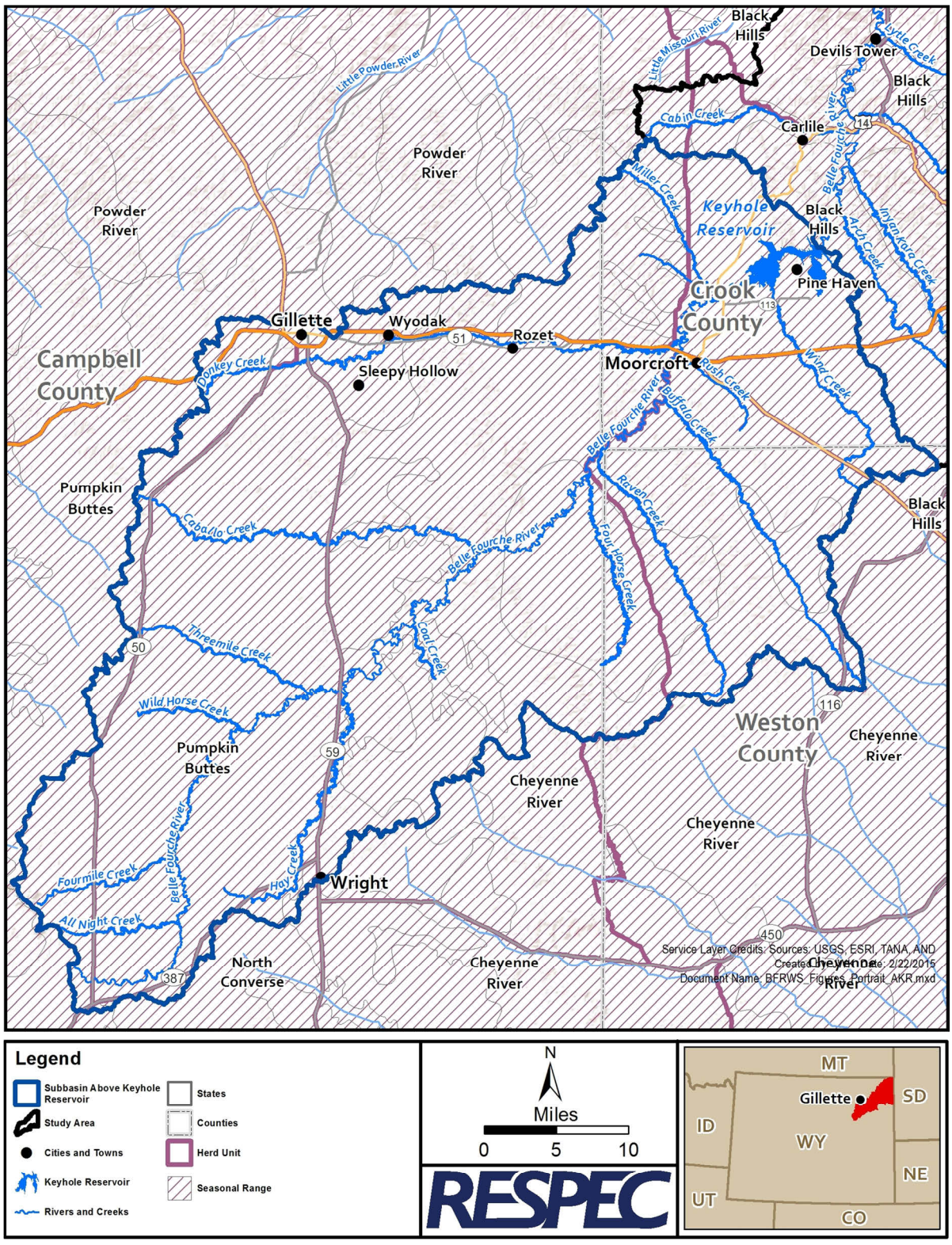


Figure 3.12. Mule Deer Habitat Within the Subbasin and Surrounding Area.

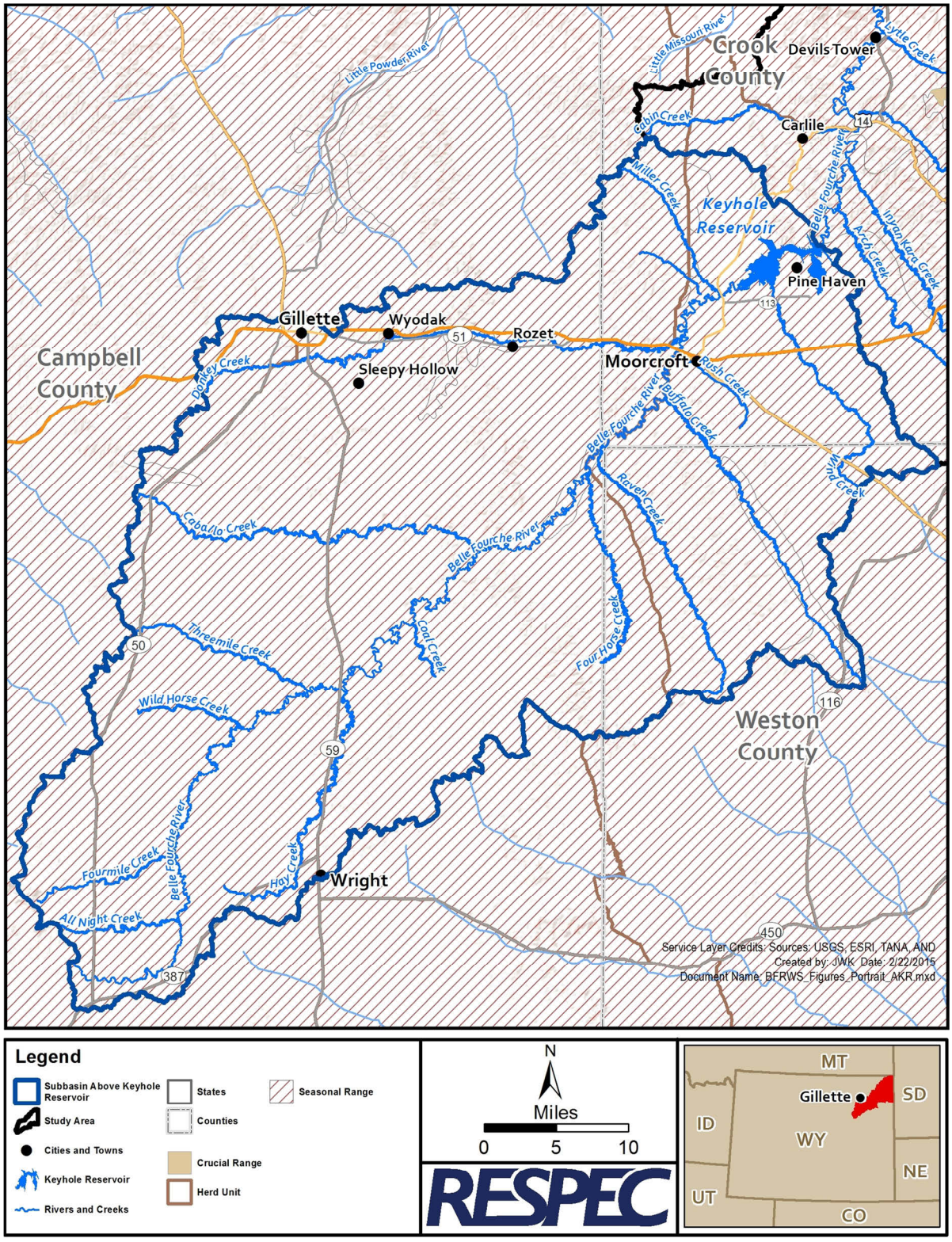


Figure 3.13. White-Tailed Deer Habitat Within the Subbasin and Surrounding Area.

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (Page 1 of 3)

Scientific Name	Common Name	Listing Status	Tracking Status
Amphibian			
Ambystoma mavortium	Tiger Salamander		Watched
Anaxyrus cognatus	Great Plains Toad		Watched
Lithobates pipiens	Northern Leopard Frog	Not Warranted for Listing	Tracked
Bird			
Accipiter gentilis	Northern Goshawk	Not Warranted for Listing	Tracked
Aechmophorus clarkii	Clark's Grebe		Tracked
Ammodramus savannarum	Grasshopper Sparrow		Watched
Aquila chrysaetos	Golden Eagle		Watched
Artemisiospiza nevadensis	Sagebrush Sparrow		Tracked
Asio flammeus	Short-eared Owl		Tracked
Athene cunicularia	Burrowing Owl		Tracked
Aythya collaris	Ring-necked Duck		Watched
Botaurus lentiginosus	American Bittern		Tracked
Bucephala albeola	Bufflehead		Watched
Bucephala clangula	Common Goldeneye		Watched
Buteo regalis	Ferruginous Hawk		Tracked
Calcarius ornatus	Chestnut-collared Longspur		Tracked
Centrocercus urophasianus	Greater Sage-Grouse	Warranted but Precluded	Tracked
Charadrius melodus	Piping Plover	Listed Threatened	Watched
Charadrius montanus	Mountain Plover	Not Warranted for Listing	Tracked
Chlidonias niger	Black Tern		Tracked
Cygnus buccinator	Trumpeter Swan	Not Warranted for Listing	Tracked
Cygnus columbianus	Tundra Swan		Watched
Dolichonyx oryzivorus	Bobolink		Tracked
Egretta thula	Snowy Egret		Watched
Falco columbarius	Merlin		Watched
Gavia immer	Common Loon		Tracked
Grus canadensis	Sandhill Crane		Watched
Haliaeetus leucocephalus	Bald Eagle	Delisted, formally monitored	Tracked
Himantopus mexicanus	Black-necked Stilt		Watched
Junco hyemalis aikeni	White-winged Junco		Watched
Lanius ludovicianus	Loggerhead Shrike		Tracked
Larus argentatus	Herring Gull		Watched

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (Page 2 of 3)

Scientific Name	Common Name	Listing Status	Tracking Status
Bird			
Larus californicus	California Gull		Watched
Larus delawarensis	Ring-billed Gull		Watched
Megascops asio	Eastern Screech-Owl		Watched
Melanerpes lewis	Lewis's Woodpecker		Tracked
Numenius americanus	Long-billed Curlew		Tracked
Nycticorax nycticorax	Black-crowned Night-Heron		Watched
Oreoscoptes montanus	Sage Thrasher		Watched
Oreothlypis virginiae	Virginia's Warbler		Tracked
Pandion haliaetus	Osprey		Watched
Pelecanus erythrorhynchos	American White Pelican		Tracked
Phalaropus lobatus	Red-necked Phalarope		Watched
Recurvirostra americana	American Avocet		Watched
Regulus satrapa	Golden-crowned Kinglet		Watched
Rhynchophanes mccownii	McCown's Longspur		Tracked
Sitta pygmaea	Pygmy Nuthatch		Tracked
Spiza americana	Dickcissel		Watched
Spizella breweri	Brewer's Sparrow		Watched
Spizella pallida	Clay-colored Sparrow		Watched
Tyto alba	Barn Owl		Watched
Vireo olivaceus	Red-eyed Vireo		Watched
Fern and Fern Ally			
Selaginella rupestris	Ledge spike-moss		Tracked
Fish			
Platygobio gracilis	Flathead Chub		Watched
Insect			
Hesperia ottoe	Ottoe Skipper		Tracked
Phyciodes batesii	Tawny Crescent		Tracked
Speyeria idalia	Regal Fritillary		Tracked
Mammal			
Bos bison bison	Plains Bison	Not Warranted for Listing	Tracked
Canis lupus	Gray Wolf	Proposed for Delisting	Tracked
Cynomys ludovicianus	Black-tailed Prairie Dog	Not Warranted for Listing	Tracked

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (Page 3 of 3)

Scientific Name	Common Name	Listing Status	Tracking Status
Mammal			
Lasionycteris noctivagans	Silver-haired Bat		Watched
Lasiurus cinereus	Hoary Bat		Watched
Mustela nigripes	Black-footed Ferret	Listed Endangered	Tracked
Mustela nivalis	Least Weasel		Watched
Myotis ciliolabrum	Western Small-footed Myotis		Watched
Myotis evotis	Long-eared Myotis		Watched
Myotis volans	Long-legged Myotis		Watched
Sorex nanus	Dwarf Shrew		Watched
Sylvilagus floridanus	Eastern Cottontail		Watched
Tamiasciurus hudsonicus dakotensis	Black Hills Red Squirrel		Tracked
Urocyon cinereoargenteus ocythous	Prairie Gray Fox	Petition Under Review	Watched
Vulpes velox	Swift Fox	Not Warranted for Listing	Tracked
Zapus hudsonius campestris	Bear Lodge Meadow Jumping Mouse		Tracked
Mollusk			
Pyganodon grandis	Giant Floater		Tracked
Reptile			
Coluber constrictor flaviventris	Eastern Yellow-bellied Racer		Watched

3.2 SETTING AND ENVIRONMENT

3.2.1 Land Cover

Table 3.12 is a summary of land cover using the National Land Cover Dataset (NLCD). The NLCD is a 16-category land cover classification method that is applied across the United States. The NLCD uses data derived from Landsat imagery and ancillary data. Approximately 803,270 acres (64 percent) of land cover in the subbasin is comprised of grassland/herbaceous vegetative cover. Approximately 370,190 acres (30 percent) of the subbasin is as shrub/scrub land. The remaining areas consist of evergreen forest, barren, developed, cultivated crops, and other classes. An estimated 4,030 acres of water exists within the subbasin.

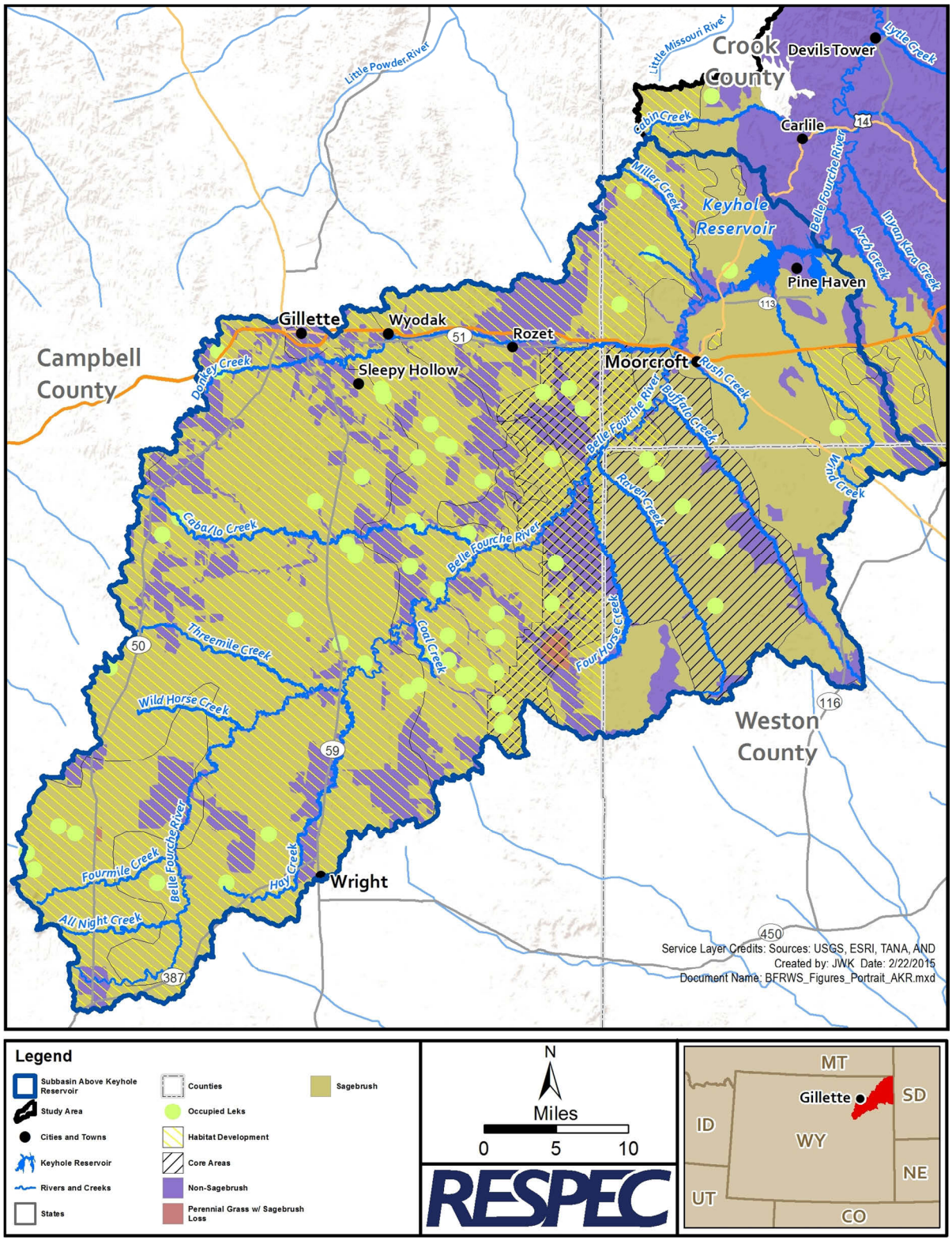


Figure 3.14. Sage-Grouse Distribution and Core Areas Within the Subbasin and Study Area.

Table 3.12. National Land Cover Dataset Classifications Within the Subbasin

Classification	Description	Area (acres)	Percent of Subbasin
Grassland and Herbaceous	Gramanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation cover. These areas are not subject to tilling, but are used for grazing.	803,266	64.4
Shrub and Scrub	Shrubs less than 16 feet tall with canopy typically greater than 20 percent of total vegetation cover. This class includes shrubs and trees in early successional stages or stunted from environmental conditions.	370,188	29.7
Evergreen Forest	Trees greater than 16 feet tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.	16,421	1.3
Barren Land (Rock/Sand/Clay)	Bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other earthen material. Vegetation accounts for less than 15 percent of total.	16,279	1.3
Developed, Open Space	A mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of cover. These areas commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developments for recreation, erosion control, or aesthetics.	10,775	0.9
Cultivated Crops	Production of annual crops and also perennial woody crops. Crops accounts for greater than 20 percent of total vegetation. This class also includes land being tilled.	9,086	0.7
Developed, Low Intensity	A mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49 percent of total cover. These areas commonly include single-family housing units.	4,387	0.4
Open Water	Open water, usually less than 25 percent cover of vegetation or soil.	4,034	0.3
Woody Wetlands	Forests or shrublands account for greater than 20 percent and the soil is periodically covered with water.	3,400	0.3
Pasture and Hay	Grasses, legumes, or mixtures planted for livestock grazing or the production of seed or hay crops on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.	3,362	0.2
Developed, Medium Intensity	A mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover. These areas commonly include single-family housing units.	2,957	0.2
Emergent Herbaceous Wetlands	Perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically covered with water.	2,020	0.2
Other	Areas with less than 0.1 percent of the study area.	575	<0.05
Total		**1,246,750**	**100.0**

3.2.2 Vegetation

The Wyoming Gap Analysis Program (GAP) data were obtained to evaluate existing vegetation in the subbasin, which are listed in Table 3.13 and shown in Figure 3.15. Additionally, Table 3.14 lists the plant species of concern within the subbasin as supplied by WYNDD. The subbasin is mostly included in the Great Plains Ecoregion which includes mostly grass, forb, shrub, and sagebrush communities. In general, the desirable grass species in the subbasin include rhizomatous wheatgrass, needleandthread, green needlegrass, prairie sandreed, big bluestem, and blue grama. Twenty-five designated and prohibited noxious weeds are on the state of Wyoming Weed and Pest Control Act Designated List and detailed in the basin wide summary report.

Table 3.13. Wyoming Gap Analysis Program: Existing Vegetation Type Within the Subbasin

Existing Vegetation Type	Area (acres)	Subbasin (%)
Northwestern Great Plains Mixedgrass Prairie	572,460	45.9
Inter-Mountain Basins Big Sagebrush Steppe	404,730	32.5
Close Grown Crop	128,710	10.3
Inter-Mountain Basins Big Sagebrush Shrubland	19,020	1.5
Northwestern Great Plains–Black Hills Ponderosa Pine Woodland and Savanna	16,910	1.4
Barren	13,750	1.1
All other classes, less than 1 percent each	91,370	7.3
Total	**1,246,950**	**100.0**

3.2.3 Wetlands

Approximately 16,560 acres of National Wetlands Inventory (NWI) are mapped wetland types, which cover approximately 1.32 percent of the subbasin. The predominant wetland type is a freshwater emergent, which occurs on approximately 9,720 acres within the subbasin. The NWI wetlands within the subbasin are listed in Table 3.15. The NWI wetland areas are shown in Figure 3.16. However, because the NWI wetland areas are very small in size relative to the subbasin and are scarcely visible when presented at this scale, the mapped wetland polygons were outlined with a thicker border to increase their visibility; NWI wetlands do not actually cover the amount of area indicated in the map figure. Site-specific wetland delineation were not part of the inventory and it is recommended that wetland delineation and inventories should be completed before planning future wetland projects.

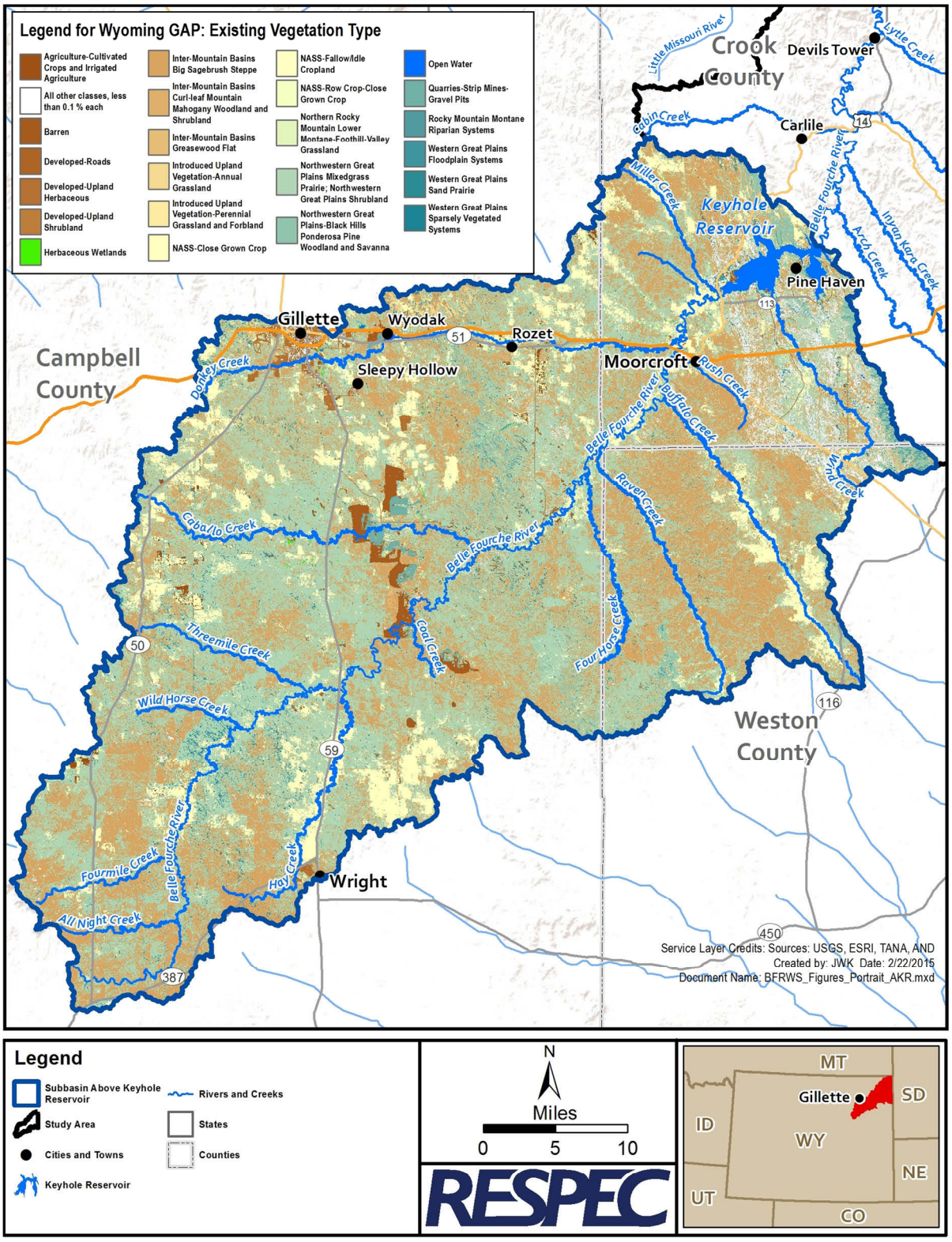


Figure 3.15. Wyoming Gap Analysis Program: Existing Vegetation Type Within the Subbasin.

Table 3.14. Wyoming Natural Diversity Database: Plants Within the Subbasin

Scientific Name	Common Name	Status
Astragalus barrii	Barr's milkvetch	Watched
Cyperus erythrorhizos	Red-root flatsedge	Tracked
Loeflingia squarrosa	Spreading loeflingia	Tracked
Physaria lanata	Woolly twinpod	Tracked

Table 3.15. Summary of Wetland Types Within the Subbasin

Wetland Type	Area (Acres)	Subbasin (%)
Freshwater Emergent Wetland	9,720	0.78
Lake	3,790	0.30
Freshwater Pond	2,490	0.20
Riverine	430	0.03
Other	130	0.01
Total	**16,560**	**1.32**

3.2.4 Geology

Geologic mapping information and data for the subbasin were obtained from the USGS and the WSGS. A variety of geological features and rocks from Precambrian metamorphics are exposed in the uplifts to Quaternary alluvium along creeks within the subbasin. The subbasin includes parts of the Powder River structural basin. The surficial geologic units within the subbasin consist of residuum mixed, alluvium, and clinker mixed covering approximately 89 percent of the subbasin as shown in Figure 3.17. The remaining prominent units include bedrock, slopewash and colluvium, and eolian mixed. These geologic units influence the subbasin by providing the parent material and morphology for the soil formations and plant communities.

The bedrock geologic units that underlie the subbasin predominantly consist of the Wasatch Formation, Fort Union Formation, and Lance Formation covering approximately 85 percent of the subbasin as shown in Figure 3.18 and listed in Table 3.16. The remaining prominent bedrock features include alluvium and colluvium, Greenhorn Formation and Belle Fourche and Mowry Shale, and Pierre Shale. Figure 3.19 displays the faults and landslides in the subbasin.

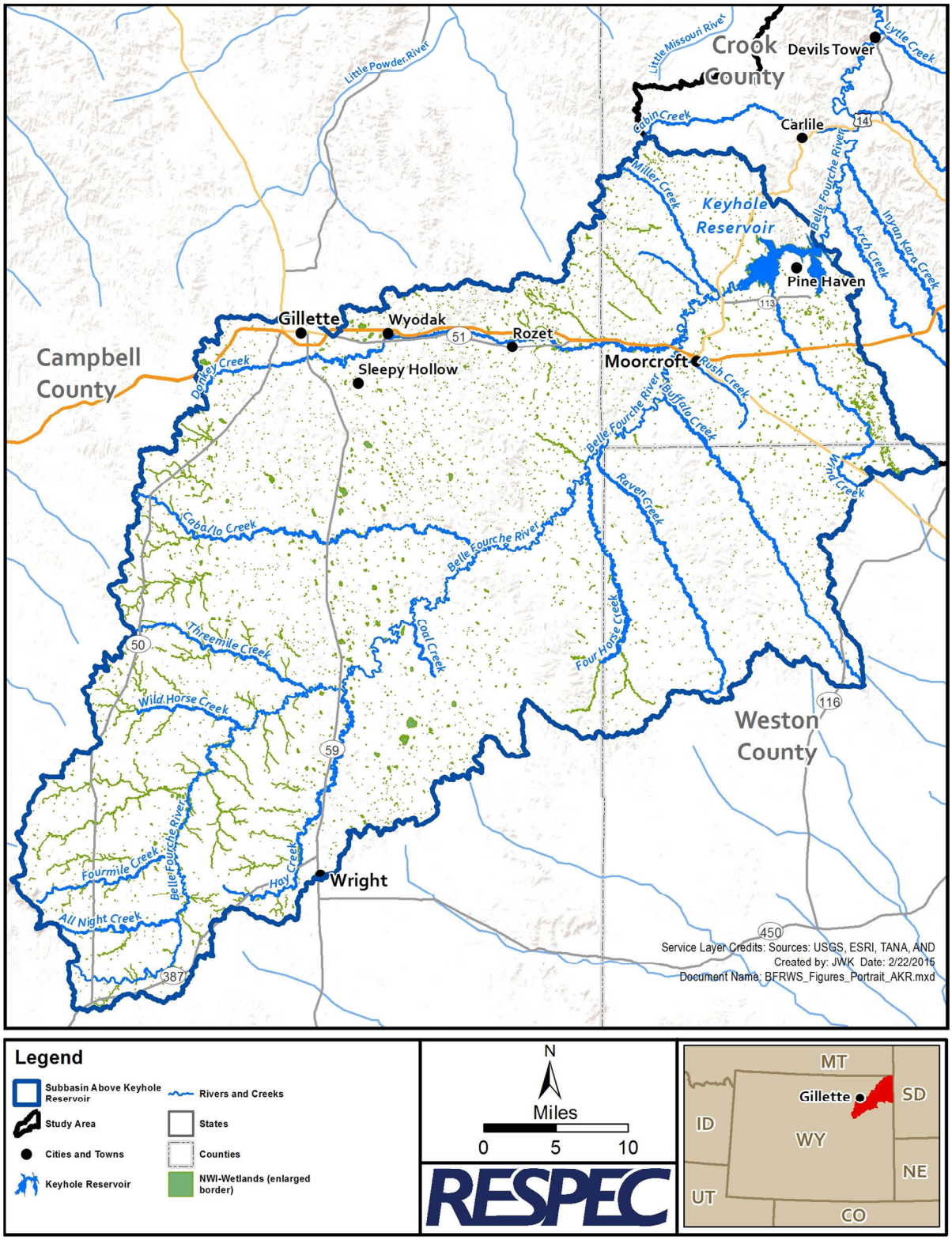


Figure 3.16. National Wetlands Inventory Wetlands Located Within the Subbasin.

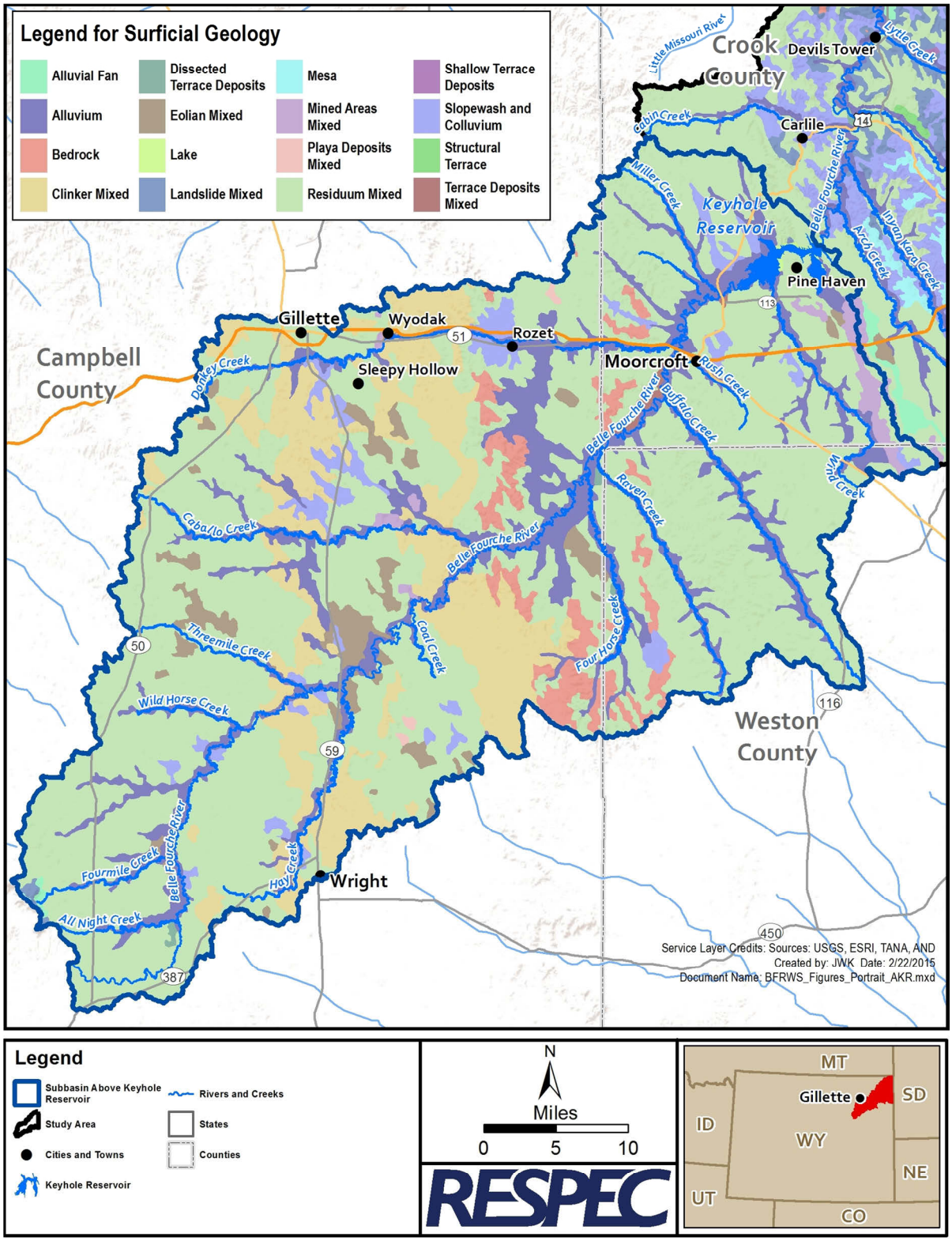


Figure 3.17. Surficial Geology of the Subbasin and Study Area.

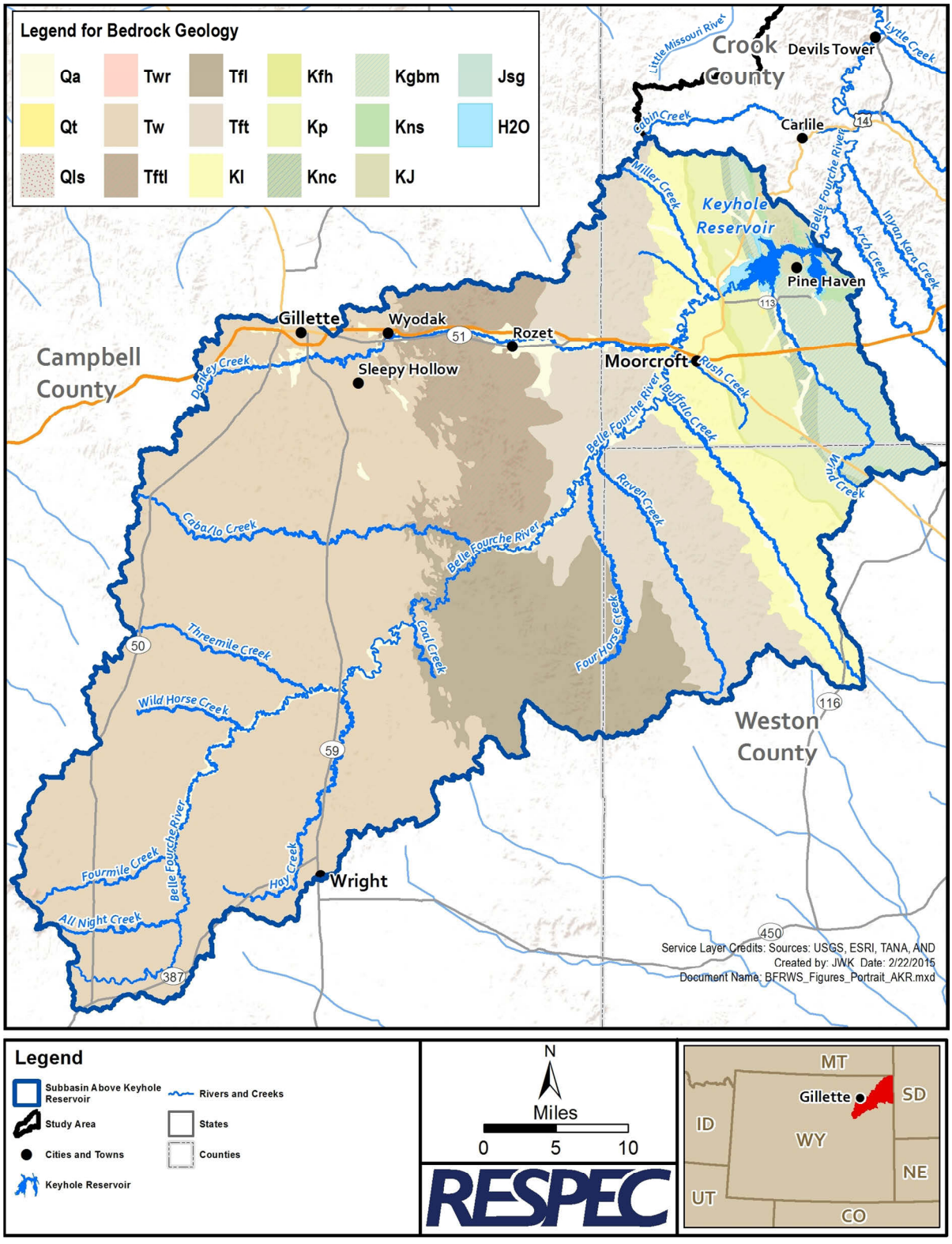


Figure 3.18. Bedrock Geology of the Subbasin.

Table 3.16. Bedrock Geologic Units Within the Subbasin

Unit Symbol	Geologic Unit Name	Area (acres)	Percent of Subbasin
Tw	Wasatch Formation	580,718	46.6
Tft	Tullock Member of Fort Union Formation	176,189	14.1
Tfl	Lebo Member of Fort Union Formation	125,703	10.1
Kl	Lance Formation	93,837	7.5
Tftl	Tongue River and Lebo Members of Fort Union Formation	87,937	7.1
Qa	Alluvium and colluvium	56,127	4.5
Kgbm	Greenhorn Formation, Belle Fourche and Mowry Shales	45,873	3.7
Kp	Pierre Shale	43,801	3.5
water	Water	8,949	0.7
Knc	Niobrara Formation and Carlile Shale	8,856	0.7
KJ	Cloverly and Morrison Formations	7,410	0.6
Kfh	Fox Hills Sandstone	5,794	0.5
Kns	Newcastle Sandstone and Skull Creek Shale	5,046	0.4
Other	Geologic units that comprise less than 0.05 percent of the subbasin	510	<0.05
Total		**1,246,750**	**100.0**

3.2.5 Soils

Soils are diverse within the subbasin because of the variable characteristics of the subbasin's underlying geology, topography and elevation, climate and precipitation, and vegetation. Soils in the subbasin vary considerably but usually are loams, with over 88 percent of the subbasin categorized as loam soils with channery, cobbly, gravelly, sandy, and stony loam surface textures. Soils information and data were obtained from the NRCS and compiled for the portions of the subbasin within Campbell, Crook, and Weston counties.

Four digitized soil surveys cover approximately 96 percent of the subbasin. NRCS published the soil surveys in the northern part of Campbell County, the southern part of Campbell County, Crook County, and Weston County in 2007, 2004, 1983, and 1990, respectively. Detailed soils information, ratings, data, and maps can be accessed by visiting the NRCS Web Soil Survey at *http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm*.

Over 360 soil map units are within the subbasin. The Forkwood-Suchman loams complex is the largest single map unit and covers 67,460 acres or 5.4 percent of the subbasin. Other major soil units include the Theedle-Kishona loam, Tassel-Shingle, Hilight-Wags-Badland, and Theedle-Shingle loam complex. Figure 3.20 displays a general soils map of the subbasin. Twenty-seven hydric soil map units covering approximately 190,010 acres within the subbasin

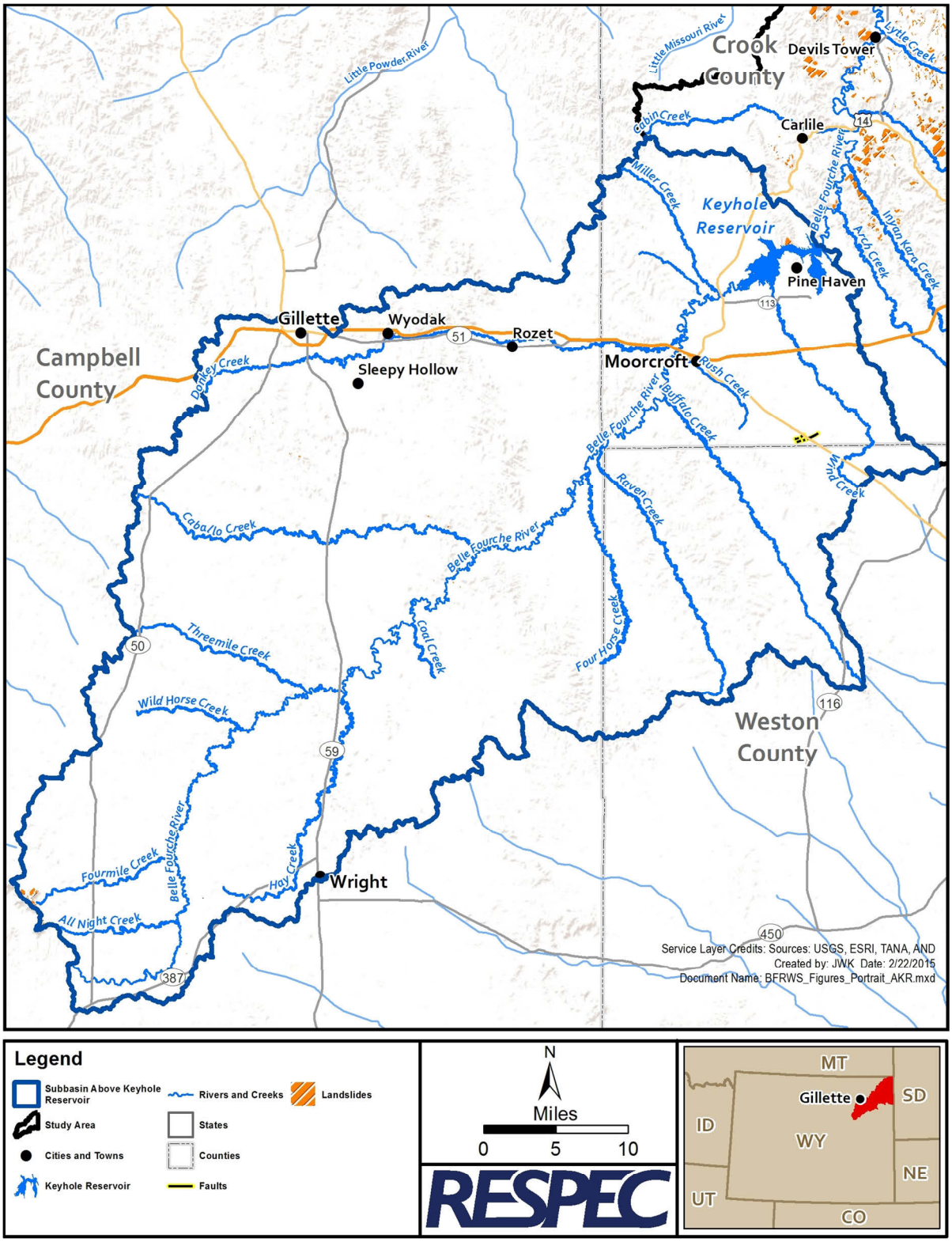


Figure 3.19. Hazardous Geologic Features Within the Subbasin and Study Area.

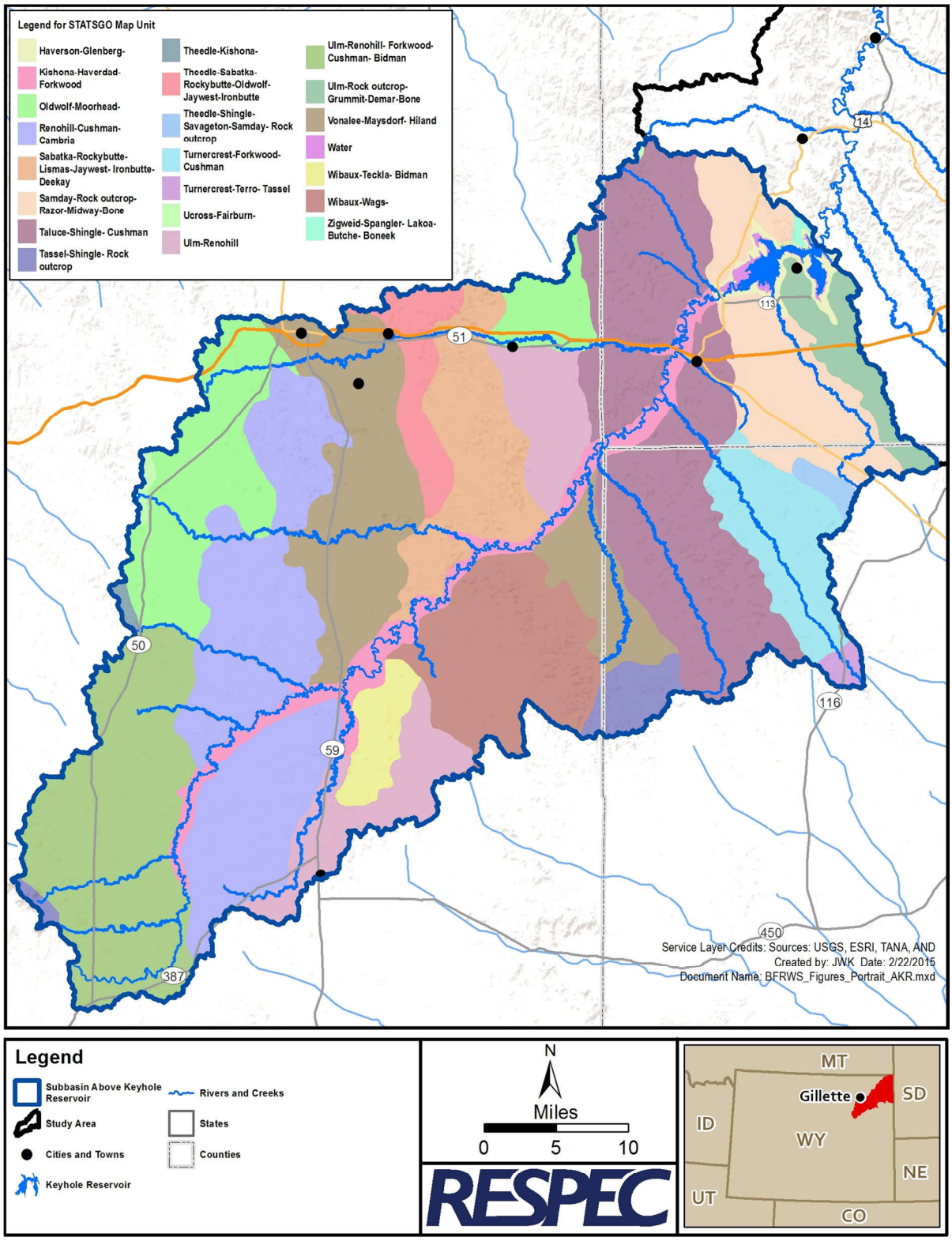


Figure 3.20. 1:250,000 Scale Soils Map of the Subbasin.

were mapped as “partially hydric” to identify areas where soils were formed under saturated, flooded, or ponded conditions during the growing season creating anaerobic conditions in the soil. Table 3.17 lists the 27 soil map units rated as hydric by NRCS within the subbasin. A detailed description of hydric soils is included in the basin wide summary report.

3.3 HYDROLOGY

3.3.1 Groundwater

Groundwater availability within the subbasin is variable because of the diverse aquifer characteristics and hydrogeological properties. Depending on the specific area, groundwater can occurs at various depths; areas near streams and along alluvial valleys have shallower groundwater with depths of 25 feet or less. Other locations in the subbasin have deep groundwater aquifers with depths of more than 1,000 feet below the ground surface. Groundwater and water well databases were obtained from the SEO.

Groundwater is locally important for livestock/wildlife water, private domestic wells, and municipal water. Approximately 11,900 wells are on file with the SEO within the subbasin and approximately 6,000 of those wells are associated with coal bed methane (CBM). Most of the CBM wells are concentrated in the western portion of the subbasin south of Gillette. More information about CBM within the subbasin is included in the basin wide summary report. The permitted wells also include 1,275 stock wells, 1,475 domestic wells, 243 industrial wells, 24 irrigation wells, and 50 municipal wells. Figure 3.21 shows the SEO wells within the subbasin. Many springs and seeps exist in the subbasin, springs mapped by USGS and BLM are shown in Figure 3.22.

3.3.2 Surface Water

The subbasin begins at the headwaters of the Belle Fourche River approximately 18 miles southwest of Wright, Wyoming and flows generally northeast where it flows into Keyhole Reservoir as shown in Figure 3.22. The subbasin includes all of the land draining to Keyhole Reservoir, which covers approximately 1,948 square miles or 1,246,750 acres in northeast Wyoming. The Belle Fourche River and its tributaries, Bone Pile Creek, Buffalo Creek, Caballo Creek, Coal Creek, Corral Creek, Deer Creek, Donkey Creek, Dry Creek, Four Horse Creek, Hay Creek, Jim Creek, Miller Creek, Mud Spring Creek, Raven Creek, Spring Creek, Threemile Creek, West Fork Coal Creek, and Wind Creek, occur in the subbasin. This subbasin includes the Wyoming portion of the eighth order HUC 10120201. Table 3.18 lists the 6 watersheds (HUC-10) and the 38 subwatersheds (HUC-12) within the subbasin.

Twelve USGS gaging stations are located within the subbasin and are listed in Table 3.19 and shown in Figure 3.23. Currently, four active USGS gages are within the subbasin and their discharge data along with historical discharge data for the inactive USGS gages are listed in Table 3.20. No temporary gages or transducers were installed within the subbasin as part of the watershed study.

Table 3.17. Summary of Hydric Soil Map Units Within the Subbasin

Map Unit Name	Area (acres)	Percent of Subbasin
Hilight-Wags-Badland complex, 3 to 45 percent slopes	43,460	3.5
Forkwood-Ulm loams, 0 to 6 percent slopes	25,090	2.0
Arvada, thick surface-Arvada-Slickspots complex, 0 to 6 percent slopes	19,750	1.6
Bidman-Parmleed loams, 0 to 6 percent slopes	19,210	1.5
Cambria-Kishona-Zigweid loams, 0 to 6 percent slopes	16,310	1.3
Bidman-Ulm loams, 0 to 6 percent slopes	12,960	1.0
Moorhead clay loam, 0 to 6 percent slopes	8,720	0.7
Haverdad loam, 0 to 3 percent slopes	7,320	0.6
Bidman loam, 0 to 6 percent slopes	5,910	0.5
Ustic Torriorthents, gullied	4,110	0.3
Haverdad, occasionally flooded-Kishona clay loams, 0-6 percent slopes	4,070	0.3
Urban land-Deekay-Moorhead complex, 0 to 6 percent slopes	3,180	0.3
Heldt-Bidman complex, saline, 0 to 3 percent slopes	2,860	0.2
Felix clay, ponded, 0 to 2 percent slopes	2,540	0.2
Clarkelen-Embry fine sandy loams, 0 to 4 percent slopes	2,240	0.18
Emigha loam, 0 to 3 percent slopes	2,160	0.17
Moorhead loam, 0 to 6 percent slopes	1,960	0.16
Clarkelen-Keeline association, 0 to 6 percent slopes	1,670	0.13
Aridic Ustorthents, saline, 0 to 4 percent slopes	1,350	0.11
Rockypoint-Iwait association, 0 to 6 percent slopes	1,290	0.10
Platmak loam, 0 to 6 percent slopes	1,290	0.10
Haverdad-Clarkelen complex, 0 to 4 percent slopes	990	0.08
Lohmiller silty clay loam, occasionally flooded, 0 to 3 percent slopes	770	0.06
Clarkelen-Draknab complex, 0 to 3 percent slopes	380	0.03
Lohmiller clay loam, occasionally flooded, 0 to 3 percent slopes	240	0.02
Colombo variant loam, occasionally flooded, 0 to 2 percent slopes	110	0.01
Rockypoint-Boruff complex, 0 to 3 percent slopes	70	0.006
Total	**190,010**	**15.2**

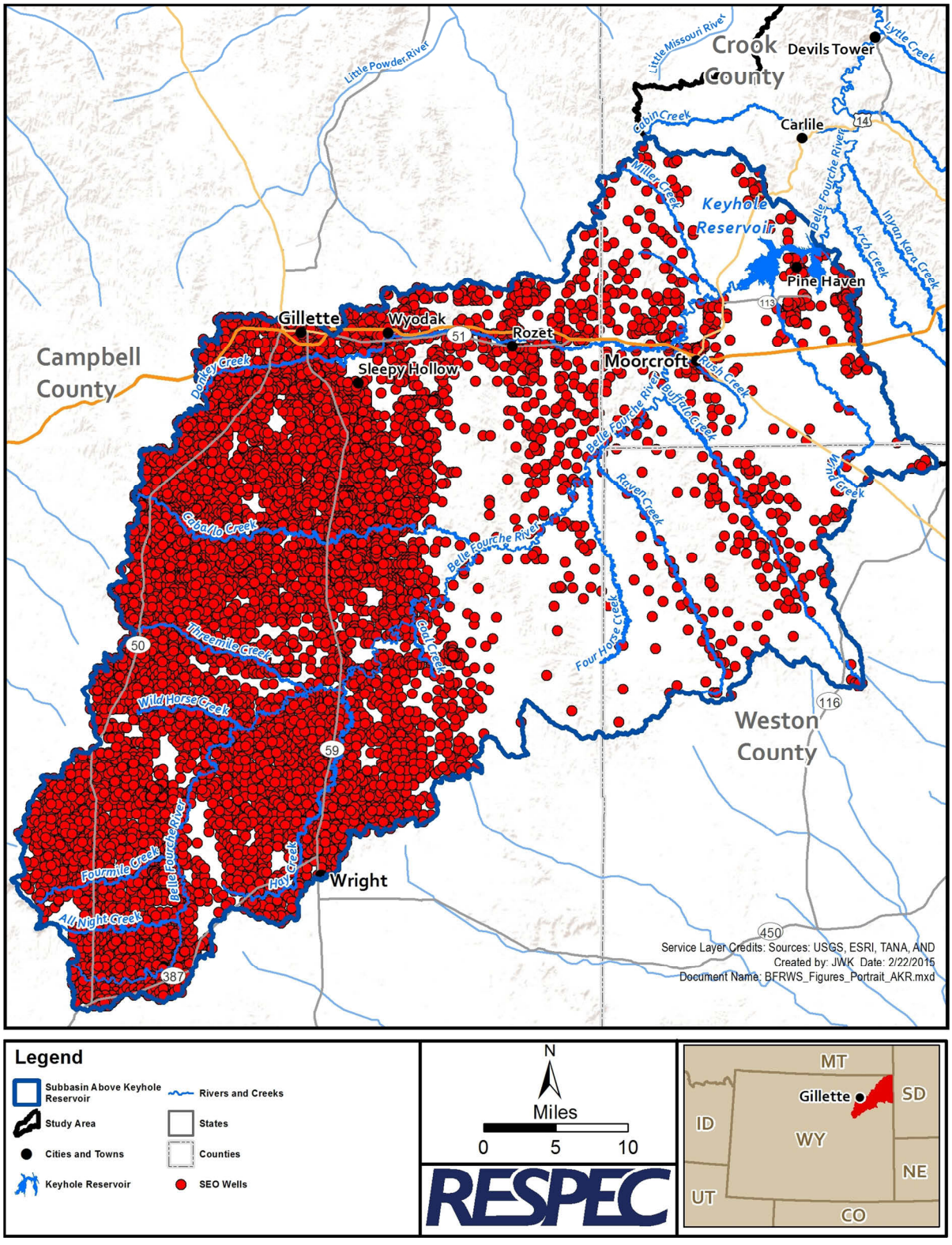


Figure 3.21. Permitted Water Wells Located Within the Subbasin.

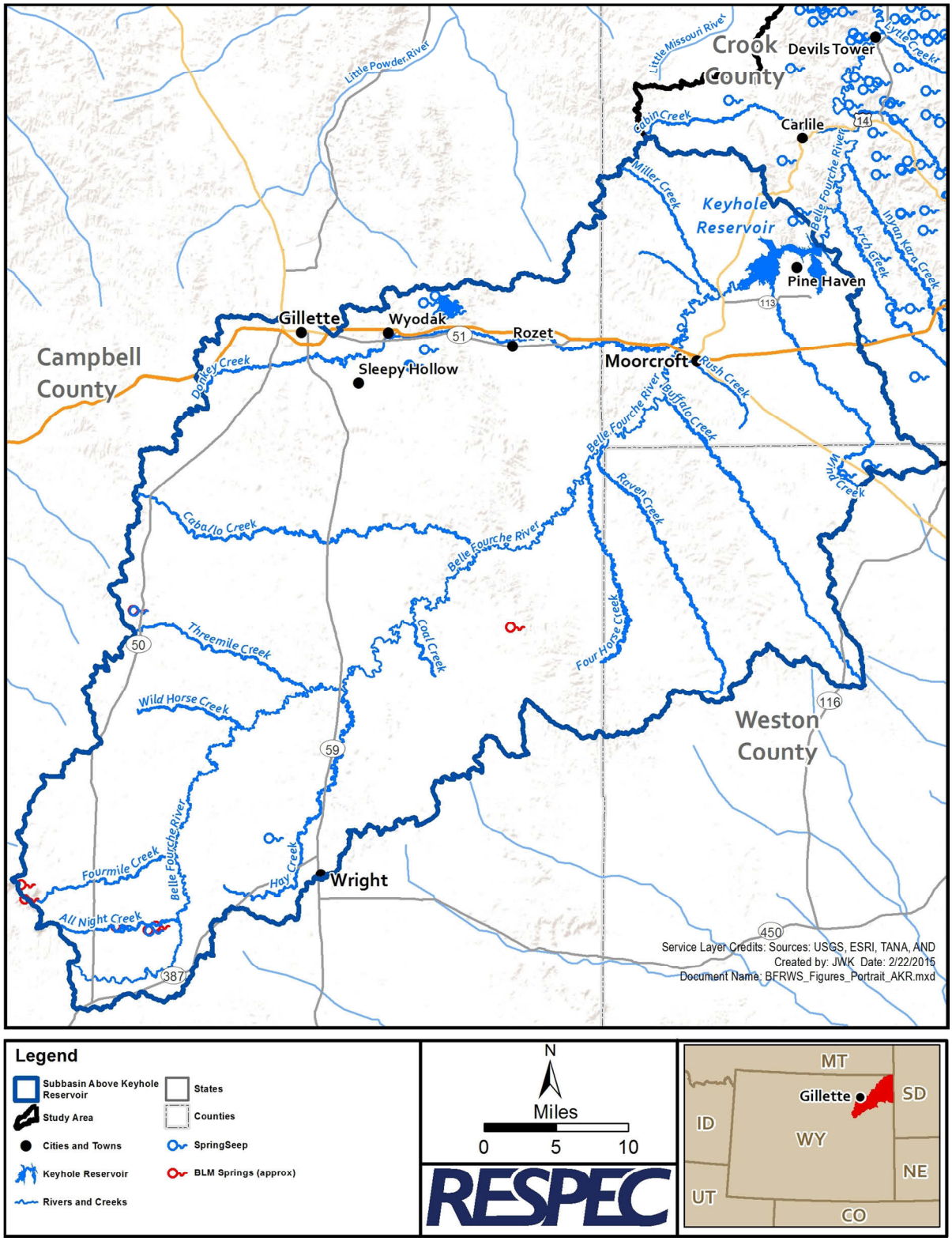


Figure 3.22. Springs Located Within the Subbasin and the Study Area.

Table 3.18. Hydrologic Unit Codes Within the Subbasin Above Keyhole Reservoir (Page 1 of 2)

HUC 2	HUC 4	HUC 6	HUC 8	HUC 10		HUC 12		Area (sq. mi.)
				Number	Name	Number	Name	
Region 10: Missouri	Subregion 1012: Cheyenne	Accounting Unit 101202: Belle Fourche	Cataloging Unit 10120201: Upper Belle Fourche	1012020101	Mud Spring Creek-Belle Fourche River	101202010101	All Night Creek-Belle Fourche River	72.2
						101202010102	Fourmile Creek	37.8
						101202010103	Rocky Butte Gulch-Belle Fourche River	42.3
						101202010104	Mud Spring Creek	60.0
						101202010105	Durham Reservoir-Belle Fourche River	46.7
						101202010106	Wild Horse Creek	52.1
						101202010107	Threemile Creek	41.6
				1012020102	Hay Creek-Belle Fourche River	101202010201	Rattlesnake Creek-Belle Fourche River	57.1
						101202010202	Upper Hay Creek	47.7
						101202010203	Lower Hay Creek	48.2
						101202010204	Coal Creek	74.0
						101202010205	Dry Creek-Belle Fourche River	54.7
				1012020103	Caballo Creek	101202010301	Upper Caballo Creek	64.5
						101202010302	Hoe Creek	59.4
						101202010303	Lower Caballo Creek	50.5
						101202010304	Bone Pile Creek	44.4
						101202010305	Tisdale Creek	41.7

Table 3.18. Hydrologic Unit Codes Within the Subbasin Above Keyhole Reservoir (Page 2 of 2)

HUC 2	HUC 4	HUC 6	HUC 8	HUC 10		HUC 12		Area (sq. mi.)
				Number	Name	Number	Name	
Region 10: Missouri	Subregion 1012: Cheyenne	Accounting Unit 101202: Belle Fourche	Cataloging Unit 10120201: Upper Belle Fourche	1012020104	Buffalo Creek-Belle Fourche River	101202010401	Yellow Hammer Creek-Belle Fourche River	66.4
						101202010402	Timber Creek-Belle Fourche River	51.5
						101202010403	Upper Four Horse Creek	53.3
						101202010404	Lower Four Horse Creek	49.6
						101202010405	Coyote Creek-Belle Fourche River	36.4
						101202010406	Raven Creek	80.0
						101202010407	Upper Buffalo Creek	64.1
						101202010408	Lower Buffalo Creek	66.5
				1012020105	Wind Creek-Belle Fourche River	101202010501	Rush Creek-Belle Fourche River	47.8
						101202010502	Trail Creek-Belle Fourche River	35.8
						101202010503	Miller Creek	48.0
						101202010504	Lone Tree Creek-Belle Fourche River	32.3
						101202010505	Upper Wind Creek	56.2
						101202010506	Lower Wind Creek	58.4
						101202010507	Deer Creek	29.0
						101202010508	Mule Creek	24.1
				1012020106	Donkey Creek	101202010601	Headwaters Donkey Creek	64.6
						101202010602	Upper Donkey Creek	60.6
						101202010603	Dry Donkey Creek	26.0
						101202010604	Middle Donkey Creek	56.1
						101202010605	Lower Donkey Creek	47.9

Table 3.19. Summary of U.S. Geological Survey Gaging Stations Within the Subbasin Above Keyhole Reservoir

USGS Station Number	Station Name	Period of Record	Drainage Area (sq. mi.)	Latitude	Longitude	Gage Elevation (ft, NGVD29)
06425720	Belle Fourche R Bl Rattlesnake C Nr Piney, WY	10/01/1975–Current	495	43°59'04"	105°23'16"	4,535
06425750	Coal Creek Nr Piney, WY	10/01/1980–09/30/1983	72	43°58'22"	105°19'53"	4,540
06425780	Belle Fourche R Ab Dry C Nr Piney, WY	10/01/1975–09/30/1983	594	44°01'30"	105°19'35"	4,463
06425900	Caballo Creek At Mouth Nr Piney, WY	08/31/1977–09/30/1983	260	44°04'48"	105°15'59"	4,382
06425950	Raven Creek Nr Moorcroft, WY	08/30/1977–09/30/1983	79	44°10'04"	105°05'11"	4,242
06426000	Belle Fourche River Nr Moorcroft, WY	09/01/1923–09/30/1930	1,380	44°16'30"	104°58'35"	4,133
06426095	Burlington Lake Ditch Above Gillette, WY	07/15/1988–09/30/1990	4,560	44°18'03"	105°30'47"	4,556
06426100	Stonepile Creek At Gillette, WY	07/15/1988–09/30/1992	11	44°17'18"	105°28'35"	4,520
06426130	Donkey Creek Near Gillette, WY	07/05/2000–Current	63	44°16'00"	105°26'17"	4,460
06426160	Stonepile Creek At Mouth, Near Gillette, WY	07/05/2000–Current	15	44°16'04"	105°26'17"	4,460
06426400	Donkey Cr Nr Moorcroft, WY	08/31/1977–10/08/1981	238	44°16'58"	105°03'48"	4,202
06426500	Belle Fourche River Below Moorcroft, WY	10/01/1943–Current	1,690	44°19'19"	104°56'24"	4,110

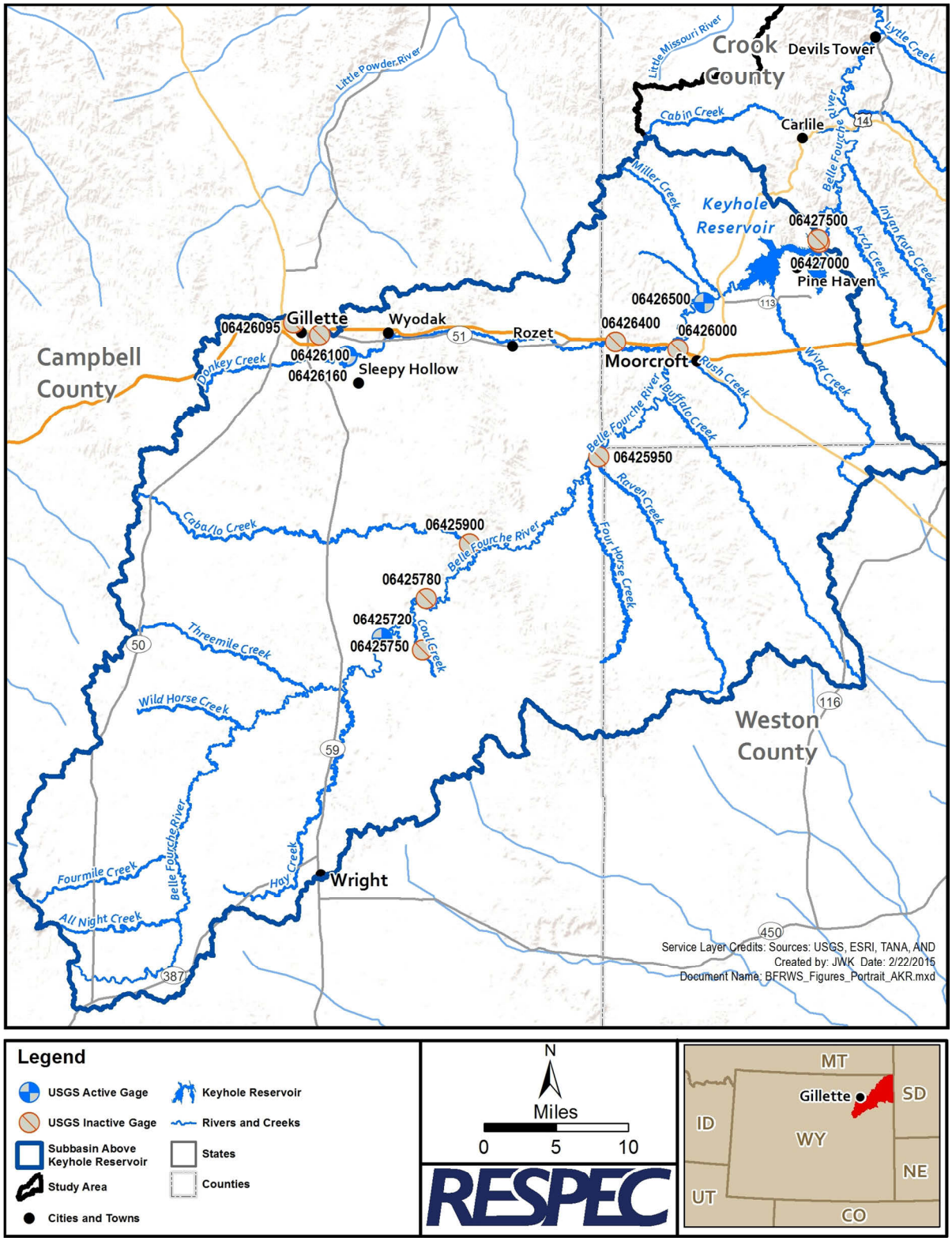


Figure 3.23. U.S. Geological Survey Gages Within the Subbasin.

Table 3.20. Historical Monthly Mean Discharge Rates for U.S. Geological Survey Gaging Stations Within the Subbasin

USGS Station Number	Period of Record	Historical Monthly Mean Discharge (cfs)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
06425720	Belle Fourche River Bl Rattlesnake Creek Near Piney, WY	0.9	2.5	4.7	3.0	8.3	4.0	2.6	1.1	0.3	0.4	0.7	0.7
06425750	Coal Creek Near Piney, WY	0.8	2.4	0.6	0.3	3.3	0.3	2.1	1.5	1.0	0.6	0.0	0.1
06425780	Belle Fourche River Above Dry Creek Near Piney, WY	0.8	3.7	10.9	2.4	19.5	5.2	4.3	3.2	1.3	0.4	0.1	0.2
06425900	Caballo Creek at Mouth Near Piney, WY	0.2	0.7	5.0	0.7	18.0	1.8	2.3	1.0	0.4	0.3	0.2	0.0
06425950	Raven Creek Near Moorcroft, WY	0.0	1.4	4.0	0.1	1.8	0.1	0.2	0.3	0.0	0.1	0.0	0.0
06426000	Belle Fourche River Near Moorcroft, WY	4.7	39.0	114.0	549.8	55.6	74.6	65.3	57.1	23.7	22.5	7.9	4.5
06426095	Burlington Lake Ditch Above Gillette, WY	NDA	NDA	NDA	0.5	0.6	0.7	0.7	0.6	0.9	0.5	NDA	NDA
06426100	Stonepile Creek at Gillette, WY	NDA	NDA	NDA	1.1	0.8	0.7	0.7	0.3	0.3	0.3	NDA	NDA
06426130	Donkey Creek Near Gillette, WY	0.6	1.4	5.3	3.0	7.7	3.7	0.9	0.5	0.3	1.1	0.6	0.4
06426160	Stonepile Creek at Mouth, Near Gillette, WY	3.9	4.3	5.5	5.6	9.2	5.9	4.5	4.7	4.4	4.7	4.2	4.0
06426400	Donkey Cr Near Moorcroft, WY	0.6	1.1	47.2	4.1	63.8	3.0	0.5	0.1	0.3	0.9	0.5	0.9
06426500	Belle Fourche River Below Moorcroft, WY	3.7	17.9	59.0	27.3	67.7	58.1	17.5	9.6	5.0	6.6	3.2	2.8

3.4 STREAM GEOMORPHOLOGY

In the basin wide summary report, an extensive discussion regarding the stream geomorphology within the subbasin is included to explain the Level I geomorphic classification methods, applicable classification systems, and Level II field stream assessments performed for this study. Within the subbasin, a Level I evaluation of Redwater Creek and its major tributaries was conducted. Results of the Level I classification effort are presented in Table 3.21. Figure 3.24 displays the subbasin's stream types resulting from the classification effort.

Table 3.21. Summary of Rosgen Level I Classification Results in the Subbasin

Name	Reach Number	Station (Distance From Mouth)		Reach Length (ft)	Sinuosity	Slope	Rosgen Type
		Station Start (ft)	Station End (ft)				
Belle Fourche River	3	814,261	1,149,811	335,550	2.13	0.001	C
	4	1,149,811	1,517,797	367,986	2.21	0.001	C
	5	1,517,797	1,778,984	261,187	2.12	0.002	C
Buffalo Creek	1	0	179,769	179,769	2.49	0.001	E
	2	179,769	275,292	95,523	1.6	0.004	C
Caballo Creek	1	0	54,915	54,915	1.78	0.002	C
	2	54,915	95,479	40,564	NA	NA	NA
	3	95,479	264,763	169,284	2.09	0.003	C
Donkey Creek	1	0	110,094	110,094	2.31	0.001	C/F
	2	110,094	241,035	130,941	2.04	0.001	C/F
	3	241,035	387,827	146,792	1.95	0.003	C
Four Horse Creek	1	0	69,157	69,157	2.13	0.001	C/F
	2	69,157	186,463	117,306	2.58	0.002	C/F
Wind Creek	1	0	66,550	66,550	2.06	0.001	C
	2	66,550	189,578	123,028	1.9	0.003	B

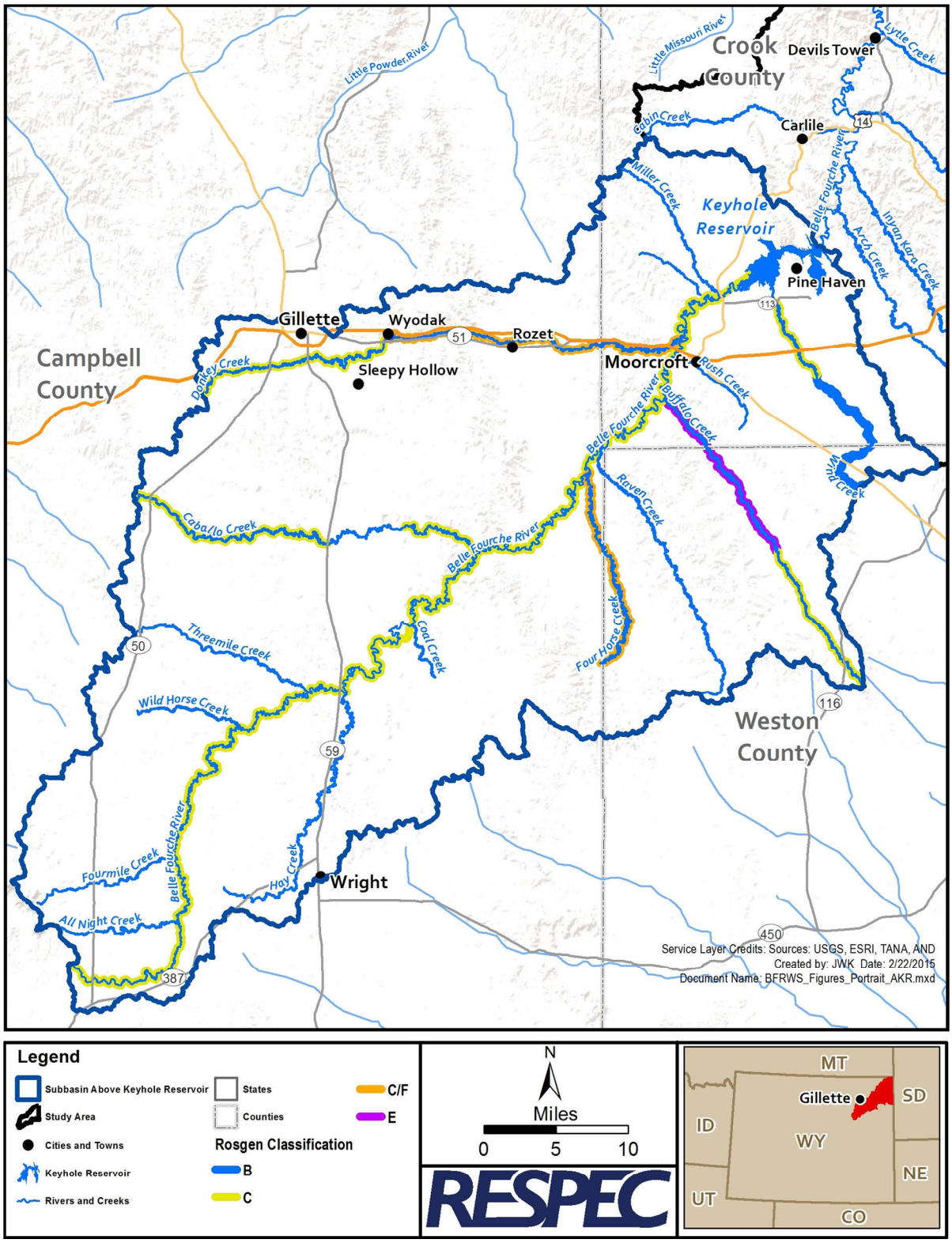


Figure 3.24. Rosgen Classification Stream Types Within the Subbasin.

3.5 WATER QUALITY

3.5.1 Wyoming Pollutant Discharge Elimination System Permitted Discharges

The subbasin contains 153 Wyoming Pollution Discharge Elimination System (WYPDES) point source discharge permits with a total of 948 outfalls, shown in Figure 3.25. A list of WYPDES permits within the study area is included in the basin wide summary report. No permitted Municipal Separate Storm Sewer Systems (MS4s) are within the study area.

3.5.2 Waters Requiring Total Maximum Daily Loads

Five waterbodies are listed as impaired in the State of Wyoming's 2012 Integrated Report within the subbasin [Wyoming Department of Environmental Quality, 2012]. The impaired waterbodies within the subbasin are summarized in Table 3.22 and shown in Figure 3.26. Fecal Coliform loadings have resulted in exceedances of the recreational use criterion in several waters, including two reaches of the Belle Fourche River, Donkey Creek, and Stonepile Creek. Gillette Fishing Lake has exceedances of the Cold Water Fishery and Aquatic Life Other Than Fish criteria due to phosphate and sediment loadings. Total Maximum Daily Load (TMDL) assessments for the Belle Fourche River, Donkey Creek, and Stonepile Creek were completed in August 2013. Also a TMDL assessment for sediment and phosphorus was completed for Gillette Fishing Lake in February 2013. Pollutant sources, load allocations, and estimated reductions necessary for the impaired waterbodies to meet water quality criteria were included in the TMDLs.

3.6 WATER STORAGE

Water storage development within the watershed has been impacted by the Belle Fourche River Compact of 1943, which divides the water in northeast Wyoming between Wyoming and South Dakota. The compact recognizes all rights in Wyoming existing as of the date of the compact, and permits Wyoming unlimited use for stock water reservoirs not exceeding 20 acre-feet in capacity. Wyoming is allowed to use 10 percent of the available flow of the Belle Fourche River in excess of the amount that is needed to supply the water rights in existence at the date of the contract. No reservoir constructed subsequent to the date of the compact solely to use the water allocated to Wyoming shall have a capacity greater than 1,000 acre-feet.

Water storage within the subbasin has been the subject of past studies and are summarized in Section 3.9.3 of the basin wide summary report. Because of the constraints related to the compact, the investigation of water storage focused on existing stock ponds and potential sites with less than 20 acre-feet. Additional storage reservoirs or enlargements to existing reservoirs may be limited by constraints identified above, however, improvements to fully realize and sustain the capacity of the existing reservoirs are not limited by these constraints. Although, no large potential sites were identified by landowners within the subbasin, problems with existing reservoirs that limited storage capacity were identified and initial field reviews were conducted to determine necessary improvements, which are included in the Chapter 4.0.

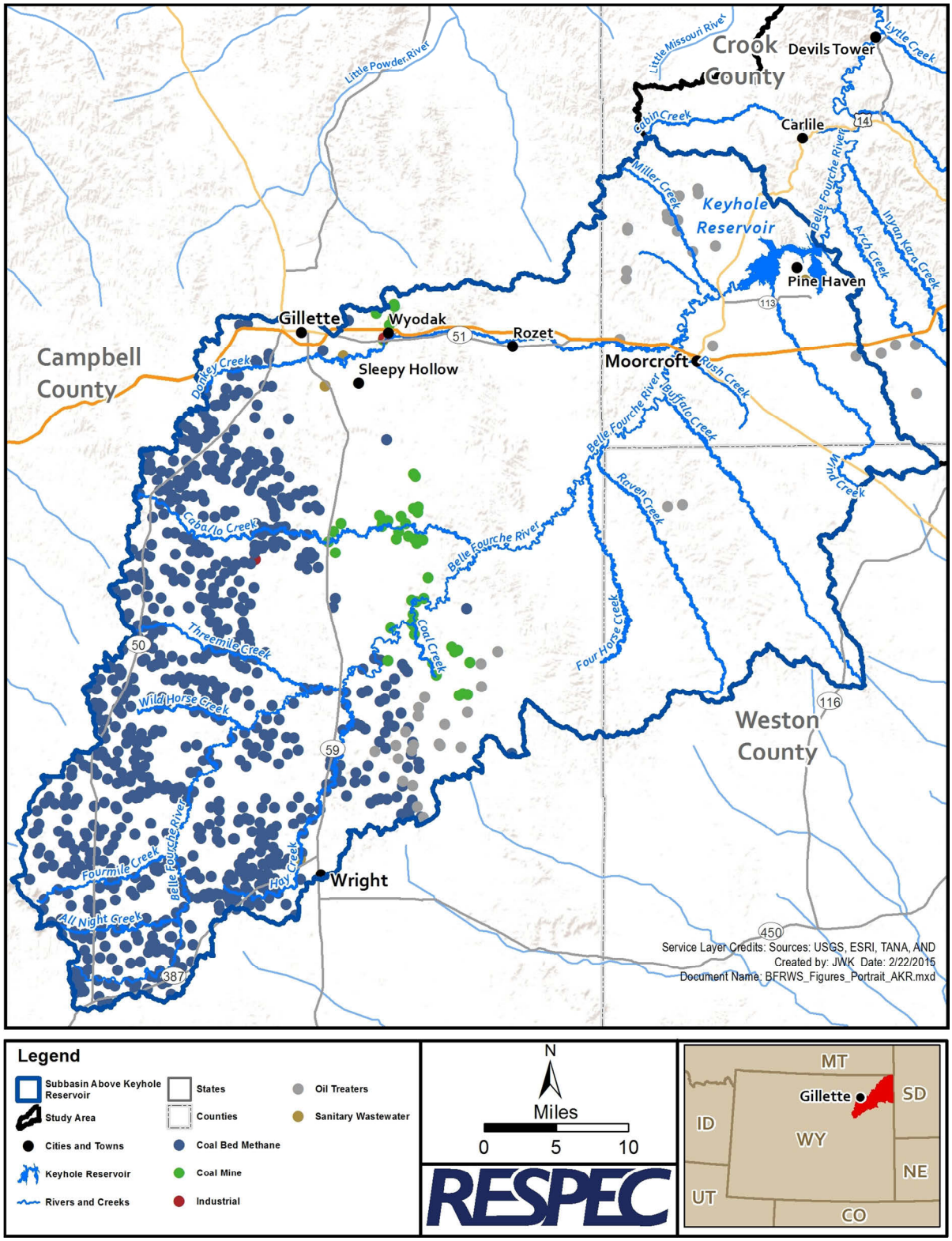


Figure 3.25. Wyoming Pollutant Discharge Elimination System Permitted Locations Within the Subbasin and Project Area.

Table 3.22. State of Wyoming's 2012 Impaired Waterbodies and Status Within the Subbasin

Waterbody	305(b) Identifier	Location	Class	Miles	Use	Cause	List Date	TMDL Date
Belle Fourche River	WYBF-101202010501_01	From the confluence with Donkey Creek to a point 6.2 miles upstream	2ABww	6.2	Recreation	Fecal Coliform	1996	2009
Belle Fourche River	WYBF-101202010504_00	From the confluence with Keyhole Reservoir upstream to the confluence with Donkey Creek	2ABww	14.2	Recreation, Warm Water Fishery, Aquatic Life other than Fish	Fecal Coliform, Ammonia, Chloride	1996 2008	2009
Donkey Creek	WYBF-101202010600_01	From the confluence with the Belle Fourche River upstream to Brorby Boulevard within the city of Gillette	3B	61.4	Recreation	Fecal Coliform	2000	2009
Stonepile Creek	WYBF-101202010602_01	From the confluence with Donkey Creek upstream to the junction of Highways 14/16 and 59	3B	7.6	Recreation	Fecal Coliform	2002	2009
Gillette Fishing Lake	WYBF-101202010601_01	Within the city of Gillette	2AB	15.4 ac	Cold Water Fishery, Aquatic Life other than Fish	Phosphate, Sediment	1996	2008

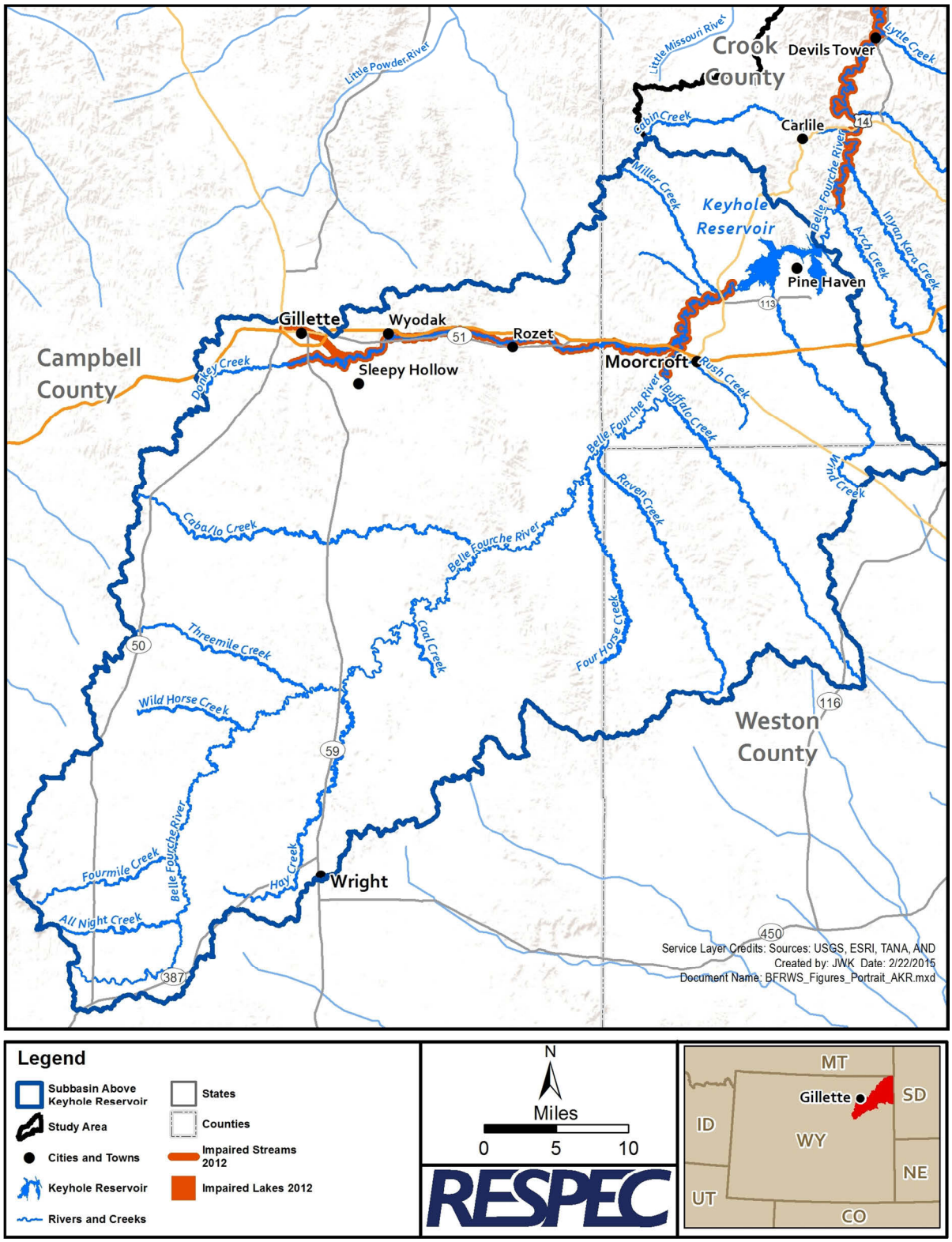


Figure 3.26. Impaired Waterbodies Within the Subbasin and Study Area.

3.6.1 Major Reservoirs

The Wyoming SEO developed a list of major reservoirs within the Northeast Wyoming Basin. To qualify as major, a reservoir must have storage capabilities of 1,000 acre-feet or more and also serve multiple users. Two major reservoirs, Keyhole Reservoir and Gillette Lake, are located within the subbasin and are discussed in the basin wide summary report.

Keyhole Dam and Reservoir, located on the Belle Fourche River northeast of Moorcroft, is the largest storage facility developed within the study area. Keyhole Unit was authorized by the Flood Control Act of 1944. The USBR began constructing Keyhole Dam in June 1950 and completed the project in March 1952. Keyhole Reservoir began releasing waters on April 20, 1953. The Keyhole Unit, consisting of Keyhole Dam and Reservoir, is a multipurpose facility that provides storage for irrigation, flood control, fish and wildlife benefits, conservation, recreation, sediment control, and municipal and industrial water supply.

Keyhole Reservoir provides supplemental water to the 57,068-acre Belle Fourche Unit located approximately 150 miles downstream in western South Dakota. Keyhole Reservoir also provides supplemental water to the irrigators in the CCID. The USBR has reservoir data records for Keyhole dating back to 1952. Reservoir storage varies by year as wet and dry cycles significantly impact the volume of water stored in Keyhole Reservoir. For water years from 1952 through 2013, the Keyhole Reservoir watershed yield has averaged 16,150 acre-feet per water year. Reservoir storage fluctuates because of spring inflows, irrigation releases, and evaporation resulting in an average annual storage change of 27,350 acre-feet.

Gillette Lake, owned and maintained by the city of Gillette, was constructed on Donkey Creek in 1949. Gillette Lake has a surface area of 48.5 acres with a capacity of 2,080 acre-feet and provides fishing and recreation opportunities because it is located on the southern edge of Gillette within a city park. More information is included in the basin wide summary report.

3.6.2 Minor Reservoirs

Over 810 stock pond and reservoir permits within the subbasin have been filed with the SEO. Permit age ranges from the year 1901 to 2000. The permitted minor reservoirs within the subbasin have a combined potential storage of 109,040 acre-feet. The majority of the ponds are small with only two having storage volumes greater than 1,000 acre-feet and approximately 77 ponds have storage volumes greater than 20 acre-feet. Figure 3.27 shows the locations of the permitted ponds and reservoirs in the subbasin.

Although it is understood that additional large water storage reservoirs or enlargements to the existing storage reservoirs may be limited by the institutional constraints laid out in the Belle Fourche River Compact, improvements to fully realize and sustain the capacity of the existing reservoirs are not limited by these constraints.

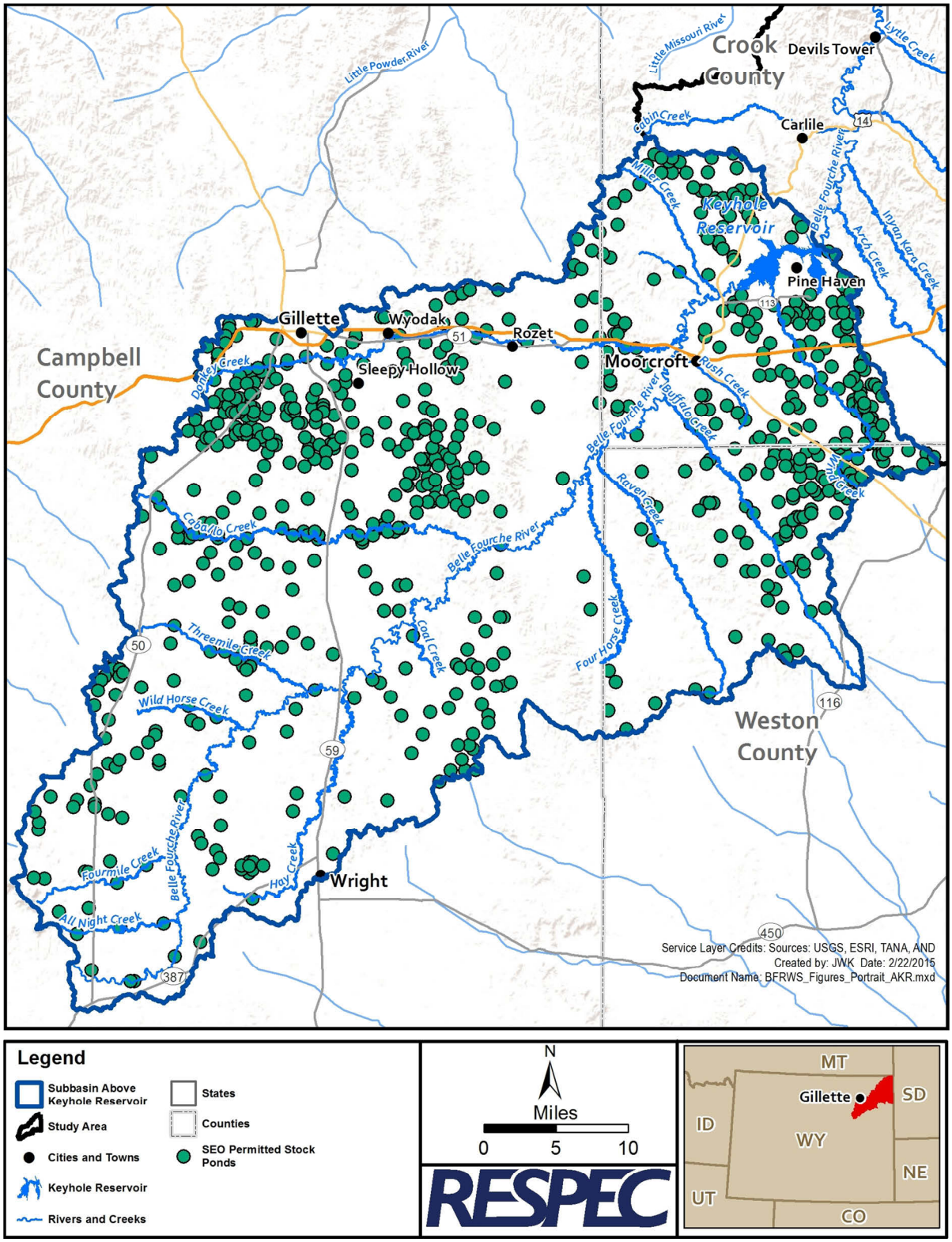


Figure 3.27. Wyoming State Engineer's Office Permitted Stock Ponds and Reservoirs Within the Subbasin.

3.6.3 Previously Proposed Water Storage Development

Several previous studies on potential reservoir development have been completed throughout the years within the study area. The WWDC has compiled a list of proposed reservoirs from these studies, which is included in the basin wide summary report. However, there have been no potential opportunities for large storage sites identified from recent studies or investigations within the subbasin [HKM Engineering Inc. et al., 2002; Short Elliott Hendrickson Inc., 2006]. The only reservoir and dam projects previously identified within the subbasin are summarized in Table 3.23 [HKM Engineering Inc. et al., 2002; Short Elliott Hendrickson Inc., 2006]. Using information found for the general location of the sites, (township, range, and section), proposed locations were mapped and are shown in Figure 3.28.

Table 3.23. Previously Proposed Reservoirs Within the Subbasin

Project Name/Water Source	Approximate Location	Estimated Storage (ac-ft)	Water Use	Estimated Cost ($)
Revised Project List, Irrigation and Storage, State of Wyoming by Drainage Basins, **Report Only), [Wyoming State Planning and Water Conservation Board, 1937], located at the Wyoming Water Development Commission**				
Caballo Scheme #1 Reservoir	Near Moorcroft, Crook County	10,000	A	1,500,000
Caballo Scheme #2 Reservoir	Near Moorcroft, Crook County	60,000	A	3,300,000
Caballo Reservoir	T47-51N, R67-70W, Weston County	58,790	A	1,000,000
Antelope Reservoir	Sec 1, T49N, R73W, Campbell County	1,649	A	20,000
Gillette Reservoir Enl.	Sec 22, T50N, R72W, Campbell County	3,248	A	20,000
Water Resources of Missouri River Basin in Wyoming (Belle Fourche), **Level 1, [Wyoming State Engineer's Office, 1939], located at the Wyoming Water Development Commission and State Library**				
Antelope/Donkey Creek	Sec 1, T49N, R73W, Campbell County	1,649	A	20,000
Caballo/Belle Fourche	Sec 2, T47N, R70W, Campbell County	58,787	A	1,011,210
City Gillette Enl./Donkey&Stonepile	Sec 22, T50N, R72W, Campbell County	3,248	M,A	20,000
Shipwheel/Belle Fourche	Sec 31, T49N, R68W, Weston County	6,308	A	212,000

Water Use Codes: A = Agriculture, M = Municipal

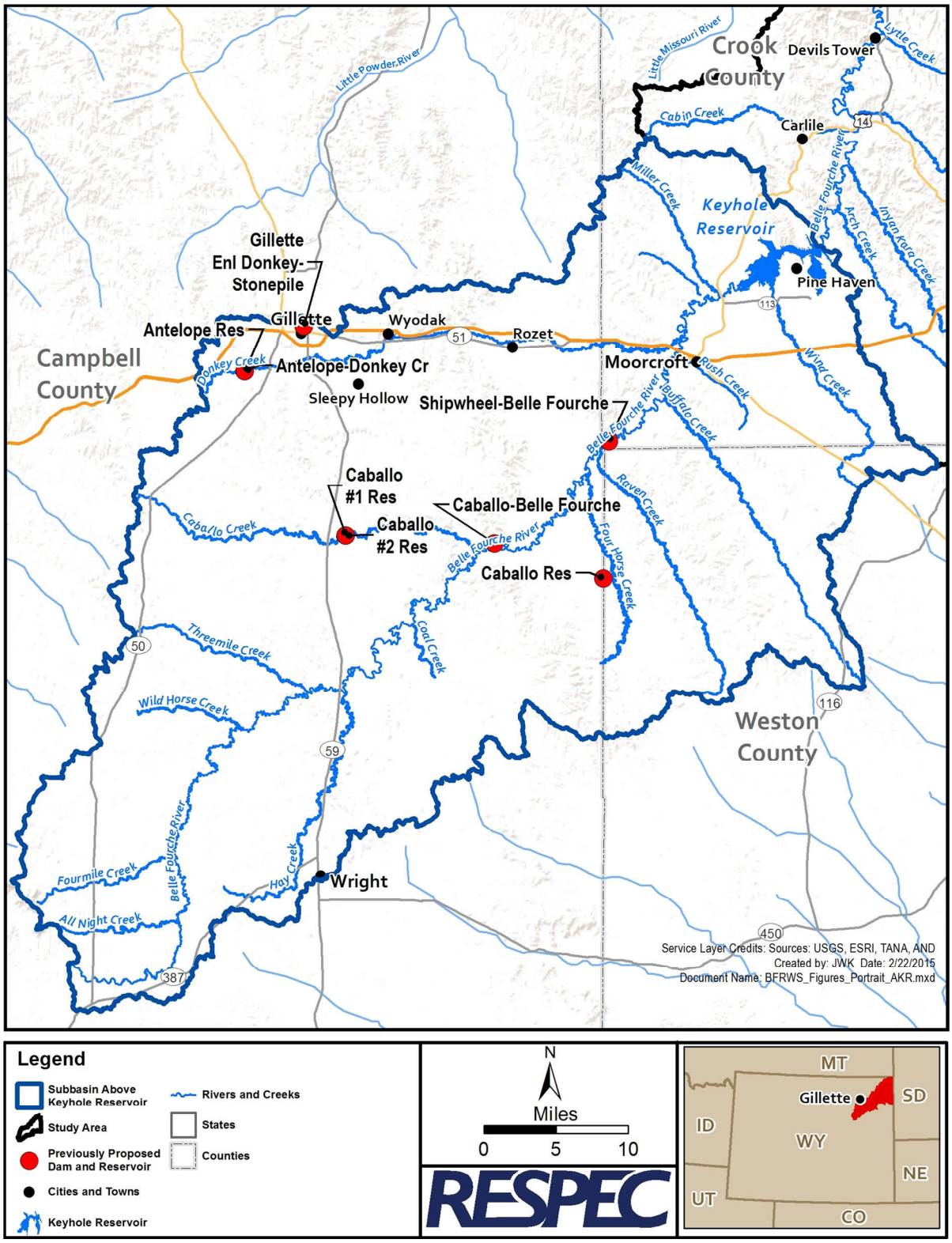


Figure 3.28. Previously Proposed Reservoir and Dam Project Locations Within the Subbasin.

4.0 SUBBASIN ABOVE KEYHOLE RESERVOIR WATERSHED MANAGEMENT AND REHABILITATION PLAN

4.1 OVERVIEW

The objective of this Level I study is to generate a Watershed Management and Rehabilitation Plan that is technically sound, practical in nature, and economically feasible. This chapter includes the proposed projects within the Subbasin Above Keyhole Reservoir Watershed Management and Rehabilitation Plan. These potential improvements were developed to address those issues described in Chapter 3.0 and are categorized into the following:

- **Livestock/Wildlife Upland Watering Opportunities.** Based on an evaluation of existing water sources and the condition of upland grazing resources, potential upland water source development projects were identified.
- **Grazing Management Opportunities.** Based on a review of the pertinent ESDs and the vegetation and soil conditions, grazing management strategies are presented.

Individual conceptual plans developed for each project component to improve the existing water supply through conservation are included in this chapter. For the purposes of tracking individual components of the watershed management plan, each component was designated a unique project or "improvement" number. The prefixes used for each improvement describe the category of the watershed management plan it falls under. The prefixes are as follows:

- Project Components "LW": Livestock/wildlife upland watering opportunities (Section 4.5)
- Project Components "G": Grazing management opportunities (Section 4.6)

The proposed projects in this chapter are commonly referred to as best management practices (BMPs) or conservation practices, which include stock ponds, water wells, buried water delivery pipelines, stock tanks, spring developments, and solar platforms and pumps. There can be one or more benefits and effects related to the implementation of these BMPs and conservation practices and are discussed in the basin wide summary report.

4.2 IRRIGATION SYSTEM AND SURFACE WATER STORAGE OPPORTUNITIES

No irrigation system rehabilitation projects or large surface water storage potential sites were identified by landowners within the subbasin. Although, problems with existing stock reservoirs that limited capacity were identified and field reviews were conducted to determine necessary improvements. Future individual irrigation rehabilitation and stock reservoir projects are eligible for application funding through the WWDC's Small Water Project Program (SWPP) because of their geographic location within the study area but would need additional

information and coordination with interested landowners before applications are submitted to the WWDO by any local sponsors.

4.3 LIVESTOCK AND WILDLIFE UPLAND WATERING SOURCES

Participating landowners identified places where existing water sources could be improved and conceptual wildlife and livestock water components and associated facilities were developed and located on parcels, allotments, and pastures. A more detailed discussion about the livestock/wildlife sources and current availability within the subbasin is included in the basin wide summary report. The following proposed projects are conceptual only and are described in general for this report.

Before installation, it is recommended to determine the actual locations, specifications, alignments, volumes, and lengths of pipelines, tanks, wells, and pumps. It is also recommended to install wildlife ramps in the proposed water tanks, and incorporating all valves, fittings, and appurtenances to manage flows and water levels. Participation in the study was voluntary and a list of interested participants was created after the scoping meetings were held. On-site, field visits were scheduled and conducted with landowners and managers where the study team listened to concerns about water needs of the participants and visited potential project sites.

Participants identified areas that needed water development then conceptual water development projects were mapped and are summarized in Section 4.3.1 through Section 4.3.21. These project designs are conceptual only and, if initiated, would require additional design work before installation. The proposed projects and components in the watershed management plan are summarized in Table 4.1. The general locations of all of the proposed livestock/wildlife water projects are included in Chapter 4.0 of the basin wide summary report.

Because federal and state lands cover approximately 12 percent of the subbasin and are intermingled with private lands, some of the water development projects could involve coordination with the BLM, USFS, and Wyoming Office of State Lands and Investments (OSLI) before initiating construction. Additionally, some projects could involve multiple landowners because of the locations of wells and routes for pipelines. For these projects spanning multiple owners, written agreements would be necessary to outline the responsibilities and liabilities of the parties involved with each individual project. Moreover, environmental evaluations would be required for any potential effects identified for a specific project or project component, especially on federal and state lands. Therefore, coordination is necessary with BLM and USFS before implementing any project on federal land and coordination with OSLI is required before constructing any improvements on state land.

Table 4.1. Summary of Livestock/Wildlife Upland Water Development Components

Item Number	Plan Component	Priority	Project Name	Description	Solar Pump	Well Construct	Spring Development	Pipeline	Stock Tank	Storage Tank	Stock Pond Rehab-Construct	Fence
1	LW-01	1	Coyote Draw	Pipeline and Tank				13,700	5			
2	LW-02	1	Coyote	Stock Reservoir							1	
3	LW-03	1	Coyote Draw	Stock Reservoir							1	
4	LW-04	2	Gold Mine Draw	Pipeline and Tank				6,600	2			
5	LW-05	2	Hallie Draw	Well, Solar Pump, and Tank	1	1		5,300	3			
16	LW-14	1	Johnson Draw	Well, Solar Pump, and Tank	1	1		400	2			6,400
17	LW-15	2	Shenandoah #4	Well, Solar Pump, and Tank	1	1		1,900	2			
18	LW-16	1	Dry Creek #2	Well, Solar Pump, and Tank	1	1		3,500	2			
19	LW-17	1	Miller Creek #1	Well, Solar Pump, and Tank	1	1		400	1			
20	LW-18	2	Dry Creek #4	Well, Solar Pump, and Tank	1	1		400	1			
21	LW-19	2	Dry Creek #3	Well, Solar Pump, and Tank	1	1		400	1			
22	LW-20	3	Hay Creek #1 & #2	Well, Solar Pump, and Tank	1	1		400	1			
23	LW-21	3	Miller Creek #2	Well, Solar Pump, and Tank	1	1		400	1			
24	LW-22	3	Dry Creek #5	Well, Solar Pump, and Tank	1	1		400	1			
36	LW-34	3	Sage Draw	Well, Pipeline, and Tank	1	1		400	2			
37	LW-35	1	Tobey Draw	Pipeline, Tank, and Stock Reservoir				4,700	2			
38	LW-35A	3	Noecker	Stock Reservoir							1	
39	LW-35B	3	Dinky	Stock Reservoir							1	
64	LW-54	1	Bennor #2	Well, Pipeline, and Tank		1		10,500	5			
65	LW-55	2	Donkey Creek	Well, Pipeline, and Tank		1		4,700	2		1	

Twenty upland livestock/wildlife water development plan components are described in Section 4.3.1 through Section 4.3.21 summarizing well construction, stock pond rehabilitation, and pipeline installation components. Future upland livestock/wildlife water projects are eligible for application funding through the WWDC's SWPP because of their geographic location within the study area and subbasin. However, these projects would need additional information and coordination with interested landowners before applications are submitted to the WWDO by any local sponsors.

4.3.1 LW-01: Coyote Draw Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from an existing well, pump, and storage tank (> 20,000-gallon capacity) to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, well, pump, and storage tank (> 20,000-gallon capacity), a buried High-density polyethlyene (HDPE) pipeline would be installed northerly to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 7,000 linear feet of 2-inch pipeline.
- From the installed pipeline and stock tanks, the other HDPE pipeline would be installed northeasterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 6,700 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.2 LW-02: Coyote Stock Reservoir Rehabilitation Project

In addition to the development of livestock/wildlife water sources described in the *LW-01: Coyote Draw Pipeline and Tank Project*, this alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Coyote Creek within Section 19 of Township 49 North, Range 70 West in Campbell County. However, the structures are at risk of being breached because of the downstream channel headcutting.

This project would include the rehabilitation of the Coyote Stock Reservoir (Permit No. P3126S). The reservoir has a permitted total capacity of 6.05 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the associated wetland and riparian areas. This alternative would involve installation of an inlet and outlet pipe control structure in the reservoir embankment and stabilizing the installed structures and spillway with rock riprap. This alternative includes the following features:

- Inspecting the embankment and rehabilitation of problem areas as needed. The embankment is approximately 300 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 15 feet wide.

- Installing an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavating the earthen, grass-lined spillway to adequately convey necessary water volumes along with stabilization with rock riprap for spillway protection.
- Contingent on determining adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- As delineated, the project involves privately owned lands only.

4.3.3 LW-03: Coyote Draw Stock Reservoir Rehabilitation Project

In addition to the development of livestock/wildlife water sources described in the *LW-01: Coyote Draw Pipeline and Tank Project*, this alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on unnamed tributary to Dry Donkey Creek within Section 20 of Township 49 North, Range 70 West in Campbell County. However, the structures are at risk of being breached because of the downstream channel headcutting.

This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the associated wetland and riparian areas. This alternative would involve installation of an inlet and outlet pipe control structure in the reservoir embankment and stabilizing the installed structures and spillway with rock riprap. The stock reservoir encompasses 0.8 acre with a total capacity of less than 2 acre-feet. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 250 feet long and less than 8 feet high at its highest point. The top-width of the embankment is approximately 12 feet wide.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the earthen, grass-lined spillway to adequately convey necessary water volumes along with stabilization with rock riprap for spillway protection.
- Contingent on determination of adequate sources of borrow material and rock riprap for a dam embankment repairs and spillway stabilization.
- As delineated, the project involves privately owned lands only.

4.3.4 LW-04: Gold Mine Draw Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from an existing well, pump, and storage tank (> 20,000-gallon capacity) to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, well, pump, and storage tank (> 20,000-gallon capacity), a buried HDPE pipeline would be installed southwesterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 6,600 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.5 LW-05: Hallie Draw Well, Solar Pump, and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply three stock tanks (1,200-gallon capacity). This pipeline would require installing 5,300 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.6 LW-14: Johnson Draw Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tanks.

4.3.7 LW-15: Shenandoah #4 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed northerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 1,900 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tanks.

4.3.8 LW-16: Dry Creek #2 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed easterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,500 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.9 LW-17: Miller Creek #2 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.

- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.10 LW-18: Dry Creek #4 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.11 LW-19: Dry Creek #3 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.12 LW-20: Hay Creek #1 and #2 Wells and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a pump and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Another existing well would be rehabilitated to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.13 LW-21: Miller Creek #2 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.14 LW-22: Dry Creek #5 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in the proposed stock tank.

4.3.15 LW-34: Sage Draw Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-inch pipeline.
- Additionally, another stock tank (1,200-gallon capacity) would be installed from an existing pipeline, well, and pump to supply water for the proposed project.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.16 LW-35: Tobey Draw Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from a well and pump to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, well, and pump, a buried HDPE pipeline would be installed northwesterly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,300 linear feet of 2-inch pipeline.

- The other pipeline would require installing approximately 2,400 linear feet of 2-inch pipeline northeasterly from the existing pipeline, well, and pump to a stock tank (1,200-gallon capacity).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.17 LW-35A: Noecker Stock Reservoir Rehabilitation Project

In addition to the development of livestock/wildlife water sources described in the *LW-35: Tobey Draw Pipeline and Tank Project*, this alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Tobey Draw, an intermittent tributary to the Belle Fourche River, within Section 23 of Township 51 North, Range 66 West in Crook County. Currently, the stock reservoir experiences seepage loss of the impounded water behind the embankment.

This project would include the rehabilitation of the Noecker Stock Reservoir (Permit No. P4565S). The reservoir has a permitted capacity of 4.87 acre-feet. This stock reservoir could be rehabilitated to provide a source of livestock/wildlife water along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankments and rehabilitation of problem areas as needed. The embankment is approximately 260 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As proposed, the project involves private lands only.

4.3.18 LW-35B: Dinky Stock Reservoir Rehabilitation Project

In addition to the development of livestock/wildlife water sources described in the *LW-35: Tobey Draw Pipeline and Tank Project*, this alternative would also provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Gill Creek, an intermittent tributary to Arch Creek, within Section 23 of Township 51 North, Range 66 West in Crook County. Currently, the stock reservoir experiences seepage loss of the impounded water behind the embankment.

This project would include the rehabilitation of the Dinky Stock Reservoir (Permit No. P4294S). The reservoir has a permitted total capacity of 0.79 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the associated wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankments and rehabilitation of problem areas as needed. The embankment is approximately 80 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As proposed, the project involves private lands only.

4.3.19 LW-36: Line Creek Spring Development and Tank Project

This alternative would involve rehabilitating an existing spring development and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- The existing spring would be rehabilitated and equipped with collection pipe, spring box, and appurtenances would be installed.
- From the rehabilitated spring, a solar platform consisting of solar panel; solar-powered pump; batteries; and regulators, connections, and appurtenances would be installed to supply water via a buried HDPE low-pressure pipeline to two stock tanks (1,200-gallon capacity each). This pipeline would be aligned westerly and require installing 1,700 linear feet of 2-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.20 LW-54: Bennor #2 Well, Pipeline, and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a pump and appurtenances.
- From the well and pump, three buried HDPE low-pressure pipelines would be installed to supply water to five stock tanks.
- One pipeline would be aligned southerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,200 linear feet of 2-inch pipeline.
- Another pipeline would require installing approximately 1,900 linear feet of 2-inch pipeline westerly from the proposed pipeline and stock tanks to a stock tank (1,200-gallon capacity).
- Another pipeline would require installing approximately 5,400 linear feet of 2-inch pipeline easterly from the proposed pipeline and stock tanks to two stock tanks (1,200-gallon capacity each).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

4.3.21 LW-55: Donkey Creek Well, Pipeline, and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a pump and appurtenances.
- From the well and pump, two buried HDPE low-pressure pipelines would be installed to supply water to two stock tanks.
- One pipeline would be aligned easterly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,200 linear feet of 2-inch pipeline.
- The other pipeline would require installing approximately 2,500 linear feet of 2-inch pipeline westerly from the well to a stock tank (1,200-gallon capacity).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

In addition to the installation of a well, pump, pipeline, and stock tanks, this alternative would also provide for the rehabilitation of a stock pond to provide an additional source of livestock/wildlife water along with providing associated wetland areas. This alternative would include the following features:

- Inspection of the embankments and rehabilitation of problem areas as needed. The pond is approximately 220 feet wide by 540 feet long with embankments less than 15 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As proposed, the project involves private lands only.

4.4 GRAZING MANAGEMENT OPPORTUNITIES

In Section 3.1.4.5 of Chapter 3.0 and within the basin wide summary report, the ecological sites within the subbasin were presented and the concept of the ESD was discussed. Within each ESD, there is a State and Transition Model (STM), which describes the patterns, causes, and indicators that cause vegetation to change from one plant community to a different group of plant species, and the management actions needed to restore to a desirable plant community.

The ESDs and their associated STMs for the five predominant ESDs that are available within the subbasin were obtained directly from the NRCS and are detailed in the following Sections 4.4.1 through 4.4.5. The five rangeland ESDs and associated HCPCs and STMs cover approximately 702,450 acres or 56.3 percent of the subbasin. The five predominant rangeland ESDs within the mapped area of the subbasin are likely to be one of the following:

- *R058BY122WY Loamy (Ly) 10–14-inch Northern Plains Precipitation Zone*
- *R058BY222WY Loamy (Ly) 15–17-inch Northern Plains Precipitation Zone*
- *R058BY150WY Sandy (Sy) 10–14-inch Northern Plains Precipitation Zone*
- *R058BY162WY Shallow Loamy (SwLy) 10–14-inch Northern Plains Precipitation Zone*
- *R058BY166WY Shallow Sandy (SwSy) 10–14-inch Northern Plains Precipitation Zone.*

In addition to the ESDs and the associated STMs, other tools are available that can be used to maintain and/or improve watershed function particularly when coupled with implementation of appropriate grazing management strategies. Other components are explained in detail in Chapter 4.0 of the basin wide summary report. Some of those grazing management components and supporting conservation practices include but are certainly not limited to the following:

- **Watershed Plan Component G-1:** Water developments can be used to expand grazing distribution to areas that do not currently have reliable water. Riparian area plant community condition can be enhanced by development of water into upland areas.
- **Watershed Plan Component G-2:** Fencing can be used to enhance grazing management options and to facilitate the planned grazing system.
- **Watershed Plan Component G-3:** Strategic salting and herding are other tools that can be used to enhance grazing distribution.
- **Watershed Plan Component G-4:** Most range improvement practices which improve watershed condition, may also improve wildlife habitat. Wildlife needs should be considered when installing practices such as wildlife friendly fences, wildlife escape ramps from tanks, and wildlife watering facilities.
- **Watershed Plan Component G-7:** Application of chemicals may be used as a tool to assist in the restoration of range health areas according to the STMs. However, identifying areas benefitting from this practice was beyond the scope of this study.

4.4.1 Loamy (Ly) 10–14-Inch Northern Plains Precipitation Zone

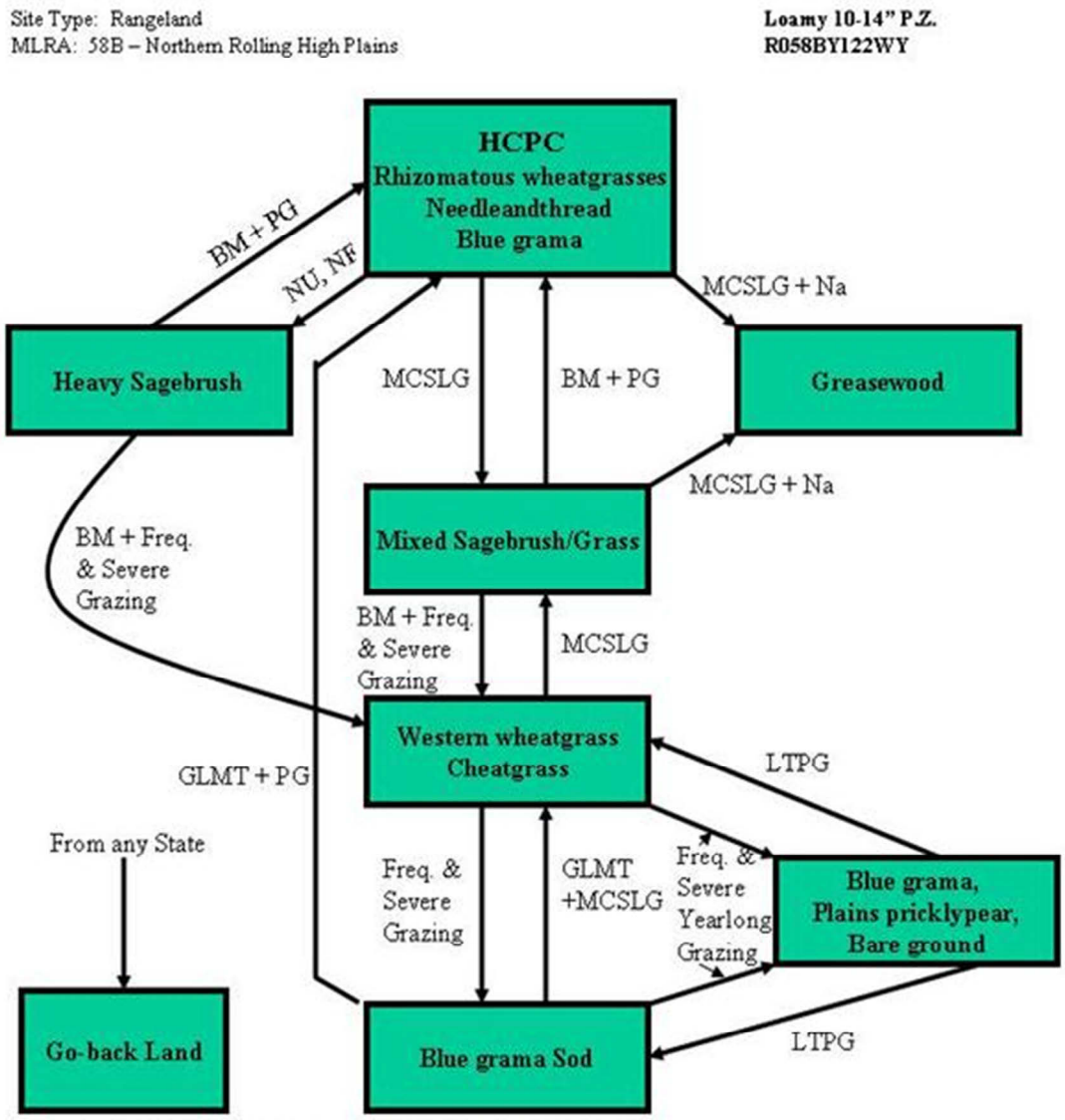
The most predominant rangeland ecological site within the subbasin is the Loamy (Ly) 10–14-inch Northern Plains Precipitation Zone (R058BY122WY) covering approximately 351,030 acres or 28.2 percent of the subbasin. The STM for the Loamy (Ly) 10–14-inch Northern Plains Precipitation Zone ESD is shown Figure 4.1.

Rhizomatous wheatgrasses/Needleandthread/Blue Grama Plant Community

This plant community is the interpretive plant community for this site and is considered to be the HCPC. This plant community evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and sometimes on areas receiving occasional short periods of rest. The potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. This state is dominated by cool-season mid-grasses.

The major grasses include western wheatgrass, needleandthread, and green needlegrass. Other grasses occurring in this state include Cusick's and Sandberg's bluegrass, bluebunch wheatgrass, and blue grama. A variety of forbs and half-shrubs also occur, as shown in the preceding table. Big sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production. Plant diversity is high. The total annual production (air-dry weight) of this state is about 1,200 pounds per acre, but it can range from about 700 pounds per acre in unfavorable years to about 1,500 pounds per acre in above average years.

This plant community is extremely stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

Technical Guide
Section IIE
4
USDA-NRCS
Rev. 02-17-01

Figure 4.1. State and Transition Model: Loamy (Ly) 10–14-Inch Northern Plains Precipitation Zone.

Transitions or pathways leading to other plant communities are as follows:

- No use and no fire for 20 years or more will convert this plant community to the Heavy Sagebrush Plant Community
- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Plant Community
- Moderate continuous season-long grazing, where greasewood occurs adjacent to the site, will convert the plant community to the Greasewood Plant Community
- When cropped annually and then abandoned without reseeding, the state is converted to the Go-back Land Plant Community.

4.4.2 Loamy (Ly) 15–17-Inch Northern Plains Precipitation Zone

The second most predominant rangeland ecological site in the subbasin is the Loamy (Ly) 15-17-inch Northern Plains Precipitation Zone (R058BY222WY) covering approximately 116,510 acres or 9.3 percent of the subbasin. The STM for the Loamy (Ly) 15–17-inch Northern Plains Precipitation Zone ESD is shown Figure 4.2.

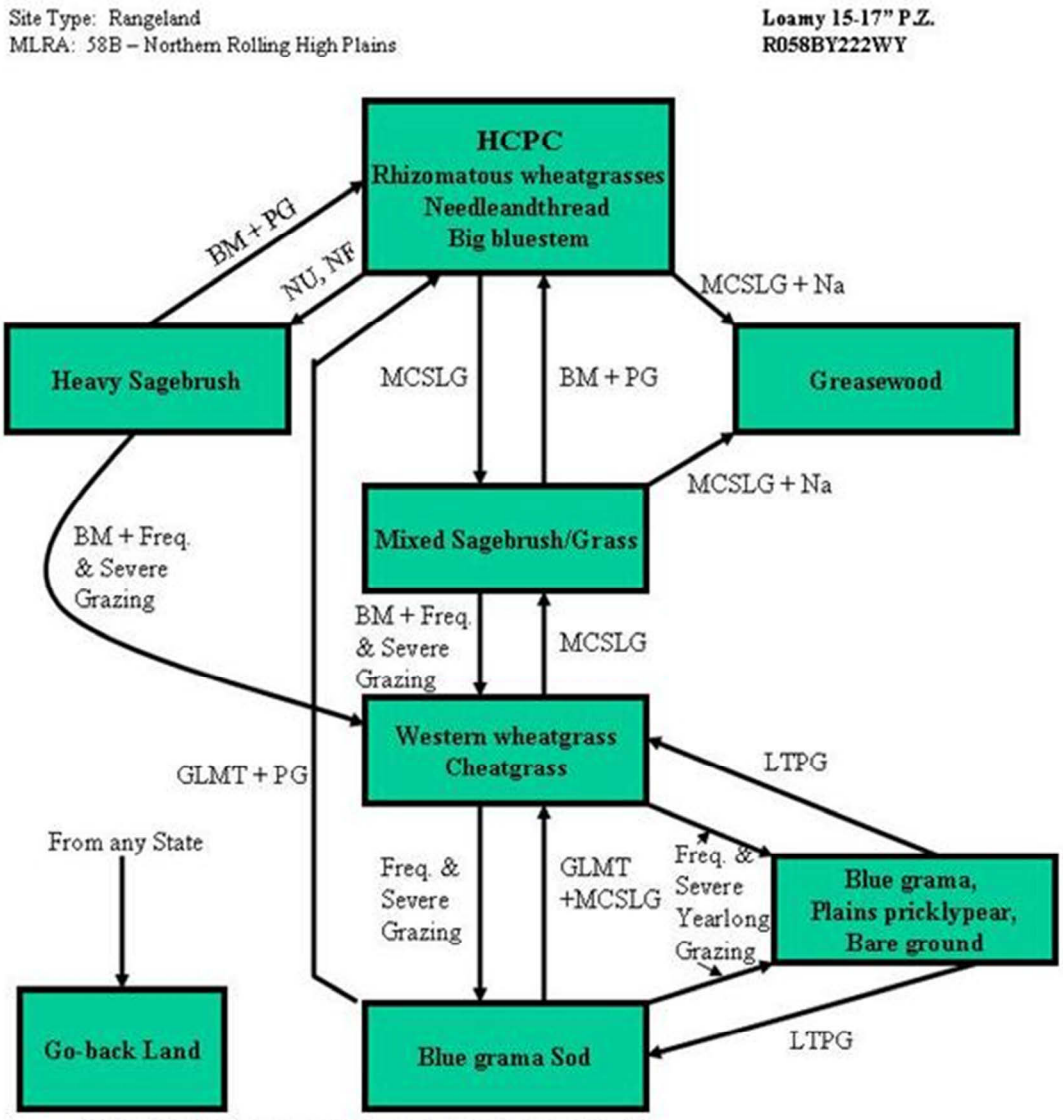
Rhizomatous Wheatgrasses/ Needleandthread/Big Bluestem Plant Community

The interpretive plant community for this site is the HCPC. This plant community evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and sometimes on areas receiving occasional short periods of rest. The potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. A mix of warm and cool-season mid-grasses dominates the state.

The major grasses include western wheatgrass, needleandthread, big bluestem, little bluestem, and green needlegrass. Other grasses occurring on the state include threadleaf sedge, Sandberg's bluegrass, bluebunch wheatgrass, blue grama, and sideoats grama. A variety of forbs and half-shrubs also occur, as shown in the preceding table. Big sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production. Plant diversity is high.

The total annual production (air-dry weight) of this state is about 1,900 pounds per acre, but it can range from about 1,500 pounds per acre in unfavorable years to about 2,300 pounds per acre in above average years.

This plant community is extremely stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

Technical Guide
Section IIE
4
USDA-NRCS
Rev. 03-08-01

Figure 4.2. State and Transition Model: Loamy (Ly) 15–17-Inch Northern Plains Precipitation Zone.

Transitions or pathways leading to other plant communities are as follows:

- No use and no fire for 20 years or more will convert this plant community to the Heavy Sagebrush Plant Community
- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Plant Community
- Moderate continuous season-long grazing, where greasewood occurs adjacent to the site, will convert the plant community to the Greasewood Plant Community
- When cropped annually and then abandoned without reseeding, the state is converted to the Go-back Land Plant Community.

4.4.3 Sandy (Sy) 10–14-Inch Northern Plains Precipitation Zone

The third predominant rangeland ecological site is the Sandy (Sy) 10–14-inch Northern Plains Precipitation Zone (R058BY150WY), which covers approximately 112,530 or 9.0 percent of the subbasin. The STM for the Sandy (Sy) 10–14-inch Northern Plains Precipitation Zone ESD is shown in Figure 4.3.

Needleandthread/Prairie Sandreed Plant Community

This plant community is the interpretive plant community for this site and is considered to be the HCPC. This state evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. The state is a mix of warm- and cool-season midgrasses. The major grasses include needleandthread, prairie sandreed, little bluestem, and Indian ricegrass. Other grasses occurring in the state include rhizomatous wheatgrasses, Sandberg bluegrass, blue grama, and threadleaf sedge. Silver sagebrush and green rabbitbrush are conspicuous components of this state.

The total annual production (air-dry weight) of this state is about 1,200 pounds per acre, but it can range from about 750 pounds per acre in unfavorable years to about 1,600 pounds per acre in above average years.

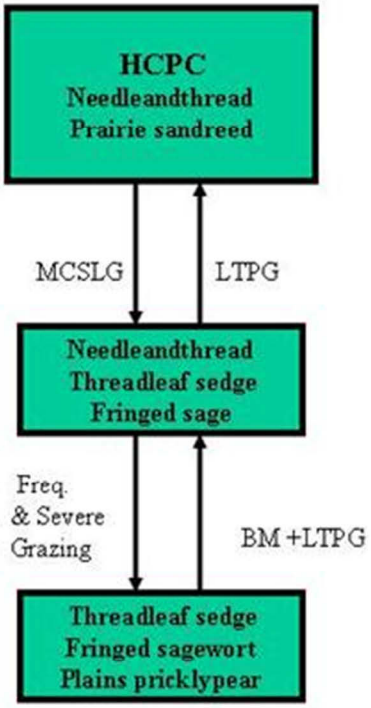
The state is stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Moderate, Continuous Season-Long grazing will convert the plant community to the Needleandthread/ Threadleaf sedge/ Fringed sagewort Vegetation State
- Frequent and Severe grazing will convert the plant community to the Threadleaf sedge/ Fringed sagewort/ Plains Pricklypear Vegetation State.

Site Type: Rangeland
MLRA: 58B – Northern Rolling High Plains

Sandy 10-14" P.Z.
R058BY150WY



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

Figure 4.3. State and Transition Model: Sandy (Sy) 10–14-Inch Northern Plains Precipitation Zone.

4.4.4 Shallow Loamy (SwLy) 10–14-Inch Northern Plains Precipitation Zone

The fourth most predominant rangeland ecological site within the subbasin is the Shallow Loamy (SwLy) 10–14-inch Northern Plains Precipitation Zone (R058BY162WY) covering approximately 63,530 acres or 5.1 percent of the subbasin. The STM for the Shallow Loamy (SwLy) 10–14-inch Northern Plains Precipitation Zone ESD is shown Figure 4.4.

Rhizomatous wheatgrasses/Needleandthread/Blue Grama Plant Community

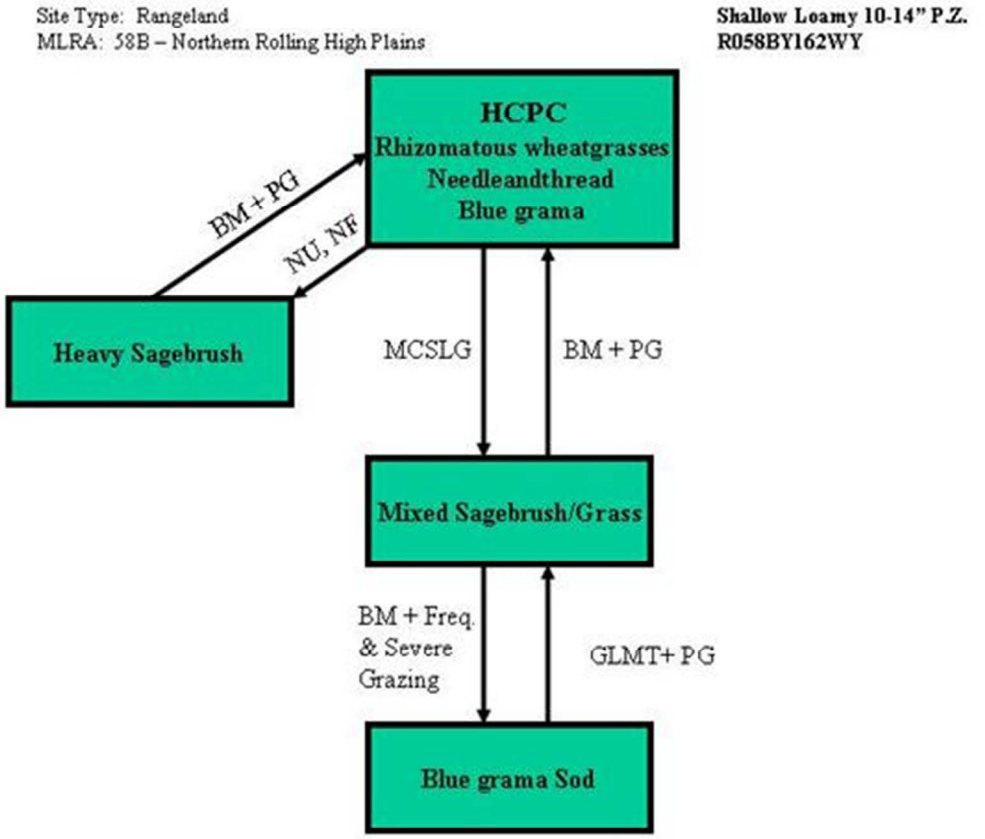
This plant community is the interpretive plant community for this site and is considered to be the HCPC. This state evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. The state is dominated by cool-season midgrasses.

The major grasses include western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. Other grasses occurring on the state include Cusick's and Sandberg bluegrass, blue grama, and prairie junegrass. Big sagebrush is a conspicuous element of this state, occurring in a mosaic pattern, and makes up 5 to 10 percent of the annual production. Big sagebrush may become dominant on some areas with absence of fire. Natural fire occurred frequently in this community and prevented big sagebrush from being the dominant landscape. Wildfires are actively controlled in recent times so chemical control using herbicides has replaced the historic role of fire on this state. Recently controlled burning has regained some popularity. The total annual production (air-dry weight) of this state is about 900 pounds per acre, but it can range from about 450 pounds per acre in unfavorable years to about 1,200 pounds per acre in above average years.

The state is extremely stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Protection from grazing and fire will convert this plant community to the Heavy Sagebrush Vegetation State
- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Vegetation State
- Frequent and severe grazing and brush management will convert the plant community to the Blue Grama Vegetation State.



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

Technical Guide
Section IIE
4
USDA-NRCS
Rev. 02-17-01

Figure 4.4. State and Transition Model: Shallow Loamy (SwLy) 10–14-Inch Northern Plains Precipitation Zone.

4.4.5 Shallow Sandy (SwSy) 10–14-Inch Northern Plains Precipitation Zone

The fifth most predominant rangeland ecological site within the subbasin is the Shallow Sandy (SwSy) 10–14-inch Northern Plains Precipitation Zone (R058BY166WY) covering approximately 58,850 acres or 4.7 percent of the subbasin. The STM for the Shallow Sandy (SwSy) 10–14-inch Northern Plains Precipitation Zone ESD is shown Figure 4.5.

Needleandthread/Prairie Sandreed Plant Community

This plant community is the interpretive plant community for this site and is considered to be the HCPC. This plant community evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. The state is a mix of warm- and cool-season midgrasses. The major grasses include needleandthread, prairie sandreed, little bluestem, and sideoats grama. Other grasses occurring on the state include bluebunch wheatgrass, Sandberg bluegrass, blue grama, and threadleaf sedge. The total annual production (air-dry weight) of this state is about 1,000 pounds per acre, but it can range from about 600 pounds per acre in unfavorable years to about 1,300 pounds per acre in above average years.

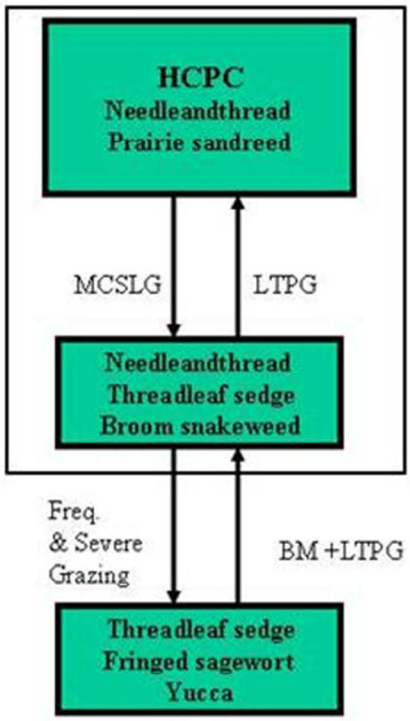
The state is stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Moderate, Continuous Season-Long grazing will convert the plant community to the Needleandthread/ Threadleaf sedge/ Broom snakeweed Vegetation State
- Frequent and Severe grazing will convert the plant community to the Threadleaf sedge/Fringed sagewort/Yucca Vegetation State.

Site Type: Rangeland
MLRA: 58B – Northern Rolling High Plains

Shallow Sandy 10-14" P.Z.
R058BY166WY



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

Technical Guide
Section IIE

4

USDA-NRCS
Rev. 02-26-01

Figure 4.5. State and Transition Model: Shallow Sandy (SwSy) 10–14-Inch Northern Plains Precipitation Zone.

5.0 PERMITS

5.1 PERMITS, CLEARANCES, AND APPROVALS

Information regarding the initial permitting and regulatory process for the proposed projects outlined in Chapter 4.0 of this report are contained within the basin wide summary report. Some of the proposed projects and future potential projects described in this study involving federal lands, funding, and programs are subject to the National Environmental Policy Act (NEPA) and other federal regulations, which requires coordination with the possibly several federal agencies. Coordination with state agencies may also be required depending on project locations and activities. Local ordinances and permits may be needed depending on the specific town, city, and/or county where the project is located. Right-of-way access is also required from the Wyoming Department of Transportation (WYDOT), utility entities, and energy companies when projects involve those properties. And finally, the state of Wyoming's "Wyoming Underground Facilities Notification Act" requires that before any excavation begins, the excavator is required to provide advance notice to the One-Call of Wyoming Notification Center at 811 (or if calling from out-of-state, 1.800.849.2476) [Wyoming State Legislature, 2013].

5.2 PROPOSED, THREATENED, AND ENDANGERED SPECIES

Two species have the potential to occur on proposed project areas within the subbasin: Endangered: Black-footed ferret (*Mustela nigripes*) and Threatened: piping plover (*Charadrius melodus*) [Wyoming Natural Diversity Database, 2014].

5.3 OTHER SPECIES OF CONCERN

The WYNDD records and maintains a list of animal and plant species in Wyoming that are thought to be rare or sensitive and included in Section 3.1.6.2 and Section 3.1.2 of this report. The sage-grouse is listed as a "candidate species; warranted but precluded" because existing information supports a proposal to list them as endangered or threatened; however, developing a proposed listing is precluded by higher priority listing activities. In 2011, the Governor of Wyoming issued an executive order that requires state agencies to focus management to the greatest extent possible to prevent the sage-grouse from being listed as a threatened or endangered species. The core areas for sage-grouse cover approximately 228,990 acres or 18 percent of the subbasin and are shown in Figure 3.14.

5.4 LAND OWNERSHIP AND PROPERTY OWNERS

Permission should be negotiated for easements, right-of-way access for all construction activities associated with a project. **Note that the WWDC has stated that lands will NOT be "taken" or condemned to construct projects recommended within the watershed management plan. WWDC representatives stated that the state is not interested in condemning lands for the purpose of constructing a reservoir built with an objective of benefitting those whose lands would be used. Participation must be voluntary.**

6.0 COST ESTIMATES

Costs are estimated in Table 6.1 for each of the conceptual proposed projects and alternatives described in Chapter 4.0. These estimated costs, representing 2014 dollars, are explained in the basin wide summary report for each of the proposed project categories.

Table 6.1. Estimated Costs Associated With Each of the Upland Livestock/Wildlife Water Source/Supply Proposed Projects and Components of the Watershed Management Plan

Item Number	Plan Component	Description	Priority	Construction Costs ($)	Engineering Costs (10%) ($)	Construction and Engineering Subtotal ($)	Contingency (15%) ($)	Total Construction Costs ($)	Final Plans and Specs ($)	Permits, Fees, Access ($)	Total Project Costs ($)
1	LW-01	Coyote Draw Pipeline and Tank	1	$77,150	$7,715	$84,865	$12,730	$97,595	$2,000	$2,000	$101,595
2	LW-02	Coyote Stock Reservoir	1	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
3	LW-03	Coyote Draw Stock Reservoir	1	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
4	LW-04	Gold Mine Draw Pipeline and Tank	2	$35,900	$3,590	$39,490	$5,924	$45,414	$2,000	$2,000	$49,414
5	LW-05	Hallie Draw Well, Solar Pump, and Tank	2	$70,350	$7,035	$77,385	$11,608	$88,993	$2,000	$2,000	$92,993
16	LW-14	Johnson Draw Well, Solar Pump, and Tank	1	$59,660	$5,966	$65,626	$9,844	$75,470	$2,000	$2,000	$79,470
17	LW-15	Shenandoah #4 Well, Solar Pump, and Tank	2	$51,950	$5,195	$57,145	$8,572	$65,717	$2,000	$2,000	$69,717
18	LW-16	Dry Creek #2 Well, Solar Pump, and Tank	1	$59,150	$5,915	$65,065	$9,760	$74,825	$2,000	$2,000	$78,825
19	LW-17	Miller Creek #1 Well, Solar Pump, and Tank	1	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
20	LW-18	Dry Creek #4 Well, Solar Pump, and Tank	2	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
21	LW-19	Dry Creek #3 Well, Solar Pump, and Tank	2	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
22	LW-20	Hay Creek #1 & #2 Well, Solar Pump, and Tank	3	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
23	LW-21	Miller Creek #2 Well, Solar Pump, and Tank	3	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
24	LW-22	Dry Creek #5 Well, Solar Pump, and Tank	3	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
36	LW-34	Sage Draw Well, Pipeline, and Tank	3	$44,300	$4,430	$48,730	$7,310	$56,040	$2,000	$2,000	$60,040
37	LW-35	Tobey Draw Pipeline, Tank, and Stock Reservoir	1	$27,350	$2,735	$30,085	$4,513	$34,598	$2,000	$2,000	$38,598
38	LW-35A	Noecker Stock Reservoir	3	$52,350	$5,235	$57,585	$8,638	$66,223	$2,000	$2,000	$70,223
39	LW-35B	Dinky Stock Reservoir	3	$52,350	$5,235	$57,585	$8,638	$66,223	$2,000	$2,000	$70,223
64	LW-54	Bennor #2 Well, Pipeline, and Tank	1	$90,250	$9,025	$99,275	$14,891	$114,166	$2,000	$2,000	$118,166
65	LW-55	Donkey Creek Well, Pipeline, and Tank	2	$82,950	$8,295	$91,245	$13,687	$104,932	$2,000	$2,000	$108,932

7.0 FUNDING OPPORTUNITIES

Sources of funding and financing for proposed projects within the subbasin and the associated technical support and assistance are available from various local, private, state, and federal entities. Local coordination is crucial in developing viable financing approaches that could be used in implementing proposed projects and realizing benefits. Voluntary cooperation between landowners, managers, irrigators, residents, organizations, and agencies is essential in addressing the identified land and water resource concerns within the subbasin.

Local, state, and federal agencies, along with private organizations, provide technical assistance for watershed and conservation projects with a smaller amount of these entities also providing financial assistance. Private contributions, such as in-kind provisions, are vital in developing and accomplishing a successful watershed or conservation project. Agencies and organizations with technical and financial assistance programs, which could potentially assist with proposed projects and alternatives, are provided within the Basin wide summary report. Funding and program information for potential conservation and watershed project and program assistance was obtained primarily from the following two sources:

- **Water Management and Conservation Assistance Programs Directory**, is an overview of local, state, and federal programs with associated contact information, (*http://wwdc.state.wy.us/wconsprog/2014WtrMgntConsDirectory.html*)
- **Catalog of Federal Funding Sources for Watershed Protection** is a searchable database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of watershed projects (*http://www.epa.gov/watershedfunding*)

Important local contact information within the subbasin for local conservation and civic organizations include, but are certainly not limited to, the following contacts:

- Campbell County Conservation District (307.682.1824)
- Crook County Natural Resource District (307.283.2870)
- Weston County Natural Resource District (307.746.3264)
- NRCS Newcastle Field Office (307.746.3264)
- NRCS Sundance Field Office (307.283.2870)
- NRCS Gillette Field Office (307.682.8843)
- BLM Buffalo Field Office (307.684.1100)
- BLM Newcastle Field Office (307.746.6600)
- USFS Douglas Ranger District (307.358.4690).

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

Resource issues and concerns within the subbasin were identified and evaluated to outline proposed improvements and alternatives associated with the following study areas:

- Livestock/Wildlife Upland Watering Opportunities
- Grazing Management Opportunities

8.1.1 Livestock/Wildlife Upland Watering Opportunities

- Opportunities to improve range and riparian conditions require the installation and operation of well-distributed, reliable upland water sources and watering facilities for wildlife and livestock. Installing pipelines and stock tanks is the foundation of effective grazing management and can be an economical way to improve rangeland conditions.
- There are 73 BLM grazing allotments encompassing 282,253 acres and 19 USFS grazing allotments encompassing 44,378 acres of rangelands consisting of private, state, and federal lands in the subbasin.
- Coordination with the BLM and the USFS regarding grazing allotment management is necessary and requires more involvement in developing proposed livestock/wildlife water supply projects beyond the conceptual level projects included within the study.
- There were 20 potential livestock/wildlife water projects identified for development resulting from an effort that evaluated available water sources in coordination with participating landowners and allotment permittees.
- Conceptual project plans and component designs along with associated cost estimates were calculated for each of the proposed projects. The primary components included water wells, solar pumps, buried pipelines, and stock tanks, which would require additional final planning, design, and permitting completed before construction.
- The proposed projects and components would need to be installed, operated, and maintained by the landowner or manager in accordance with current standards and specifications realize the expected benefits to the project area and watershed.

8.1.2 Grazing Management Opportunities

- Construction and operation of reliable water supply projects must be developed and implemented in areas with inadequate water sources before adjustments or alternatives in grazing management could be made on a particular area or allotment.

- Development of reliable water sources and associated watering facilities can aid in distribution, timing, and frequency of grazing animals. However, additional measures such as cross-fencing, low-stress herding, mineral/salting, and grazing density should be evaluated as part of the site-specific, grazing management inventory and plan.
- Available tools such as the ESD and the STM can be used by landowners and managers to become aware of the growth potential of desirable vegetation and predicted responses on a particular range site.
- These tools could be used in developing appropriate rangeland treatments and grazing practices to begin the transition from an undesirable to a desirable plant community.

8.2 RECOMMENDATIONS

Several proposed conceptual projects, identified opportunities, suggested alternatives, and initial conclusions have been presented and discussed within this report and watershed management plan. Summary recommendations listed below are included for consideration:

- Several livestock/wildlife upland water projects could be eligible to apply for funding through the WWDC SWPP.
- Priority projects should be reviewed, selected, and components implemented once the necessary technical and financial requirements are determined.
- Landowners or managers seeking to participate in the SWPP should consult and coordinate with their local conservation districts, which are eligible sponsors of SWPP applications and project agreements.
- The study's GIS and digital library should be used as a tool in planning and developing projects and should be updated as necessary from available information sources.
- Potential funding opportunities exist for proposed and future improvement projects within the watershed including ranch and farm improvements, irrigation system rehabilitation, riparian/wetland enhancements, river corridor and stream channel restoration, and surface water storage projects.
- Innovative strategies for coordinated project funding and financing involving private, local, state, and federal sources will need to be pursued since many of the opportunities are unique in this watershed and do not conform to traditional programs and guidelines.
- It is essential that this approach be based on local, collaborative endeavors that integrate more than one watershed issue that could result in achievement of multiple benefits.

9.0 REFERENCES

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