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Kirby Creek Watershed
Level I Study

PBS&J

FINAL Report
September 2010

FINAL

Kirby Creek Watershed

Level I Study

Prepared for:

Wyoming Water Development Commission
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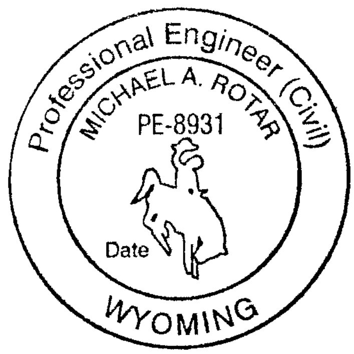
September 2010

Kirby Creek Watershed
Level I Study

PBS&J Project No. 100008648
WWDC Contract No. 05SC0293899

October 12, 2010



I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Wyoming.

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LIST OF APPENDICES

1.0 INTRODUCTION

In May 2009 Post, Buckley, Schuh and Jernigan (PBS&J) was selected by the Wyoming Water Development Commission (WWDC) to conduct a Level I study of the Kirby Creek watershed. The Hot Springs Conservation District (HSCD), which is the local sponsor of the project, requested funding from the WWDC for an updated watershed study to gather information needed to develop a management and rehabilitation plan and to evaluate the effects of previous project implementation to current watershed function. A previous Level I watershed study was completed for the Kirby Creek watershed in 2005 (Sunrise Engineering, 2005).

A watershed can be defined as, “the area of land where all of the water that is under it or drains off of it goes into the same place”. Everyone lives in a watershed. The use of watersheds as a boundary for developing water resource and land management strategies is not a new concept. In fact, many of the Soil and Water Conservation Districts established across the United States in the 1930’s were defined by a watershed area. More recently, the term “watershed approach” has become somewhat of a buzzword to describe a decision-making process that reflects a common strategy for information collection and analysis as well as a common understanding of the roles, priorities, and responsibilities of all stakeholders within a watershed. Watersheds are appropriate as an organizational entity because they are readily identifiable landscape units with readily identifiable boundaries that integrate terrestrial, aquatic, and geologic features. An additional characteristic of the watershed approach is that it complements and coordinates other land and water resource management activities. This facilitates close cooperation with local citizen groups, local governments, and state and federal resource agencies.

The WWDC acknowledges the importance of watersheds as a division for planning and management of water development projects through their watershed study program. A WWDC watershed study, or its equivalent, is typically used as an initial planning tool to define water development opportunities within a watershed. In support of their Small Water Projects Program (SWPP), the WWDC further defines a watershed study as follows:

> *A watershed study will incorporate, at a minimum, available technical information describing conditions and assessments of the watershed including hydrology, geology, geomorphology, geography, soils, vegetation, water conveyance infrastructure, and stream system data.*
>
> *A management and rehabilitation plan outlining site-specific projects that may remediate existing watershed impairments or address opportunities beneficial to the watershed is required for access to the SWPP. Activities should improve watershed condition and function and provide benefit for wildlife, livestock and the environment. Projects may provide improved water quality, riparian habitat, habitat for fish and wildlife and address environmental concerns by providing water supplies to support plant and animal species or serve to improve natural resource conditions.*

This study satisfies the primary objectives of the HSCD, the Kirby Creek Coordinated Resource Management (CRM) group, landowners in the watershed, and other project stakeholders by updating the previous watershed study, assessing the function and value of projects that have been implemented, and providing a look forward with a watershed management and rehabilitation plan.

1.1 PURPOSE AND SCOPE

The principal purposes of the Kirby Creek Watershed Study are to:

1) Inventory relevant physical and biological conditions in the watershed and describe the connections that exist between watershed condition and opportunities for water resource development. Provide a discussion of recently completed water development projects, and the effects of these projects on watershed function and management.
2) Complete a watershed management and rehabilitation plan that identifies and prioritizes future water development projects and management practices, including conceptual-level design of significant projects.
3) Determine which environmental regulations may affect potential projects and management strategies, and describe the applicable regulatory framework (i.e., permits, environmental studies) required to implement a project.
4) Provide conceptual-level cost estimates for water development projects and management practices identified in the watershed management plan.
5) Describe potential funding sources for identified projects, including an assessment of the sponsor's ability to provide funds assuming WWDC financing.

The scope of this watershed study responds to the principal purposes above as well as each of the work tasks listed in the Scope of Services in Exhibit A (Section D), of the Consultant Contract for Services #05SC0293899.

1.2 OVERVIEW OF PROJECT AREA

The Kirby Creek watershed is located at the southern end of the Big Horn Basin in north-central Wyoming (**Figure 1.1**). The watershed lies almost entirely within Hot Springs County, with very small areas also located in Fremont and Washakie Counties. The watershed covers approximately 200 square miles. Kirby Creek is tributary to the Big Horn River; the confluence is located just northeast of the community of Lucerne, Wyoming. Major tributaries to Kirby Creek within the watershed include Alkali Creek, East Kirby Creek, West Kirby Creek, and Lake Creek. Elevations within the watershed range from 4,260 feet at the Big Horn River confluence to 8,140 feet at the watershed's high point, resulting in a total relief of nearly 3,900 feet. There are no incorporated cities or towns within the watershed boundary. Wyoming State Highway 172, also known as Black Mountain Road, enters the watershed just east of the Big Horn River and traverses the northern portion of the watershed in generally an east-west alignment. It is the only paved road within the watershed.

Approximately 50% of the watershed consists of land managed by the federal government (U.S. Dept. of Interior, Bureau of Land Management - BLM). The State of Wyoming owns about 12% of the watershed. Private land ownership comprises the remaining 38% of the watershed area. The BLM manages 38 grazing allotments and 20 operators in the watershed. Land cover in the watershed is dominated by shrublands, followed by grasslands, riparian areas, and forested area. The majority of the shrublands in the Kirby Creek watershed are sagebrush dominated. The Kirby Creek watershed receives relatively little precipitation (10 to 16 inches per year) and is classified as semi-arid.

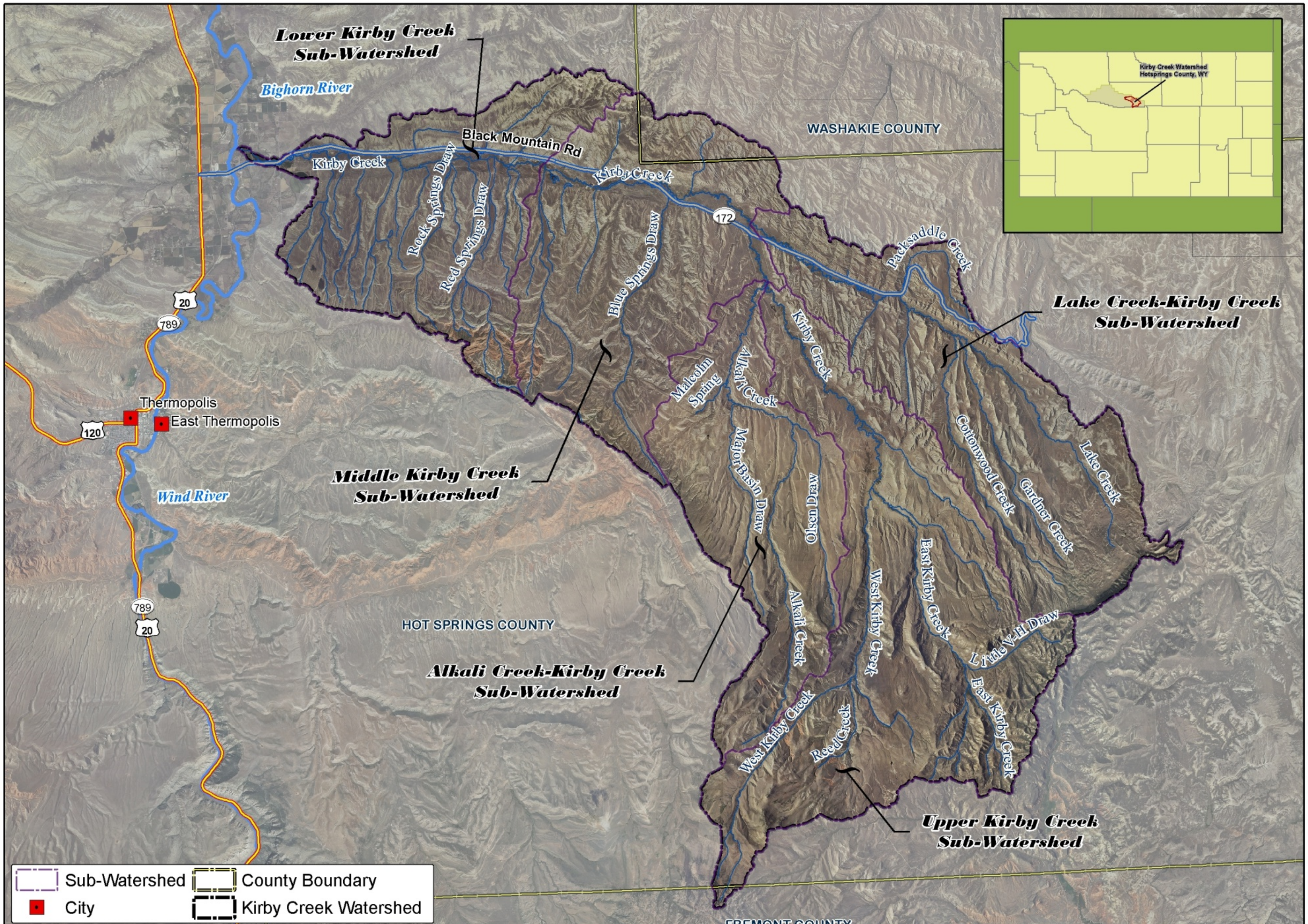

FIGURE 1.1	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Kirby Creek Watershed Study Area	
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N

0 1 2 4 Miles

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1.3 STUDY FOCAL POINTS

Landowners and project stakeholders are challenged in their management and utilization of water by the physical state of the watershed. To that end, this study focuses on several ongoing processes that influence overall watershed condition and health and which critically affect the development, distribution and efficient use of water resources. An emphasis is placed on identifying management strategies and potential projects that are compatible with existing conditions within the watershed and which have potential to mitigate current limitations to water development opportunities.

A number of key issues have been identified by the Kirby Creek CRM group, which has played a significant role in the direction and focus of this study. The Kirby Creek CRM group's mission is to assess, maintain and enhance the quality of the Kirby Creek watershed through a voluntary cooperative process while protecting the quality of life, custom, culture, and economic base of the community. It is currently comprised of individuals, landowners, and federal/state/local resource agency staff working together. The CRM-process provides a tool for people to manage and use natural resources for long-term productivity and environmental well-being. This can be best accomplished by local people addressing local issues in a collaborative and consensus-driven manner.

To date, an investment of approximately $1.5 million has been expended in the watershed through various funding sources for improvements such as weed control, fencing, streambank restoration, off-site water development and historic channel restoration. These projects have facilitated better livestock distribution which in turn has improved sage grouse and riparian habitat, and increased cottonwood and willow cover along portions of Kirby Creek. Continuing efforts are being made to tackle problems that include:

Water Quantity and Retention

- The Kirby Creek watershed is a semi-arid landscape with a limited water supply. Snowmelt runoff in the spring typically has a very short duration. Presently, there is limited ability and capacity to capture and store the runoff that is available.
- Limitations in available surface water can be partially mitigated by maximizing the ability to retain runoff in storage facilities (e.g., reservoirs), subject to legal availability per administration of water rights.

Figure 1.2 In-stream water impoundment on Kirby Creek (Twin Tubes pond)

Channel Morphology and Stability

- Long-term geomorphic processes, both natural and human-induced, have resulted in significant channel degradation and incision throughout much of the watershed. In some areas channel incision is greater than 30 feet below the historic valley bottom. In many locations, the stream channel is currently in a state of recovery whereby a new, lowered floodplain surface has developed.

Figure 1.3 Example of channel incision typical within the watershed (Blue Springs Draw)

- The disconnect between historic floodplain surfaces and the present base elevation of stream channels presents obstacles to effective and efficient use of surface water for livestock/wildlife watering, irrigation, and support of aquatic and riparian habitat.

Grazing Management

- Livestock grazing is one of the main land uses in the watershed. Severe channel incision in many locations has resulted in limited access to surface waters for livestock watering. Numerous projects (including well development, water pipelines, and upland stock water tanks) have been implemented in the watershed to increase and distribute watering opportunities across a greater land area.
- Provision of upland watering sources away from riparian and wetland areas reduce the impact on these critical resources. Furthermore, proactive management of upland range can directly affect conditions in the riparian area. Consequently, it is important to consider the *entire* watershed when developing a grazing management strategy.

1.4 REVIEW OF BACKGROUND INFORMATION

This Level I study is the second to be completed for the Kirby Creek watershed in the last five years. Sunrise Engineering, Inc. (SEI) of Afton, WY completed a Level I study (SEI, 2005) under contract with the WWDC. The Kirby Creek watershed is the first watershed in the state to have an "update" of a previous Level I study prepared. Therefore, the nature and content of this study is somewhat different than other Level I studies because:

1) Some of the recommendations and projects identified in the previous study have been implemented and an evaluation of their effectiveness and functionality is desired.

2) Much of the baseline information that describes the watershed has not changed since the previous study; where possible, factual information presented in the SEI study is simply referenced in this study once its validity is confirmed.

3) The Kirby Creek CRM group has been very active over the past decade having completed numerous water development and habitat restoration projects within the watershed, as well as initiating several conservation practices including riparian fencing and riparian (willow) plantings.

Based on these findings this study emphasizes a more detailed characterization and description of watershed features that, through management and/or manipulation via potential projects, have the ability to facilitate improvements in water use and conservation.

Numerous other sources for data and information were accessed or contacted throughout the project term. This includes the following resource agencies or other entities:

- U.S. Bureau of Land Management (BLM) – Worland and Lander Field Offices
- U.S. Dept. of Agriculture/Natural Resources Conservation Service (USDA/NRCS) – Hot Springs County and Washakie County Field Offices
- U.S. Dept. of Agriculture/Farm Services Agency (USDA/FSA)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Geological Survey (USGS)
- Wyoming Water Development Commission (WWDC)
- Wyoming Water Resources Data System (WRDS)
- Wyoming Dept. of Agriculture (WDA)
- Wyoming Dept. of Environmental Quality (WDEQ)
- Wyoming Game and Fish Dept. (WGFD)
- Wyoming State Engineer's Office (WSEO)
- Wyoming Oil and Gas Conservation Commission (WOGCC)
- Wyoming State Geological Survey (WSGS)
- Wyoming Board of Land Commissioners/State Lands and Investments Board (WBLC/SLIB)
- Wyoming Wildlife and Natural Resources Trust (WWNRT)
- Wyoming Geographic Information Science Center (WyGISC)
- Hot Springs County Assessor's Office
- Hot Springs County Conservation District
- Hot Springs County Weed and Pest District

Information was acquired from these agencies and entities by one or more of the following means: electronic access via website, acquisition of published materials directly from agency, contact via telephone and e-mail, or personal contact at meetings or in the field.

2.0 PROJECT MEETINGS

A key element of this watershed study has been the close coordination with landowners and other project stakeholders. Their input has played an important role in helping shape the study to insure that focus areas are of interest to the group and that recommended management practices and potential projects are tailored to address specific issues and concerns. As discussed previously, the fact that an organized CRM group was already in place, coupled with a supportive local sponsor (HSCD), has helped streamline communication and facilitate participation and interaction between landowners and the PBS&J project team.

In 2008 the HSCD, with support from the Kirby Creek CRM group, requested funding from the WWDC for an updated watershed study to gather information needed to develop a management and rehabilitation plan and to evaluate the effects of previous project implementation to current watershed function. Subsequently, the Wyoming Legislature authorized funding for the study, and a request for professional services was issued by the WWDC in January 2009. As part of the consultant selection process, PBS&J staff attended the following two meetings:

- Pre-Proposal Tour: March 18, 2009 Thermopolis, WY/Kirby Creek Watershed
- Consultant Interviews: May 7, 2009 Cheyenne, WY/WY Water Development Office

2.1 PROJECT SCOPING AND UPDATE MEETINGS

Throughout the term of the contract PBS&J coordinated several project scoping and update meetings with assistance from Carla Thomas (HSCD, District Clerk) and members of the Kirby Creek CRM group. The purpose of these meetings was to present an outline of our approach to the project, solicit feedback and direction from meeting attendees regarding our proposed course of action, and provide periodic updates of our progress and findings. An initial project scoping meeting was held at Jim and Terry Wilson's high country cabin during a watershed tour of previously implemented projects.

Figure 2.1 Initial project scoping meeting held on June 24, 2009.

All subsequent scoping/update meetings were held at public facilities in Thermopolis, WY. Each of the meetings was well attended with good interaction between participants. Representatives from key resource agencies were usually present, including the BLM, USDA-NRCS, USDA-FSA, WSEO, HSCD, and Hot Springs County Weed & Pest District. Ron Vore, WWDO project manager, attended each of the meetings and provided guidance and perspective on project progress. PBS&J was represented by its project manager, Michael Rotar, at each meeting along with various other staff. Dennis Phillippi, of Natural Resource Options (NRO), a rangeland scientist and the lone subcontractor to PBS&J on the project, also attended most of the scoping meetings.

Project scoping and update meetings were announced through a variety of formats including mailed invitations, telephone and e-mail contact, and word of mouth. Meeting dates and locations were as follows:

▪ Project Kick-off Scoping Meeting:	June 24, 2009	Jim and Terry Wilson's high country cabin
▪ Project Scoping/Update Meeting:	January 14, 2010	Thermopolis/Hot Springs County Museum
▪ Project Scoping/Update Meeting:	February 23, 2010	Thermopolis/Hot Springs County Museum
▪ Project Update Meeting:	May 26, 2010	Thermopolis/Big Horn Federal Bank
▪ Draft Report Presentation:	August 25, 2010	Thermopolis/Big Horn Federal Bank

At each of the scoping/update meetings, PBS&J/NRO staff provided a status report on project progress. Feedback from attendees was encouraged. A presentation of the Geographical Information System (GIS) being developed as part of the project was given at each of the Thermopolis meetings.

2.2 FIELD MEETINGS/TOURS WITH LANDOWNERS

Numerous field meetings and tours were conducted with individual landowners during the study. Field reconnaissance efforts were focused on obtaining an accurate inventory and evaluation of existing projects, review and discussion of currently proposed projects and/or potential project opportunities, and a general characterization of stream channel and upland range conditions. Field visits were often scheduled to coincide with project scoping/update meetings. PBS&J representatives conducted field visits within the watershed on the following dates:

▪ June 24, 2009:	in conjunction with the initial scoping meeting; visited existing projects
▪ July 28-29, 2009:	field visits with Baird, Bunch, Anderson, Jones
▪ August 26-28, 2009:	field visits with Wilsons, Henthorne, Mishurda (Nyes), Brown
▪ December 2-4, 2009:	field visits with Baird, Wilsons, Jones
▪ January 15, 2010:	field visit with Marty Smith (in conjunction with scoping/update meeting)
▪ Apr 19-22, 27-28, 2010:	field visits with Wilsons, Mishurda (Nyes), Jones, Henthorne; Jim Mischke
▪ May 25-27, 2010:	field visit with Wilsons; Brett Belden (in conjunction with update mtg.)

Informal conversation with landowners proved to be an invaluable means of gaining familiarity with the landscape as well as a first-hand understanding of the issues and problems faced by ranchers on a day-to-day basis. A substantial portion of the knowledge and information about the watershed presented in this study was obtained in this manner.

3.0 WATERSHED DESCRIPTION AND INVENTORY

The Kirby Creek watershed is comprised of five 6th level hydrologic unit codes (HUC), which are termed 'sub-watersheds'. These sub-watersheds include: Lower Kirby Creek, Middle Kirby Creek, Upper Kirby Creek, Alkali Creek-Kirby Creek, and Lake Creek. Because the sub-watershed level of organization can be a useful management tool, Kirby Creek sub-watersheds are used throughout this section of the report to assist the reader in understanding where different features occur. For more information on these sub-watersheds refer to **Section 3.4.1**.

3.1 METHODS USED

The Kirby Creek Geographic Information System (GIS) is made up of data from a wide variety of sources including field-collected GPS (Global Positioning System) data. As each data source was used for analysis, or subsequent creation of a report figure, the data was checked for uniformity and placed in to a geodatabase. This was done so that consistency could be kept for all project data. Layer files were also exported so that the symbology of all figures could be recreated if needed

The Kirby Creek GIS was developed with a "clearinghouse" approach in mind. The GIS is the platform used to incorporate not only the spatial data for the watershed, but also the analysis that was used to develop the watershed management and rehabilitation plan. **Appendix A** lists the individual data sources and is organized with the same structure as the delivered geodatabase. The geodatabase is organized by feature classes and data sets.

The Kirby Creek GIS can be used as a comprehensive resource for the community for years to come. Note that it is always good practice to research data sources and sets to determine if more recent data are available. All of the GIS data included in this study has the ability to be used in ArcGIS or the free version of ESRI GIS software called ArcExplorer. Each layer file in the GIS was also exported so that the symbology of all figures could be recreated if necessary.

3.2 NATURAL ENVIRONMENT

This section provides an overview of the existing conditions of natural resources found in the Kirby Creek watershed, including climactic, topographic, geologic, edaphic (soil), and vegetative conditions. These factors form the general structure for the watershed.

3.2.1 Climate

A region's climate affects what plants can grow in an area, what animals inhabit it, and sets some fundamental limitations as to what is possible for humans to achieve in that region. For example, severe storm events such as hurricanes, tornados, severe thunderstorms, winter blizzards, as well as the force and direction of winds, minimum/maximum temperatures, timing and frequency of precipitation all influence how humans build homes and public infrastructure and affect our approach to private and commercial enterprises.

There are many variables which affect the climate of an area. In Wyoming several of the primary factors that affect climate at any particular location are a site's location relative to the continental divide, the elevation of the site, and topography. Located east of the continental divide, the Kirby Creek watershed is in the rain shadow of the Absaroka Mountain Range and the continental divide located roughly 97 miles west of the project area. Storm systems that travel eastward across the North American continent from the Pacific Ocean must first drop their moisture before they are light enough to get over the continental divide. Consequently, the Kirby Creek watershed receives relatively little precipitation (10 to 16 inches per year) and is classified as semi-arid under the Köppen Climate Classification System (Wikipedia 2010). The semi-arid classification signifies that evapotranspiration (e.g., water loss from evaporation and plant respiration and growth) is greater than the amount of precipitation an area receives (Wikipedia 2010). Though specific values for evapotranspiration are not available for the Kirby Creek watershed and vary considerably among plant species and site specific conditions, free water surface evaporation is estimated at about 40 inches per year (Curtis and Grimes 2004). By way of comparison, at the AgriMet station in Afton, Lincoln County, WY in the southwestern part of the state the average annual evapotranspiration for alfalfa is 41.96 inches per year (BOR 2010). This same area is expected to have between 35 and 40 inches of free water surface evaporation per year (Curtis and Grimes 2004).

Elevation also affects the amount of precipitation an area receives. Essentially, as one moves up in elevation, the more precipitation an area receives. This phenomenon is evident in the Kirby Creek watershed with lower amounts of precipitation occurring at the northwestern end of the watershed where Kirby Creek confluences with the Big Horn River and the elevation is around 4,260 feet above mean sea level (MSL), compared to the relatively higher amounts of precipitation occurring at the southern and eastern ends of the watershed where elevations generally range from approximately 6,400 feet to 7,500 feet above MSL. The highest point in the watershed of 8,140 above MSL, is located just south of Guffy Peak (8,046 feet above MSL). **Figure 3.1** depicts several precipitation zones of where computer models (OSU 2006) have predicted the average annual precipitation to be.

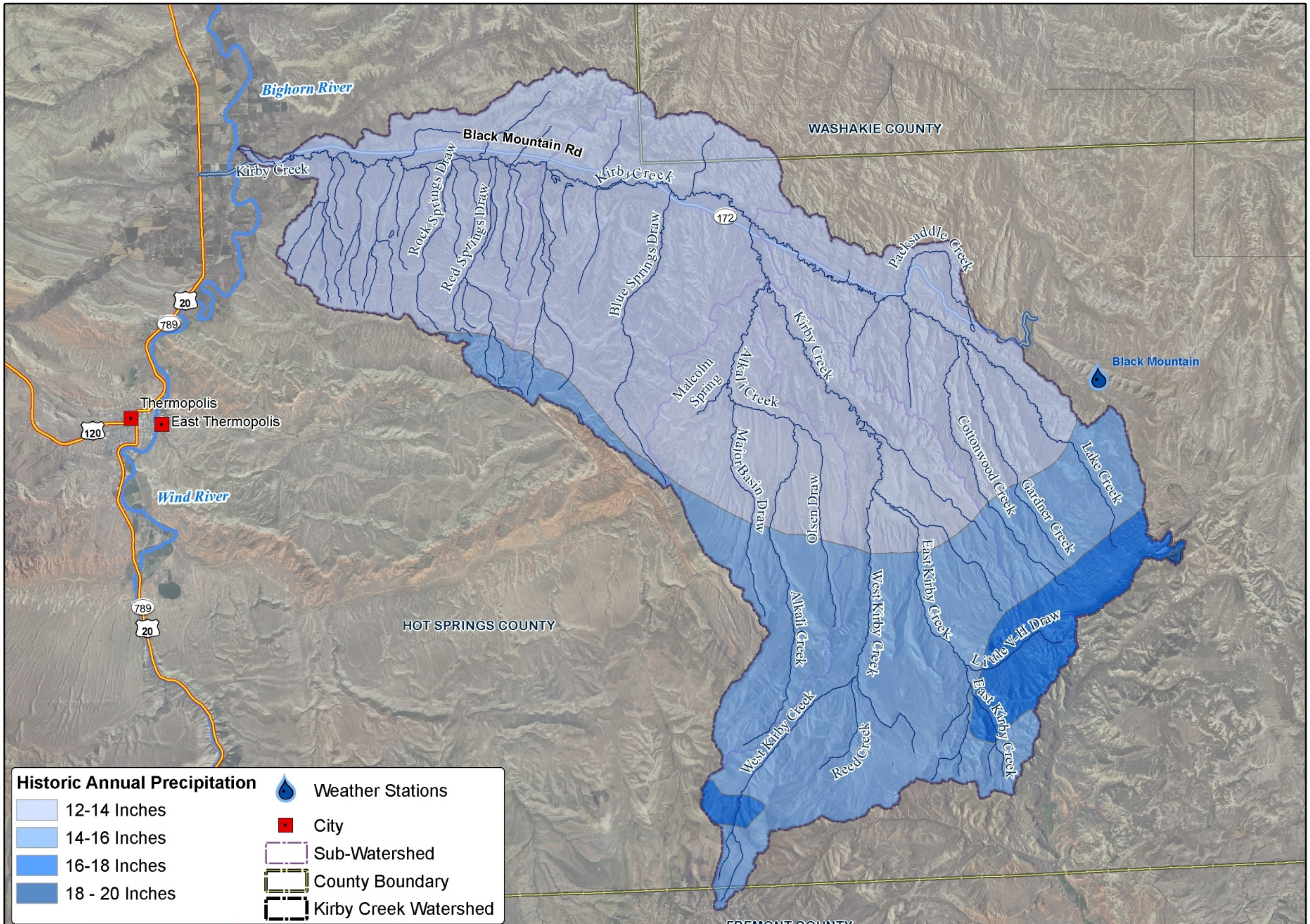

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FIGURE 3.1	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Average Annual Precipitation		
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N
0 1.5 3 6 Miles

Actual precipitation levels and other climactic variables in the area have been monitored at the Black Mountain weather station since 1963 (WRCC 2010). The Black Mountain weather station is located just outside of the watershed, northeast of the Lake Creek sub-watershed at an elevation of 5,640 feet above MSL (**Figure 3.1**) (WRCC 2010). Between the 1963 and 2009 the average annual precipitation at this weather station has been 13.74 inches, and has ranged between roughly 7 inches in 1988 to over 22.5 inches in 1998 (WRCC 2010). In general over 50 percent of the precipitation falls during the months of March, April, May or June (**Figure 3.2**). During this same time period the most precipitation recorded in a single month was in May 1978 when over 6.75 inches of precipitation fell (WRCC 2010). However, anecdotal evidence suggests that May 2010 will prove to be even wetter than in 1978.

Snowfall has occurred at the Black Mountain weather station during all months of the year except July and August (WRCC 2010). Average annual snowfall at the Black Mountain weather station is about 65 inches. The most snowfall that has occurred at the weather station between 1963 and 2009 occurred in 1967 when 130 inches fell in one year. The majority of snow generally falls between December and April (WRCC 2010).

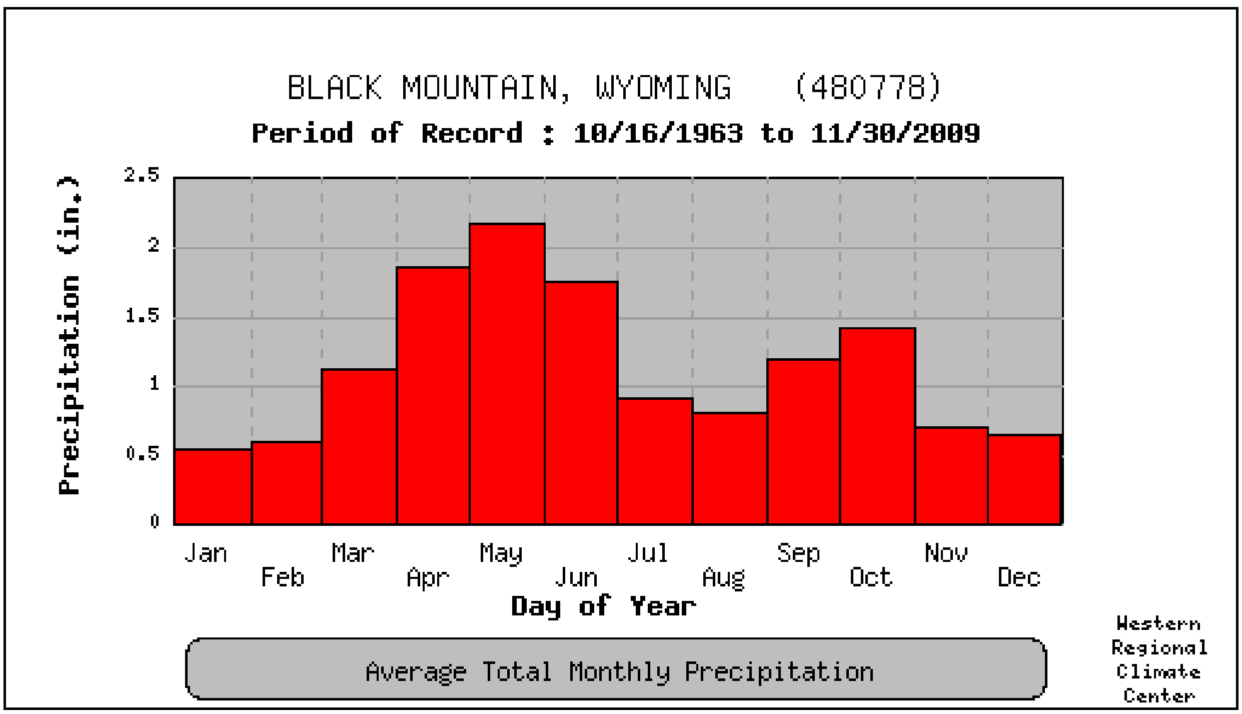

Figure 3.2. Average monthly precipitation in the Kirby Creek Watershed, Hot Springs County, Wyoming (WRCC 2010).

Temperatures recorded at the Black Mountain weather station have ranged between -36 degrees F in April 1989 and 104 degrees F in July 2002 (**Figure 3.3**) (WRCC 2010). The minimum mean temperature in the winter months is about 27 degrees F and the maximum mean temperature in the summer months is about 83 degrees F (WRCC 2010). According to the NRCS (2002) the growing season (i.e., days greater than 28 degrees F) typically occurs between May 7th and September 30th, for a total of 146 days.

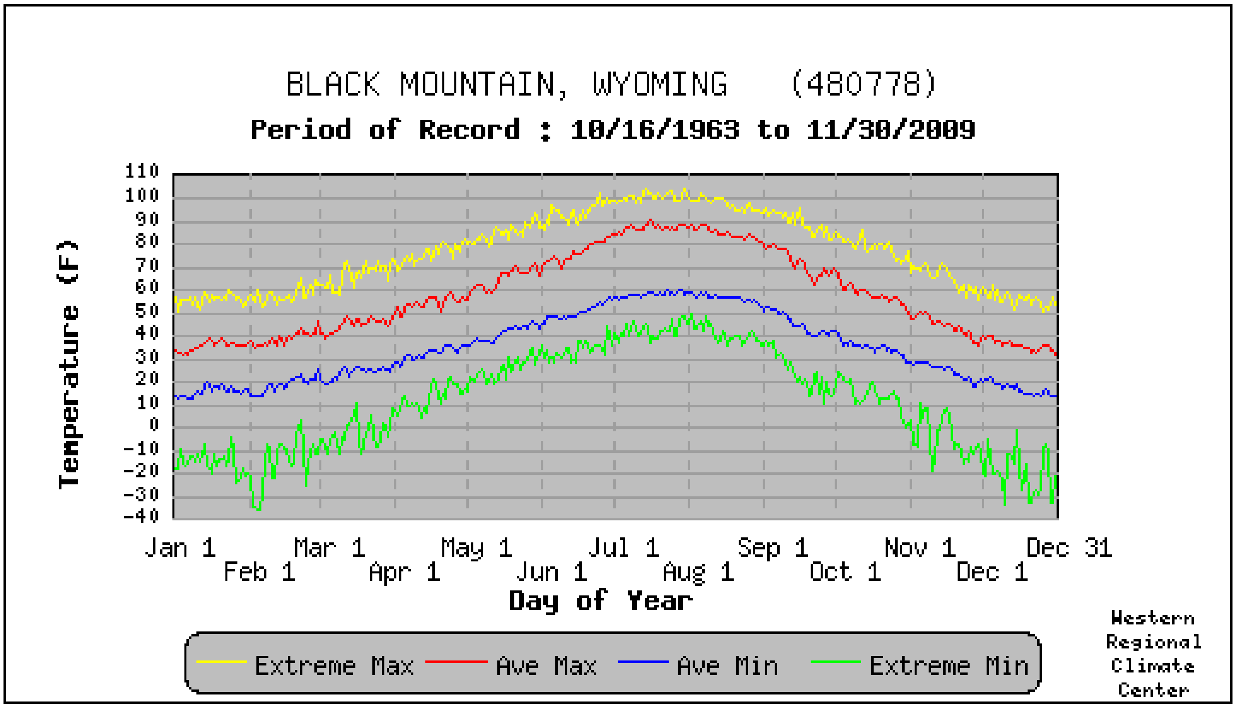

Figure 3.3. Extreme and average maximum and minimum temperatures in the Kirby Creek Watershed, Hot Springs County, Wyoming (WRCC 2010).

3.2.2 Geology

According to Lageson and Spearing (1988), Hot Springs County is located in the southern part of the Bighorn Basin, which is a Rocky Mountain synclinal (downward dipping) sedimentary basin that formed during the Laramide orogeny (mountain building) about 65 million years ago. Marine limestone and shale are the primary rock types in the southern Bighorn Basin (Plafcan and Ogle 1994). These were deposited during the Paleozoic Era (570 million years ago to about 225 million years ago) by fluctuating water levels in the seas. During this same time period the less dominant rock types, such as sandstone and shale, were deposited in beach and other near shore environments. Sandstone was the primary rock type deposited during the early Mesozoic Era (225 million years ago to about 65 million years ago) and was formed under shallow seas (Plafcan and Ogle 1994). During the middle of the Mesozoic Era the depositional environment was terrestrial and resulted in the formation of sandstone and shale as the primary rock types. This changed during the later part of the Mesozoic Era when shallow marine and deltaic environments were common and resulted in the formation of thick sequences of interbedded sandstone and shale (Plafcan and Ogle 1994).

The Laramide orogeny began during the Late Cretaceous Epoch (136 million years ago to about 65 million years ago) about 70 to 80 million years ago and continued into the Tertiary Period (65 million years ago to about 2 million years ago) when it ended about 35 to 55 million years ago (Wikipedia 2010). During the Tertiary period sediments from the Bridger Mountains, Owl Creek Mountains, and Absaroka Range were deposited in fan, fluvial, or lacustrine environments (Plafcan and Ogle 1994). Many of these Tertiary deposits were eroded during the middle of the Tertiary Period when there was a general upwarping of the Bighorn Basin. In the western part of the Bighorn Basin several thousand feet of volcanic rocks were deposited during the middle of the Tertiary Period (Plafcan and Ogle 1994).

3.2.2.1 Surficial Geology

Over 50 percent of the surficial geologic units in the Kirby Creek watershed are classified as ‘sci’ (**Table 3.1**, **Figure 3.4**), which is a mixture of slopewash and colluvium mixed with scattered deposits of slopewash, residuum, grus, glacial, periglacial, alluvium, eolian, and/or bedrock outcrops (Case et al. 1998). Residuum is a deposit of decomposed rocks that has remained in place. Over 20 percent of the watershed is comprised of residuum mixed with alluvium, eolian, slopewash, grus, and/or bedrock outcrops (‘ri’) (Case et al. 1998) (**Table 3.1**, **Figure 3.4**). Alluvium (‘ai’) is another relatively major component (roughly 10 percent) of the surficial geology of the watershed. It occurs along the main streams and drainages and is formed through episodic depositional event (e.g., flooding), and through the lateral migration of point bars. Dissected terrace deposits mixed with alluvium, residuum, eolian, and slopewash (‘tdi’) comprises approximately 7 percent of the watershed, and landslides mixed with scattered deposits of slopewash, residuum, Tertiary landslides, and bedrock outcrops (‘li’) comprises roughly 5 percent of the watershed (Case et al. 1998). The dissected terrace deposits (‘tdi’) are prevalent on the south sides of the creeks in the Alkali Creek-Kirby Creek, Middle Kirby Creek, and Lower Kirby Creek sub-watersheds. The landslide deposits (‘li’) are prevalent in steeper areas of the Upper Kirby Creek and Lake Creek-Kirby Creek sub-watersheds.

Table 3.1. Surficial geologic units found in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	SG Unit	Reclassification	Acres	% or Sub-watershed
Alkali Creek-Kirby Creek	at	ai	661	3%
Alkali Creek-Kirby Creek	sfr	fi	661	3%
Alkali Creek-Kirby Creek	l	li	26	0.1%
Alkali Creek-Kirby Creek	rsR	ri	6,802	35%
Alkali Creek-Kirby Creek	scrR	sci	4,053	21%
Alkali Creek-Kirby Creek	sr	sci	2,225	11%
Alkali Creek-Kirby Creek	srR	sci	1,693	9%
Alkali Creek-Kirby Creek	srcR	sci	93	0.5%
Alkali Creek-Kirby Creek	td	tdi	3,184	16%
Lake Creek-Kirby Creek	at	ai	2,691	11%
Lake Creek-Kirby Creek	l	li	2,598	10%
Lake Creek-Kirby Creek	rsR	ri	6,193	25%
Lake Creek-Kirby Creek	sa	sci	790	3%
Lake Creek-Kirby Creek	scrR	sci	570	2%
Lake Creek-Kirby Creek	sfR	sci	56	0.2%
Lake Creek-Kirby Creek	srR	sci	12,267	49%
Lower Kirby Creek	a	ai	351	2%
Lower Kirby Creek	at	ai	3,405	16%
Lower Kirby Creek	b	bi	244	1%
Lower Kirby Creek	rsR	ri	5,613	26%
Lower Kirby Creek	sa	sci	1	0.003%
Lower Kirby Creek	sr	sci	2,402	11%
Lower Kirby Creek	srR	sci	6,721	31%
Lower Kirby Creek	srcR	sci	187	1%
Lower Kirby Creek	td	tdi	2,481	11%
Lower Kirby Creek	t	ti	450	2%
Middle Kirby Creek	at	ai	2,799	11%
Middle Kirby Creek	Rcs	Ri	40	0.2%
Middle Kirby Creek	rsR	ri	2,015	8%
Middle Kirby Creek	sr	sci	7,984	31%
Middle Kirby Creek	srR	sci	6,806	27%
Middle Kirby Creek	srcR	sci	2,322	9%
Middle Kirby Creek	td	tdi	3,475	14%
Upper Kirby Creek	at	ai	2,740	8%
Upper Kirby Creek	l	li	3,352	9%
Upper Kirby Creek	Ruc	Ri	288	1%
Upper Kirby Creek	rs	ri	1,784	5%
Upper Kirby Creek	rsR	ri	6,843	19%
Upper Kirby Creek	scrR	sci	7,758	21%
Upper Kirby Creek	srR	sci	8,262	23%
Upper Kirby Creek	sra	sci	4,294	12%
Upper Kirby Creek	srcR	sci	473	1%
Upper Kirby Creek	td	tdi	297	1%

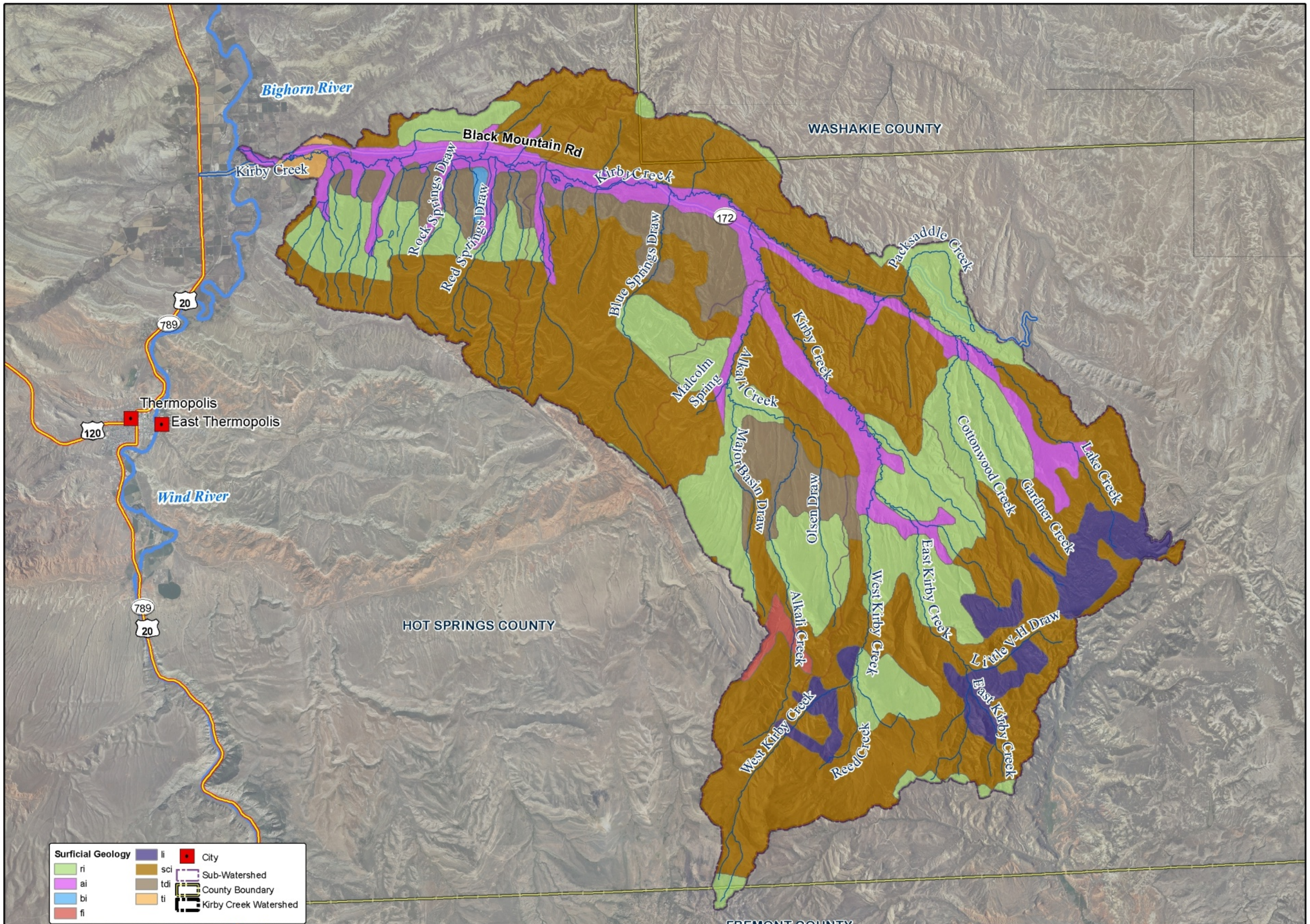

FIGURE 3.4	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Surficial Geology		N
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

0 1.5 3 6 Miles

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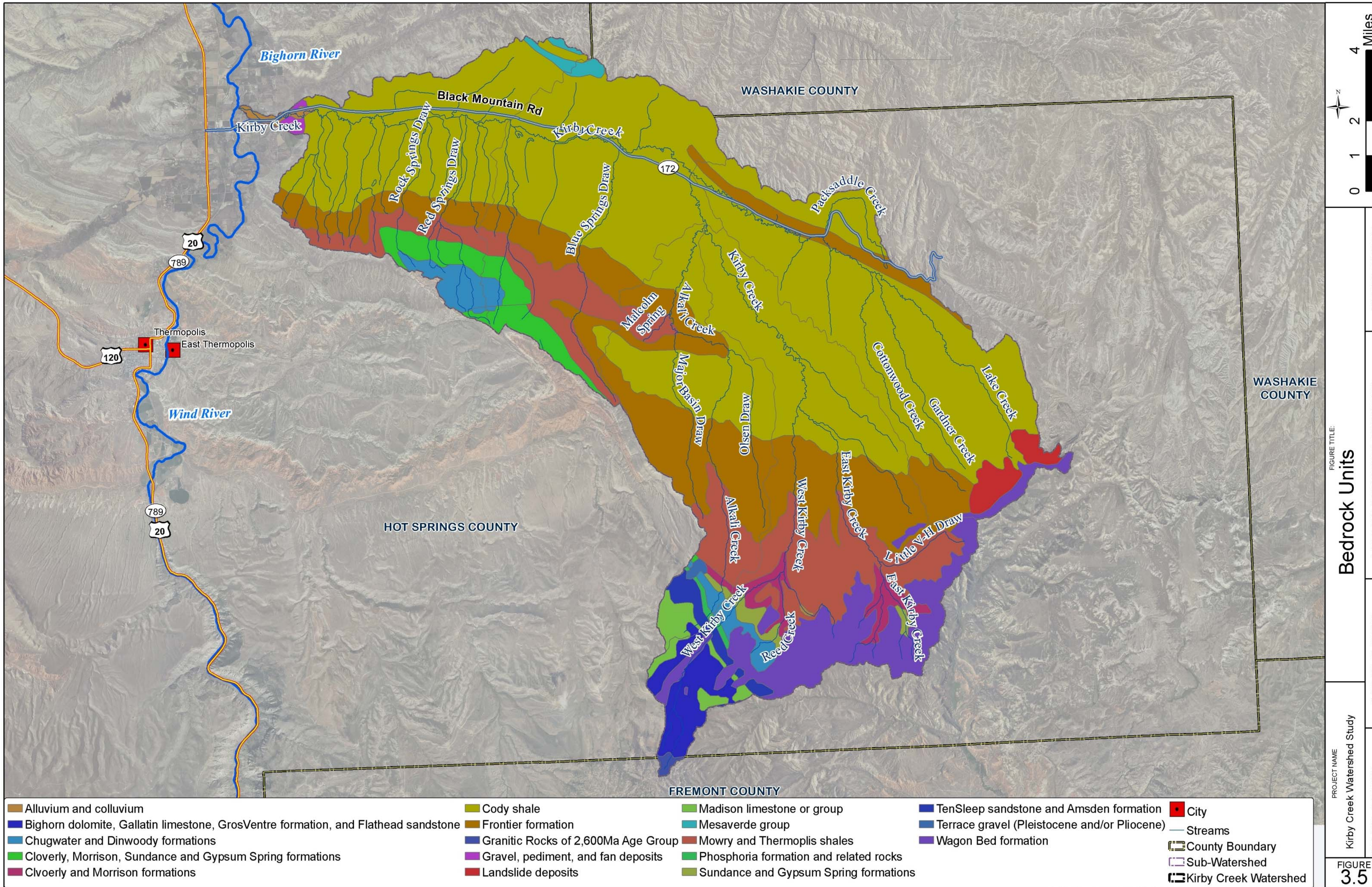
3.2.2.2 Bedrock Units

Cody shale and the Frontier Formation comprise the majority (70 percent) of the bedrock found in the watershed (**Figure 3.5**). Mowry and Thermopolis shales are also a dominant component (11 percent) of the bedrock in the watershed. Cody shale was formed during the late Cretaceous Period about 100 to 70 million years ago and is named for some outcroppings outside of Cody, WY (USGS 2008). It is described as, "upper part is buff, sandy shale and thinly laminated buff sandstone; lower part is dark gray, thin-bedded marine shale." (Wikipedia 2010). The Frontier Formation is comprised of sandstone and shales formed in the mid-Cretaceous Period, from about 110 million years ago to about 85 million years ago (USGS 2008). It is described as, "thick, lenticular, grey sandstone, gray shale, carbonaceous shale, and bentonite" (Wikipedia 2010). Within the Kirby Creek watershed oil occurs in the Frontier and Phosphoria formations (Stillwell et al. 2009). Mowry shale was formed during the mid-Cretaceous, about 95 to 100 million years ago (USGS 2008). Thermopolis shale was also formed during the mid-Cretaceous, but earlier than the Mowry shale at about 100 to 110 million years ago (USGS 2008).

A generalized stratigraphy and lithography of the Bighorn Basin is shown in **Figure 3.6**. It shows the general age of the different geologic features found in Kirby Creek watershed as well as the typical depth and thickness of each bedrock layer.


Bighorn River
Wind River
WASHAKIE COUNTY
HOT SPRINGS COUNTY
FREMONT COUNTY
Thermopolis
East Thermopolis
Black Mountain Rd
Kirby Creek
Rock Springs Draw
Red Springs Draw
Blue Springs Draw
Packsaddle Creek
Malcolm Spring
Alkali Creek
Major Basin Draw
Olsen Draw
Cottonwood Creek
Gardner Creek
Lake Creek
East Kirby Creek
West Kirby Creek
Little V-H Draw
Reed Creek
Alluvium and colluvium
Bighorn dolomite, Gallatin limestone, GrosVentre formation, and Flathead sandstone
Chugwater and Dinwoody formations
Cloverly, Morrison, Sundance and Gypsum Spring formations
Clvoerly and Morrison formations
Cody shale
Frontier formation
Granitic Rocks of 2,600Ma Age Group
Gravel, pediment, and fan deposits
Landslide deposits
Madison limestone or group
Mesaverde group
Mowry and Thermoplis shales
Phosphoria formation and related rocks
Sundance and Gypsum Spring formations
TenSleep sandstone and Amsden formation
Terrace gravel (Pleistocene and/or Pliocene)
Wagon Bed formation
City
Streams
County Boundary
Sub-Watershed
Kirby Creek Watershed
0 1 2 4 Miles
FIGURE TITLE:
Bedrock Units
PROJECT MGR:MR
LOCATION:HOT SPRINGS COUNTY, WY
PLOTTED:07-15-2010
PROJ NO:100008648
PROJECT NAME
Kirby Creek Watershed Study
FIGURE
3.5
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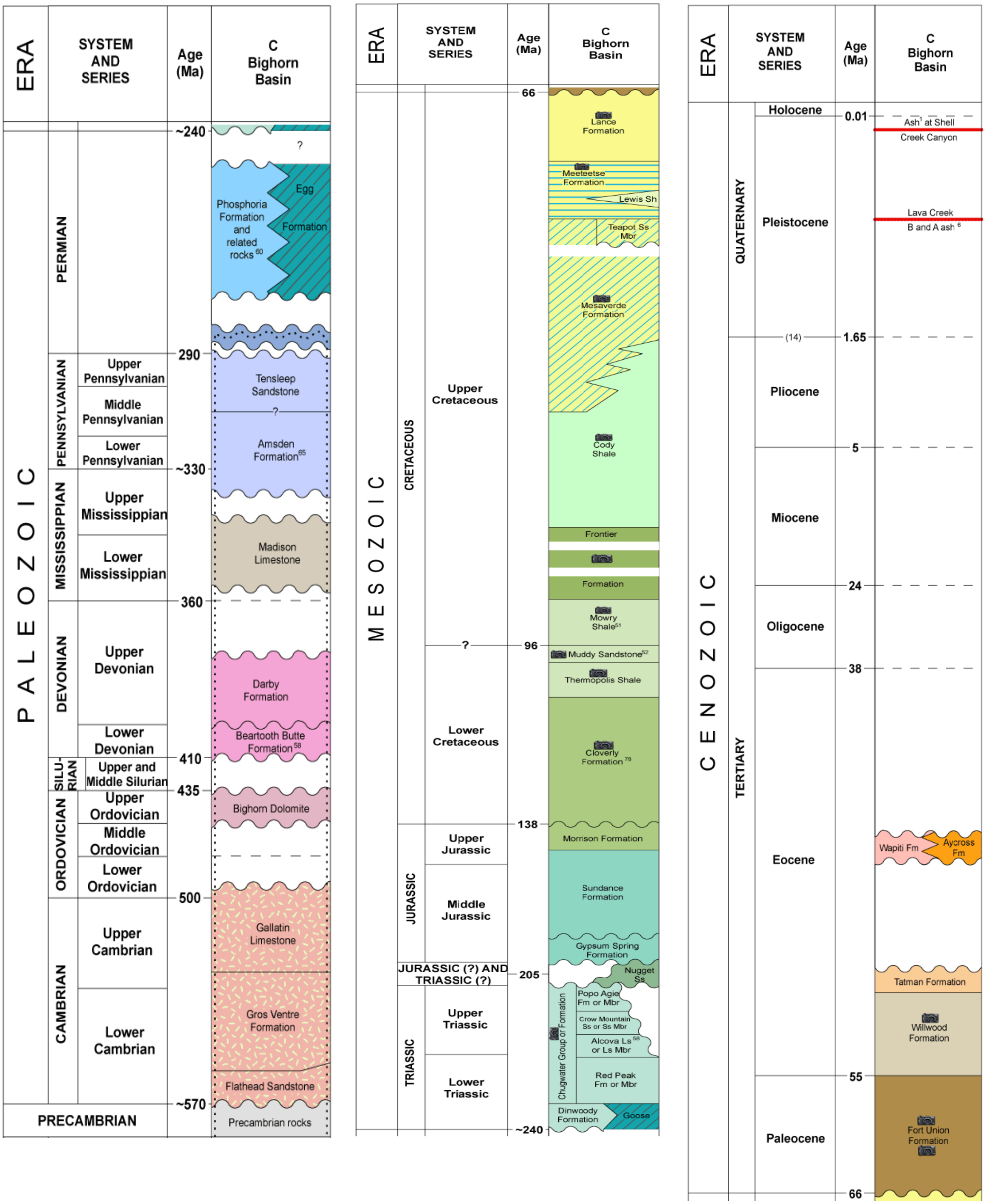

Figure 3.6. Generalized stratigraphic and lithologic section of the Bighorn Basin for the Paleozoic, Mesozoic and Cenozoic Eras (WYGS 2010).

The composition of bedrock units in each of the sub-watersheds is provided in **Table 3.2**. The southern portion of each sub-watershed shows the most bedrock complexity, with the Upper Kirby Creek sub-watershed being the most geologically complex of all the sub-watersheds (see **Figure 3.5**).

Table 3.2. Bedrock units found in the Kirby Creek watershed, Hot Springs County, WY.*

Bedrock Unit Classification	Map Symbol	Acres	% of Sub-watershed
Lower Kirby Creek Sub-watershed			
Alluvium and colluvium	Qa	300	1%
Chugwater and Dinwoody formations	@cd	1,202	6%
Cloverly, Morrison, Sundance and Gypsum Spring formations	KJg	1,393	6%
Cody shale	Kc	14,067	64%
Frontier formation	Kf	2,589	12%
Gravel pediment and fan deposits	Qt	211	1%
Mesaverde group	Kmv	319	1%
Mowry and Thermopolis shales	Kmt	1,773	8%
Middle Kirby Creek Sub-watershed			
Chugwater and Dinwoody formations	@cd	287	1%
Cloverly, Morrison, Sundance and Gypsum Spring formations	KJg	1,847	7%
Cody shale	Kc	16,523	65%
Frontier formation	Kf	3,295	13%
Mesaverde group	Kmv	242	1%
Mowry and Thermopolis shales	Kmt	3,247	13%
Alkali Creek-Kirby Creek Sub-watershed			
Bighorn dolomite, Gallatin Limestone, GrosVentre formation and Flathead sandstone	O_	57	0.3%
Chugwater and Dinwoody formations	@cd	250	1%
Cloverly, Morrison, Sundance and Gypsum Spring formations	KJg	16	0.1%
Cloverly and Morrison formations	KJ	115	1%
Cody shale	Kc	6,785	35%
Frontier formation	Kf	7,903	41%
Madison limestone or group	Mm	663	3%
Mowry and Thermopolis shales	Kmt	2,747	14%
Phosphoria formation and related rocks	Pp	117	1%
Sundance and Gypsum Spring formations	Jsg	101	1%
TenSleep sandstone and Amsden formation	PM	519	3%
Terrace gravel (Pleistocene and/or Pliocene)	QTg	128	1%

Bedrock Unit Classification	Map Symbol	Acres	% of Sub-watershed
Lake Creek-Kirby Creek Sub-watershed			
Cody shale	Kc	19,990	79%
Frontier formation	Kf	3,209	13%
Landslide deposits	Qls	1,378	5%
Wagon Bed formation	Twb	588	2%
Upper Kirby Creek Sub-watershed			
Alluvium and colluvium	Qa	36	0.1%
Bighorn dolomite, Gallatin Limestone, GrosVentre formation and Flathead sandstone	O_	2,417	7%
Chugwater and Dinwoody formations	@cd	716	2%
Cloverly and Morrison formations	KJ	1,543	4%
Cody shale	Kc	9,987	28%
Frontier formation	Kf	5,594	15%
Granitic Rocks of 2,600 Ma Age Group	Wg	153	0.4%
Madison limestone or group	Mm	587	2%
Mowry and Thermopolis shales	Kmt	6,523	18%
Phosphoria formation and related rocks	Pp	97	0.3%
Sundance and Gypsum Spring formations	Jsg	620	2%
TenSleep sandstone and Amsden formation	PM	416	1%
Wagon Bed formation	Twb	7,403	21%

*Source: USGS 1994.

3.2.2.3 Structure

The geologic structure of the Big Horn Basin is described by the Wyoming State Geological Survey (WYGS) (2010) as:

> Structurally, the [Bighorn] basin is an asymmetric syncline with the deepest part on the west side; the synclinal axis extends southeastward from the Beartooth mountain front to several miles east of Cody, to a few miles east of Meeteetse, to north of Thermopolis. The basin is very deep in a few places, with structural relief in the 30,000-foot range. Structural relief is defined by the difference between the elevation of the Precambrian-Cambrian contact in the deepest part of the basin and the elevation of the contact in the highest part of the adjacent mountains. Like the Powder River Basin, the interior of the Bighorn Basin consists of a thick sequence of relatively flat-lying Eocene and Paleocene rocks surrounded by bands of Mesozoic rocks dipping more steeply into the basin. These Mesozoic rocks, along with the underlying Paleozoic rocks, are folded into anticlines and synclines in a zone between the basin interior and the surrounding mountains. Many of the large anticlines contain important oil and gas resources that are developed in well-known fields such as Elk Basin, Oregon Basin, Grass Creek, Byron/Garland, Buffalo Basin, and Badger Basin.

Within the watershed only one east-west trending fault has been mapped (USGS and WYGS 1994a). It occurs at the southern end of the Lower Kirby Creek and Middle Kirby Creek sub-watersheds (**Figure 3.7**). No geologic dykes (a discordant, sheet-like intrusion in the crust) have been mapped within the watershed (USGS and WYGS 1994b).

3.2.2.4 Geologic Hazards

Geologic hazards in the Kirby Creek watershed are limited to the single fault mentioned previously and landslide areas. According to the USGS, documented earthquakes have been felt in the Thermopolis area as early as 1928. On February 13, 1928 mine props near Thermopolis were loosened during an earthquake, and later became tight. Tremors were felt throughout a 7,800 Km square area including Thermopolis, Crosby, Gebo, Kirby, Owl Creek, and Worland (USGS 2010a). Again on December 8, 1972 slight damage occurred at Thermopolis from a magnitude 4.1 earthquake. Tremors were felt in much of the surrounding area (USGS 2010a). No other earthquakes have been reported within a 50 Km radius of Thermopolis since 1972 (USGS 2010a). Because the fault in the Kirby Creek watershed is not exposed to the surface, it is unlikely that it could generate an earthquake greater than a magnitude of 6.5 (Case and Green 2000). However, the Stagner Creek fault system and Cedar Ridge-Dry Fork fault system are located just south of the watershed and are considered to be active (Case and Green 2000).

Landslide areas are most common in the upper, headwater portions of the Alkali-Creek-Kirby Creek, Upper Kirby Creek, and Lake Creek-Kirby Creek sub-watersheds (**Figure 3.7**).

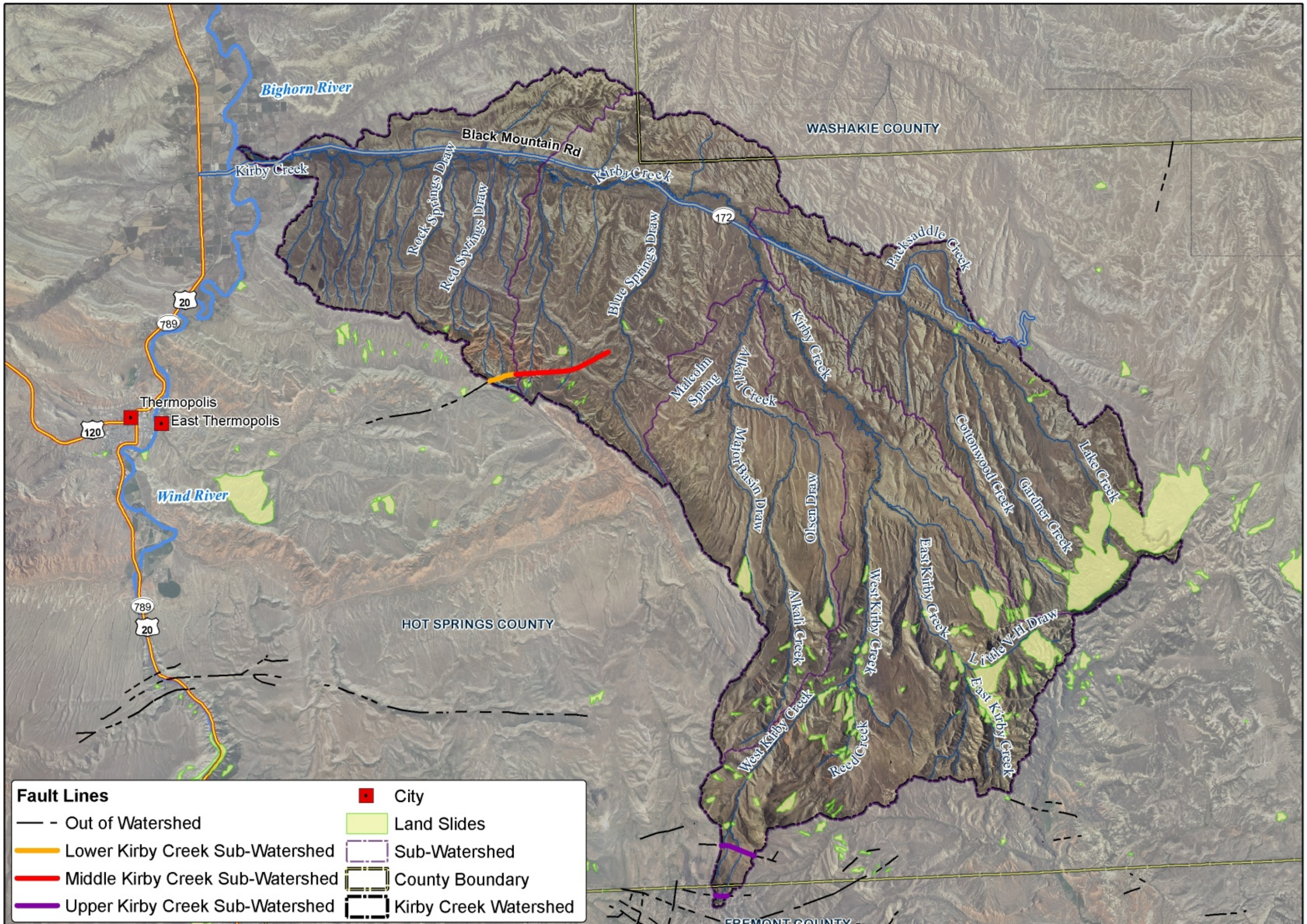

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FIGURE 3.7	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Geologic Structures and Hazards	
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

3.2.3 Topography

Climate and geology have played primary roles in the current topography found in the Kirby Creek watershed. The watershed occurs at the southern end of the Big Horn River Basin, on the northern flanks of the Owl Creek Mountain Range. The Big Horn Basin generally drains northward to the Yellowstone River, which confluences with the Missouri River in northwestern North Dakota and ultimately drains into the Gulf of Mexico.

The Kirby Creek watershed drains in a westerly direction and confluences with the Big Horn River just north of Thermopolis, WY. There is nearly 3,900 feet elevational difference between the elevation at its lowest point (4,260 feet above MSL) at its confluence with the Big Horn River to its highest point at the southern most point in the watershed (about 8,140 feet above MSL). Most of the streams occur on the south side of the watershed and drain northward to Kirby Creek, which then drains to the west. These streams have dissected the landscape creating relatively narrow valleys in the upper watershed surrounded by steep slopes leading to ridges often topped with rimrock. The middle and lower portions of the watershed are more open with wide alluvial valleys surrounded by rolling hills.

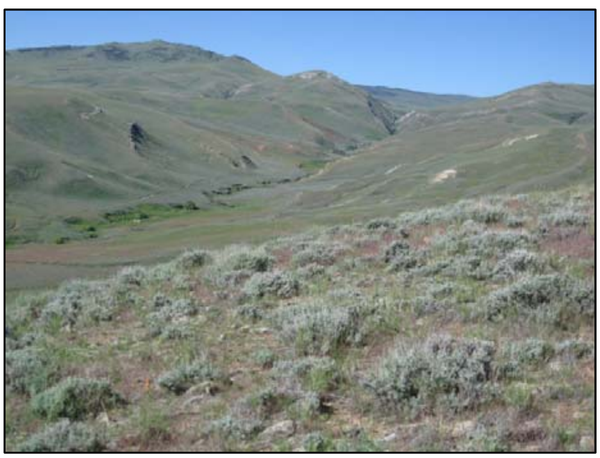


Figure 3.8. Examples of topography in the upper portion of the watershed (photo on left) and the lower portion of the watershed (photo on right). The left-hand photo is looking upstream at the upper portion of the West Kirby Creek drainage (6/24/2009). The right-hand photo is looking south at the confluence of the Blue Springs drainage and Kirby Creek in the Middle Kirby Creek sub-watershed, Guffy Peak is the mountain in the background (5/27/2010).

Some prominent topographical features in the watershed are Guffy Peak (elev. 8,046 feet), Klondike Peak (elev. 7,170 feet), Lake Creek Divide on the northwest side of Lake Creek (elev. approximately 5,100 feet), Zimmerman Buttes on the north edge of the Lower Kirby Creek sub-watershed (elev. 5,080 feet), Wild Horse Butte on the southeastern side of the Middle Kirby Creek sub-watershed (elev. 6,032), and Blue Hill (6,015 feet) on the southern end of the Alkali Creek-Kirby Creek sub-watershed.

3.2.4 Soils

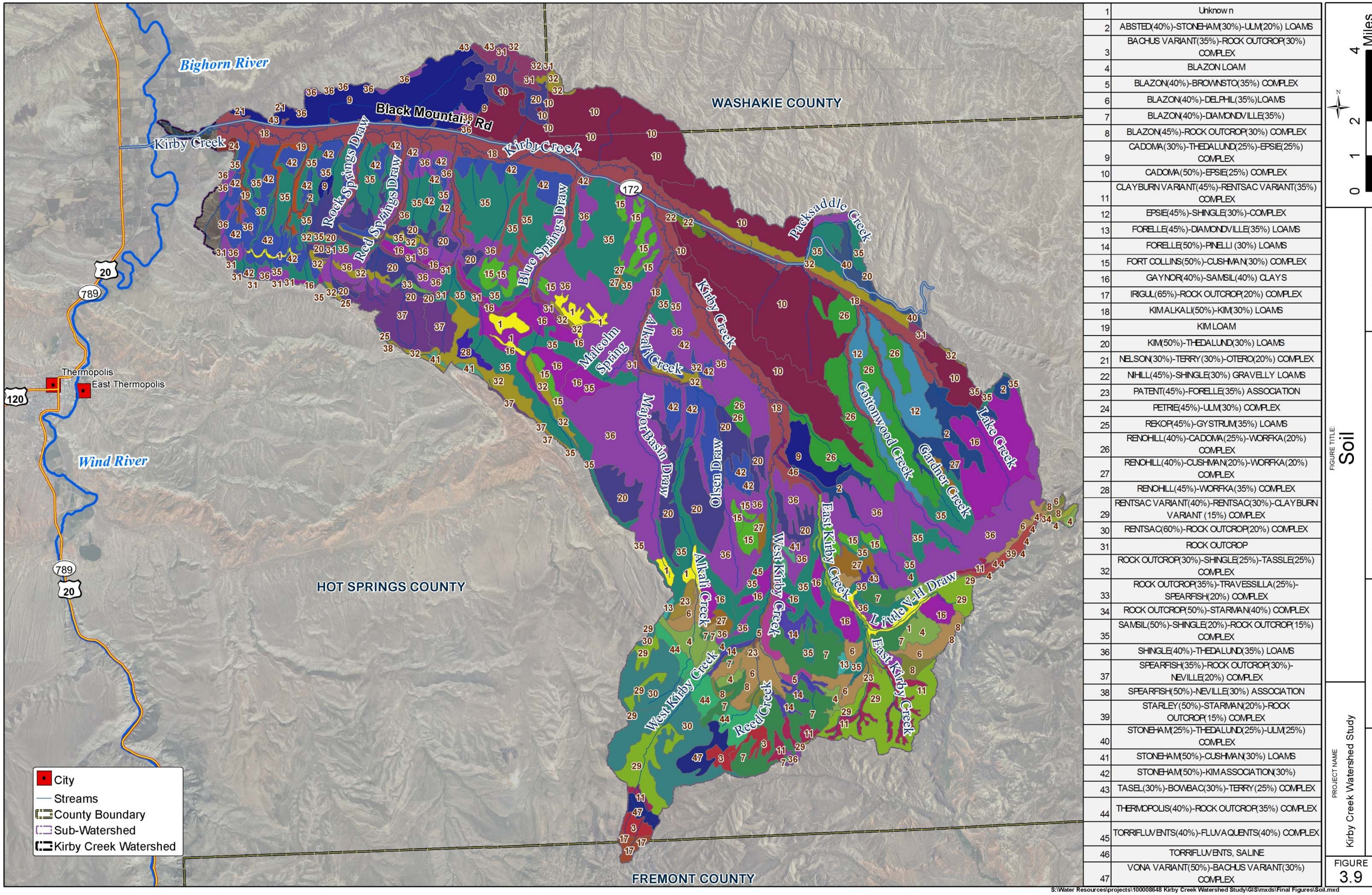
A detailed soils investigation was not conducted as part of this study. The NRCS has not completed a soil survey for Hot Springs County, but a private contractor did map the soils in the watershed (SEI 2005). Unless otherwise indicated, the following information was taken from the previous watershed study completed by Sunrise Engineering, Inc. (SEI) in 2005 or was developed from the soil information used in that report.

There are a total of 49 identified soil map units (SMUs) within the watershed and two unidentified soil types (**Figure 3.9**, **Appendix B**). The three most common SMUs in the watershed comprise 41 percent of the soils in the watershed, these are: Shingle (40%) - Thedalundi (35%) Loams (17 percent); Samsil (50%) – Shingle (20%) - Rock Outcrop (15%) Complex (13 percent); and Cadoma (50%) – Epsie (25%) Complex (11 percent). Within the Lower Kirby sub-watershed there are 21 different SMUs, of which three comprise 44 percent of the soils found in the sub-watershed. The Middle Kirby Creek sub-watershed has a total of 18 SMUs, of which 4 comprise 69 percent of the soils found in the sub-watershed. The Alkali Creek-Kirby Creek sub-watershed contains 22 different SMUs, three of which comprise 65 percent of the soils found in the sub-watershed. The Lake Creek-Kirby Creek sub-watershed contains 24 SMUs, three of which comprise 51 percent of the soils found in the sub-watershed. With 34 different SMUs the Upper Kirby Creek sub-watershed has the most complex soils. Eight different SMUs comprise 67 percent of the soils found in the sub-watershed.

All of these different soil series developed from the weathering of Cretaceous through Triassic era shales and sandstones found in the watershed. Upland soils are generally shallow, ranging from 0 to 20 inches in depth. Bottomland soils are deeper and consist primarily of clay, silty clay, and clay loams. All soils in the watershed are typically high in exchangeable salts, such as gypsum, calcium, and sodium. Soil pH varies throughout the watershed from neutral (pH 6.6-7.3) to very [strongly] alkaline (pH >9.0).

Areas within the Kirby Creek watershed were grouped by SEI (2005) into four soil category zones based on topographic location and climate: Flood Plains; Warm Temperature and Driest Moisture; Warm Temperature and Intermediate Moisture; and, Intermediate Temperature and Moisture (SEI 2005). Each category zone, with the exception of Intermediate Temperature and Moisture, includes sub-groups depending on general locations of specific attributes within each category (**Table 3.3**; SEI 2005).

As part of the 2009-2010 watershed study each SMU was assigned to a hydrologic soil group. Hydrologic soil groups provide a relative measure of the amount of surface runoff that can be expected to occur under saturated soil conditions. According to the NRCS (2007), "Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms." The four hydrologic soil groups are described in **Table 3.4**.



Bighorn River
Kirby Creek
Black Mountain Rd
WASHAKIE COUNTY
HOT SPRINGS COUNTY
FREMONT COUNTY
Thermopolis
East Thermopolis
Wind River
Rock Springs Draw
Red Springs Draw
Blue Springs Draw
Malcolm Spring
Alkali Creek
Packsaddle Creek
Cottonwood Creek
Gardner Creek
Lake Creek
Major Basin Draw
Olsen Draw
West Kirby Creek
East Kirby Creek
Little V-H Draw
Reed Creek
City
Streams
County Boundary
Sub-Watershed
Kirby Creek Watershed
1 Unknown
2 ABSTED(40%)-STONEHAM(30%)-ULM(20%) LOAMS
3 BACHUS VARIANT(35%)-ROCK OUTCROP(30%) COMPLEX
4 BLAZON LOAM
5 BLAZON(40%)-BROWNSTO(35%) COMPLEX
6 BLAZON(40%)-DELPHIL(35%)LOAMS
7 BLAZON(40%)-DIAMONDVILLE(35%)
8 BLAZON(45%)-ROCK OUTCROP(30%) COMPLEX
9 CADOMA(30%)-THEDALUND(25%)-EPSIE(25%) COMPLEX
10 CADOMA(50%)-EPSIE(25%) COMPLEX
11 CLAYBURN VARIANT(45%)-RENTSAC VARIANT(35%) COMPLEX
12 EPSIE(45%)-SHINGLE(30%)-COMPLEX
13 FORELLE(45%)-DIAMONDVILLE(35%) LOAMS
14 FORELLE(50%)-PINELLI (30%) LOAMS
15 FORT COLLINS(50%)-CUSHMAN(30%) COMPLEX
16 GAYNOR(40%)-SAMSIL(40%) CLAYS
17 IRIGUL(65%)-ROCK OUTCROP(20%) COMPLEX
18 KIM ALKALI(50%)-KIM(30%) LOAMS
19 KIM LOAM
20 KIM(50%)-THEDALUND(30%) LOAMS
21 NELSON(30%)-TERRY(30%)-OTERO(20%) COMPLEX
22 NIHILL(45%)-SHINGLE(30%) GRAVELLY LOAMS
23 PATENT(45%)-FORELLE(35%) ASSOCIATION
24 PETRIE(45%)-ULM(30%) COMPLEX
25 REKOP(45%)-GYSTRUM(35%) LOAMS
26 RENOHILL(40%)-CADOMA(25%)-WORFKA(20%) COMPLEX
27 RENOHILL(40%)-CUSHMAN(20%)-WORFKA(20%) COMPLEX
28 RENOHILL(45%)-WORFKA(35%) COMPLEX
29 RENTSAC VARIANT(40%)-RENTSAC(30%)-CLAYBURN VARIANT (15%) COMPLEX
30 RENTSAC(60%)-ROCK OUTCROP(20%) COMPLEX
31 ROCK OUTCROP
32 ROCK OUTCROP(30%)-SHINGLE(25%)-TASSLE(25%) COMPLEX
33 ROCK OUTCROP(35%)-TRAVESSILLA(25%)-SPEARFISH(20%) COMPLEX
34 ROCK OUTCROP(50%)-STARMAN(40%) COMPLEX
35 SAMSIL(50%)-SHINGLE(20%)-ROCK OUTCROP(15%) COMPLEX
36 SHINGLE(40%)-THEDALUND(35%) LOAMS
37 SPEARFISH(35%)-ROCK OUTCROP(30%)-NEVILLE(20%) COMPLEX
38 SPEARFISH(50%)-NEVILLE(30%) ASSOCIATION
39 STARLEY(50%)-STARMAN(20%)-ROCK OUTCROP(15%) COMPLEX
40 STONEHAM(25%)-THEDALUND(25%)-ULM(25%) COMPLEX
41 STONEHAM(50%)-CUSHMAN(30%) LOAMS
42 STONEHAM(50%)-KIM ASSOCIATION(30%)
43 TASEL(30%)-BOWBAC(30%)-TERRY(25%) COMPLEX
44 THERMOPOLIS(40%)-ROCK OUTCROP(35%) COMPLEX
45 TORRIFLUVENTS(40%)-FLUVAQUENTS(40%) COMPLEX
46 TORRIFLUVENTS, SALINE
47 VONA VARIANT(50%)-BACHUS VARIANT(30%) COMPLEX
0 1 2 4 Miles
FIGURE TITLE: Soil
PROJECT MGR: MR
LOCATION: HOT SPRINGS COUNTY, WY
PLOTTED: 07-15-2010
PROJECT NAME Kirby Creek Watershed Study
PROJ NO: 100008648
FIGURE 3.9
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Table 3.3. Soil Categories as a Result of Climate and Topographic Location[1]

Category[2]	Watershed Location[2]	Soil Taxonomy	Depth[3]	Slope[4]	pH[5]	Drainage	Texture		Vegetation
							Upper Layer	Lower Layers	
Floodplains (2 Sub-groups)	**Lower Kirby Creek**	**Typic and Ustic Torrifluvents and Torriorthents**	**deep**	**nearly level**	**strongly to very alkaline**	**well to somewhat poorly**	**loam**	**stream alluvium**	**desert shrub: primarily greasewood**
	Upper Kirby Creek	Ustic and Aquic Torrifluvents, Aeric and Typic Fluvaquents, Borollic Haplargids, Borollic Calciorthids, Typic and Argic Cryoborolls	deep	nearly level	neutral to moderately alkaline	well to somewhat poorly	loam, clay	stream and fan alluvium	desert shrub: primarily basin big sage brush
Warm Temperature and Driest Moisture (2 Sub-groups)	Middle and Upper Kirby Creek	Typic Torrifluvents and Torriorthents, Typic Natrargids, Typic Haplargids	deep, moderately deep and shallow	nearly level, to sloping and steep	moderately to strongly alkaline	well	loam and clay	alluvium, shale, sandstone	shrub grasslands: black sagebrush, Wyoming Big sagebrush
Warm Temperature, Intermediate Moisture (4 Sub-groups)	Middle and Upper Kirby Creek	Ustic and Lithic Torriorthents, Ustollic Natrargids, Ustic Haplargids, Ustic Camborthids	deep, moderately deep and shallow	nearly level, gently sloping, steep	mildly to very strongly alkaline	well	loam, clay, gravel	alluvial fill, outwash gravel, shale, red shale, sandstone, gravelly deposits, gypsiferous shale	shrub grasslands and desert shrub: Wyoming big and black sagebrush, saltbrush, juniper
Intermediate Temperature and Moisture (no Sub-groups)	Middle and Upper Kirby Creek	Torriorthents, Borollic Calciorthids	deep	gently sloping to steep	mildly to moderately alkaline	well	loam	sandstone, shale	shrub grasslands: low and Wyoming big sage brush, juniper

[1] ***Source:*** SEI 2005.
[2] Soil characteristics within each sub-group generally occur to some extent in other sub-groups and are therefore combined under each soil category, with the exception of Floodplains, where soil characteristics distinctly occur in specific creek areas of the watershed.
[3] Deep: 40-60 inches; Moderately Deep: 20-40 inches; Shallow: 10-20 inches (NRCS 2010)
[4] Nearly Level: 0-3%; Gently Sloping: 1-8%; Moderately Steep: 10-30%; Steep: 20-60% (NRCS 2007)
[5] Very Strongly Alkaline: >9.0; Strongly Alkaline: 8.5-9.0; Moderately Alkaline: 7.9-8.4; Neutral: 6.6-7.3 (NRCS 2007)

Table 3.4. NRCS hydrologic soil group descriptions[1]

Group	Runoff Potential[2]	Water Transmission	Texture
A	low	freely	<10% clay, >90% sand or gravel (may include sand, loam, and/or silt texture combinations)
B	moderately low	unimpeded	10-20% clay, 50-90% sand or loamy sand (may include sand, loam, clay and/or silt texture combinations)
C	moderately high	restricted or very restricted	20-40% clay, <50% sand with loam, silt, clay combinations
D	high	restricted or very restricted	>40% clay, <50% sand and include clayey textures, and soils <20 inches from a water impermeable layer or within the water table

[1] NRCS 2007, [2] Runoff potential when thoroughly wet.

As shown in **Table 3.5** and **Figure 3.10**, the majority (74 percent) of the watershed is classified as hydrologic soil group D. This suggests that the majority of precipitation that falls within the watershed does not infiltrate into the soil and is lost from potential use as runoff into the creeks. The Lower Kirby Creek sub-watershed has the smallest area of hydrologic soil group D and the largest area of hydrologic soil group B (**Table 3.5, Figure 3.10**). In fact, in all sub-watersheds hydrologic soil group B is prevalent along the streams themselves; though in the Lower Kirby, Middle Kirby, and Alkali Creek-Kirby Creek sub-watersheds a good portion of the soils classified as hydrologic soil group B also occur away from the stream channels (**Figure 3.10**).

Table 3.5. Hydrologic soil groups by sub-watershed, Kirby Creek watershed, Hot Springs County, WY.

Sub-Watershed	Hydrologic Soil Group (acres)									
	A		B		C		D		Not Classified*	
	Acres	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*
Lower Kirby Creek	0	0%	8,709	41%	42	0.2%	12,390	58%	67	0.3%
Middle Kirby Creek	0	0%	6,204	24%	224	1%	18,622	73%	508	2%
Alkali Creek-Kirby Creek	0	0%	5,433	28%	376	2%	13,355	70%	0	0%
Lake Creek-Kirby Creek	0	0%	1,909	8%	2,108	8%	21,272	84%	0	0%
Upper Kirby Creek	0	0%	6,127	17%	1,749	5%	28,139	78%	267	1%
Total	0	0%	28,382	22%	4,499	4%	93,777	74%	841	1%

*Soil information not available.

Based on the distribution of hydrologic soil group B in the watershed and the occurrence of surface water, it appears that the most effective locations to promote subsurface soil water storage (i.e., alluvial aquifer storage) are:

- along the mainstem of Kirby Creek in the Lower Kirby and Middle Kirby Creek sub-watersheds;
- in the central portion of the Alkali Creek-Kirby Creek sub-watershed;
- along the mainstem of Kirby Creek from the confluence of E. Kirby and W. Kirby Creeks downstream; and,
- along the lower 1.5 miles of E. Kirby Creek, immediately above the confluence with W. Kirby Creek.

Soils can be quite variable even within SMUs, so field testing should be employed to refine these conclusions on a site by site basis prior to developing a particular site for this purpose.

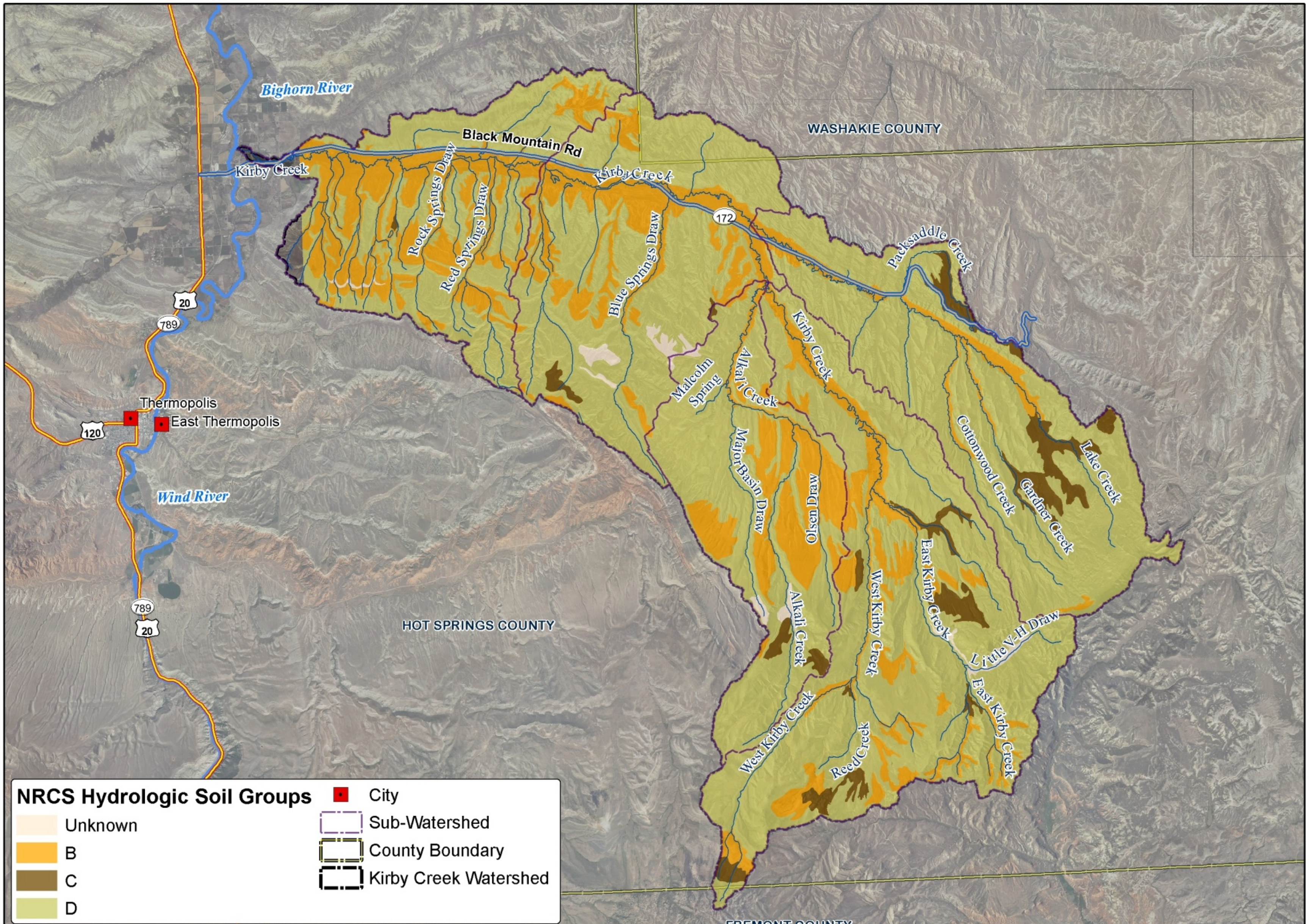

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FIGURE 3.10

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE:

NRCS Hydrologic Soil Groups

N

0 1.5 3 6 Miles

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

3.2.5 Vegetation and Land Cover

Based on analysis of USGS LANDFIRE vegetation data for the Kirby Creek watershed, roughly 73 percent of the watershed is dominated by shrublands, followed by grasslands, riparian areas, and forested area (**Table 3.6, Figure 3.11**). Specifics regarding vegetation cover are provided in **Appendix C**. The majority of the shrublands in the Kirby Creek watershed are sagebrush dominated.

Table 3.6. General land cover types occurring in the Kirby Creek watershed, Hot Springs County, WY.[1]

	Sub-watershed Name											
	Alkali Creek-Kirby Creek		Lake Creek-Kirby Creek		Lower Kirby Creek		Middle Kirby Creek		Upper Kirby Creek		TOTAL	
Vegetation Type	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*
Agriculture	0	0%	0.5	0.002%	180	1%	0	0%	10	0.03%	190	0.15%
Barren	0	0%	1	0.005%	2	0.01%	2	0.01%	1	0.004%	7	0.01%
Forested	530	3%	1,534	6%	603	3%	444	2%	3,884	11%	6,995	5%
Grassland	2,938	15%	3,606	14%	1,622	7%	3,773	15%	2,362	7%	14,301	11%
Open Water	0	0%	0	0%	0	0%	2	0.01%	0	0%	2	0.001%
Riparian	1,834	9%	2,273	9%	2,857	13%	3,392	13%	2,973	8%	13,329	10%
Shrubland	14,187	73%	17,863	71%	16,660	76%	17,938	70%	27,033	75%	93,681	73%
Sparse	0.2	0.001%	0	0%	1	0.004%	0.4	0.001%	0.2	0.001%	2	0.001%
Urban	0	0%	0	0%	23	0.1%	0	0%	0	0%	23	0.02%
Total	**19,489**	**100%**	**25,278**	**100%**	**21,948**	**100%**	**25,551**	**100%**	**36,263**	**100%**	**128,530**	**100%**

[1]***Source:*** USGS 2010.

If the current vegetation cover types are compared to the modeled pre-settlement conditions (USGS 2010), the major changes to vegetation cover in the watershed have been increases in agricultural area, forested area, grasslands, and riparian areas and decreases in shrublands (**Table 3.7**). Increases in forested area have occurred in the Lake Creek and Upper Kirby Creek sub-watersheds, and decreased in the other sub-watersheds. Grasslands have increased in all sub-watersheds and roughly correspond to the observed decreases in shrublands. Increases in forested area may be due to wildfire fire suppression since settlement in the area; whereas the increases in grasslands and decreases in shrublands may be caused by prescribed fires to increase livestock forage.

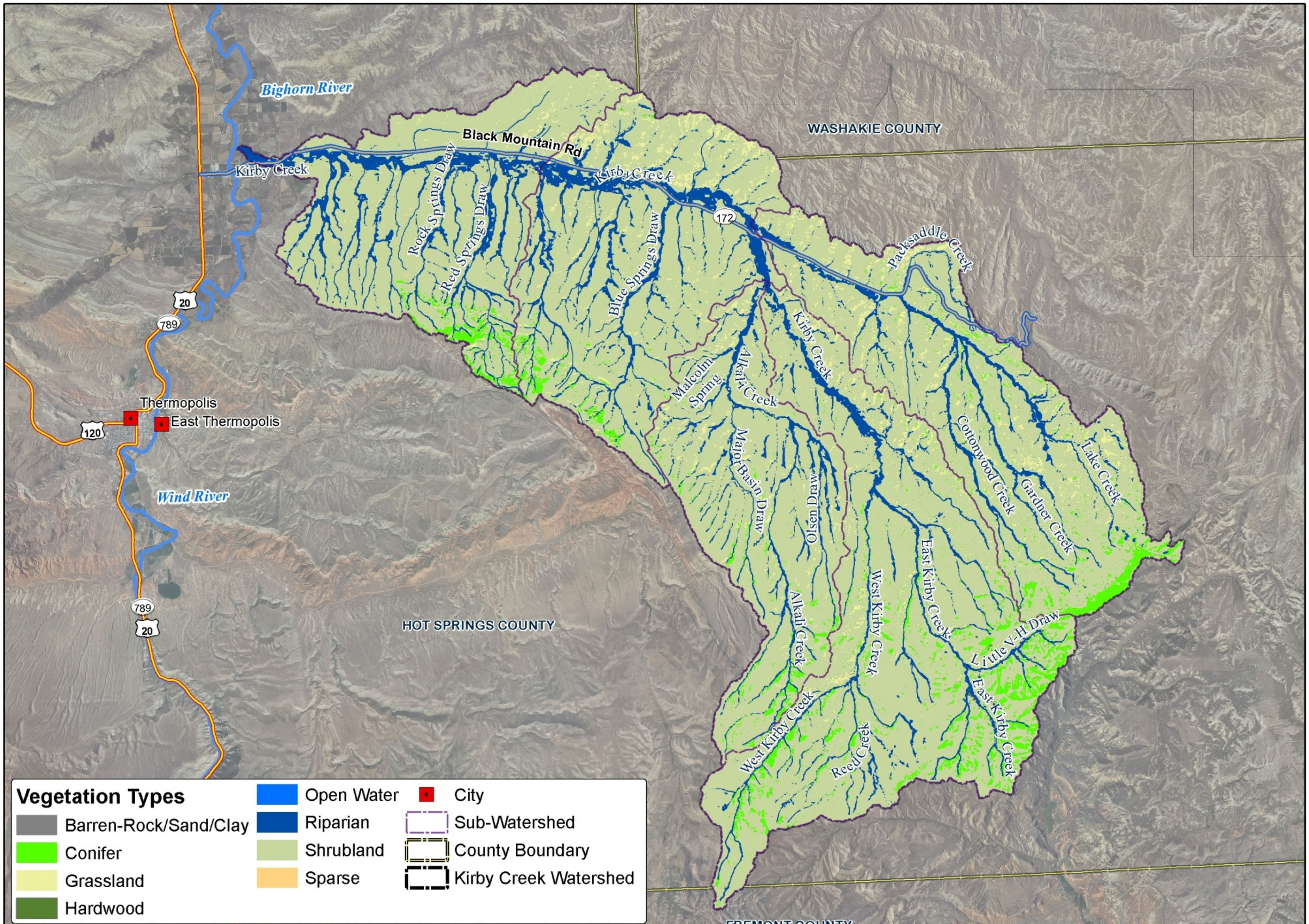

FIGURE 3.11

PROJECT NAME
Kirby Creek Watershed Study

FIGURE TITLE:
Vegetation

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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Table 3.7. Difference between current vegetation cover types and modeled pre-settlement vegetation cover types in the Kirby Creek Watershed, Hot Springs County, WY.[1]

Vegetation Type	Sub-watershed Name (acres)					TOTAL
	Alkali Creek-Kirby Creek	Lake Creek-Kirby Creek	Lower Kirby Creek	Middle Kirby Creek	Upper Kirby Creek	
Agriculture	0	0	180	0	10	190
Barren	0	0	0	0	0	1
Forested	-22	301	-3	-36	1,082	1,322
Grassland	2,294	1,915	1,221	2,411	1,383	9,225
Open Water	0	0	0	0	0	0
Riparian	30	35	-18	64	69	180
Shrubland	-2,303	-2,252	-1,403	-2,439	-2,544	-10,941
Sparse	0.1	0.0	0.1	0.1	0.0	0.2
Urban	0	0	23	0	0	23

[1]***Source:*** USGS 2010.

3.2.5.2 Riparian and Wetland Areas

In general terms, riparian/wetland areas can generally be identified in the Kirby Creek watershed during the summer months as the green belt adjacent to streams, rivers, lakes, and reservoirs. They can also occur as seeps, sloughs, or wet meadows in areas where groundwater is close to the soil surface. Drought conditions can make identification of wetland/riparian areas problematic.

Wetland and riparian science and federal and state water quality laws are still evolving. Definitions of terminology used in this report are provided below to ensure that all readers have a clear understanding of the terminology used and the conclusions made.

Riparian areas — Many definitions of riparian areas have been used by various agencies (NRC 2002). For the purposes of this report, riparian areas are defined as "areas that are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are "adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines" (NRC 2002, p 33).

Wetlands — The interaction of a site's hydrology, vegetation, and anaerobic soils results in the development of characteristics unique to wetlands. The term "wetland" has a specific definition (see 33 CFR 328.3 [51 Federal Register 41250]), and are typically found in the wettest portions of a riparian area. Wetlands are commonly referred to as playas, swamps, marshes, wet meadows, willow carrs, bogs, and fens. In the project area wetlands are most commonly associated with bodies of water such as ponds, lakes, and streams. Activities in wetlands are regulated by the USACE. It is beyond the scope of this report to distinguish between mapped riparian areas and wetlands, therefore the term "riparian/wetland area" is used throughout this report.

Site hydrology is the overriding characteristic that distinguishes riparian/wetland areas from adjacent uplands. The hydrology of any site or region is ultimately linked to precipitation, but the development of riparian/wetland areas is dependent on the longer term presence of available water. In much of the western U.S. annual precipitation is less than 20 inches and annual evapotranspiration is over 30 inches per year (WRCC 2009), indicating a water deficit and that precipitation alone is insufficient to support the establishment or persistence of wetland/riparian areas. These conditions hold true for the Kirby Creek watershed. Because of this water deficit the hydrology of riparian/wetland areas in the project area originates primarily from surface water, groundwater, or both.

Soils in riparian/wetland areas differ from upland soils by their formation and the prolonged presence of water. Riparian/wetland soils form under conditions characterized as flowing (lotic) or standing water (lentic) environments (Lewis et al. 2003). Soils in lotic environments, such as floodplains, typically exhibit a high level of stratification developed by successive depositional events during floods. Organic matter in these areas can often be found as deposits derived from offsite sources. Soils in lentic environments, such as in depressional areas or lakes, frequently have higher levels of organic matter accumulation than either lotic environments or uplands (Lewis et al. 2003). The amount of organic matter accumulation in lentic areas is affected by the type of vegetation and the amount of wave action the site receives, among other factors (Lewis et al. 2003).

When a soil becomes saturated with water, the bio-geochemical processes change because of the lack of oxygen (the environment is anaerobic). These changes in soil chemistry are unique to saturated soils and have been termed "hydric." Hydric soil is defined as "a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (NRCS 2007). Hydric soils are most commonly found in wetland areas and can be identified by field indicators such as mottling, gleying, darker color (i.e., chroma), among others (NRCS 2010). Hydric soils within the project area can be expected on active floodplains, floodplain terraces, depressional areas, swales, playas, and drainages. Hydric soils can also be found as inclusions in other, non-hydric, soil types.

Figure 3.12. Tamarisk is a highly aggressive non-native shrub.

Riparian/wetland areas in the Kirby Creek watershed occur as ponds, emergent (i.e., herbaceous), and scrub-shrub communities. Emergent riparian/wetland areas typically contain different assemblages of hydrophytic (water-loving) grasses, sedges, rushes, and forb species (e.g., wet meadows, marshes). Common plant species present in emergent riparian/wetland areas include sedges (*Carex* spp.), rushes (*Juncus* spp.), spikerushes (*Eleocharis* spp.), scouring rush (*Equisetum* spp.), cattails (*Typha* spp.), bulrushes (*Scirpus* spp.), foxtail barley (*Hordeum jubatum*), saltgrass (*Distichlis spicata*), redtop (*Agrostis alba*), tufted hairgrass (*Deschampsia caespitosa*), cocklebur (*Xanthium strumarium*), and western dock (*Rumex crispus*). Many of these same species can also occur in the understory of scrub-shrub riparian/wetland areas in the watershed. Scrub-shrub riparian/wetland areas in the watershed are typically dominated by coyote willow (*Salix* *exigua*) (also referred to as sandbar willow). Other native woody riparian/wetland species in the watershed include gooseberry (*Ribes* spp.), peachleaf willow (*Salix amygdaloides*), narrowleaf cottonwood (*Populus angustifolia*) and plains cottonwood (*Populus deltoides*) among others. Non-native woody species include tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*). These non-native species were observed by SEI (2005) in the Middle and Lower Kirby Creek sub-watersheds. Tamarisk (**Figure 3.12**) is particularly aggressive and can crowd out native riparian vegetation.

According to the National Wetlands Inventory (NWI), a total of about 203 acres of riparian/wetland areas occur in the Kirby Creek watershed, the majority of which are emergent (**Table 3.8**) (USFWS 2010).

Table 3.8. National Wetland Inventory data for the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	Wetland Type (acres)			Total (acres)
	Pond	Emergent	Scrub-Shrub	
Lower Kirby Creek	4.8	23.6	0.01	28.4
Middle Kirby Creek	16.6	41.2	1.0	58.9
Alkali Creek-Kirby Creek	3.1	12.9	0	16.1
Lake Creek-Kirby Creek	13.3	28.3	0	41.6
Upper Kirby Creek	13.4	43.7	0.6	57.8
Total	51.2	149.9	1.7	202.8

Source: USFWS 2010.

In their 2005 report, SEI documented their efforts and conclusions with regard to riparian/wetland areas in the watershed. They used the *Proper Functioning Condition* (PFC) methodology (Pritchard et al. 1998). **Table 3.9** summarizes their findings. Overall they found that 33 percent of the 72 sites they visited were in PFC, and the remaining 67 percent were functional at-risk or non-functional (SEI 2005).

Table 3.9. Summary of riparian proper functioning condition surveys completed in 2005, Kirby Creek Watershed, Hot Springs County, WY (SEI 2005).

Sub-watershed	Proper Functioning Condition	Functional At-Risk	Non-Functional	Total
Lower Kirby Creek	6	3	2	11
Middle Kirby Creek	1	5	2	8
Alkali Creek-Kirby Creek	6	10	3	19
Lake Creek-Kirby Creek	*Not sampled*			
Upper Kirby Creek	11	17	6	34
Total	24	35	13	72

The BLM-Worland FO has also conducted PFC assessments in the watershed (**Figure 3.13**). According to their Riparian/Aquatic Information Database System (RAIDS) database they have rated a total of 12.99 miles of stream in the watershed (excluding ephemeral streams). Based on the number of stream miles, roughly 61 percent of the stream reaches they assessed are in PFC, while 37 percent are Functional At-Risk and two percent were rated as 'unknown', signifying that more information is needed (**Table 3.10**).

Table 3.10. BLM-Worland proper functioning condition ratings for streams they assessed in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	Stream Name	Rating*	No. of Reaches	Total Stream Miles
Lower Kirby Creek	Kirby Creek	FAR	2	1.44
Lower Kirby Creek	Kirby Creek	PFC	1	0.17
Lower Kirby Creek	Kirby Creek	U	1	0.27
Lower Kirby Creek	Rock Springs Draw	FAR	1	0.35
Lower Kirby Creek	Rock Springs Draw	PFC	1	0.14
Middle Kirby Creek	Blue Springs Draw	FAR	1	0.15
Middle Kirby Creek	Blue Springs Draw	PFC	4	0.87
Middle Kirby Creek	Kirby Creek	PFC	1	0.03
Alkali Creek-Kirby Creek	Alkali Creek	PFC	1	0.66
Alkali Creek-Kirby Creek	Trib. Major Basin Draw	PFC	1	0.42
Alkali Creek-Kirby Creek	Unknown	PFC	2	0.62
Lake Creek-Kirby Creek	Lake Creek	FAR	6	2.19
Lake Creek-Kirby Creek	Lake Creek	PFC	1	1.08
Upper Kirby Creek	East Kirby Creek	FAR	1	0.30
Upper Kirby Creek	East Kirby Creek	PFC	4	0.67
Upper Kirby Creek	Kirby Creek	PFC	5	1.94
Upper Kirby Creek	Trib. East Kirby Creek	FAR	2	0.37
Upper Kirby Creek	Trib. East Kirby Creek	PFC	2	1.33

Source: BLM RAIDS database

* FAR=Functional-At Risk; PFC=Proper Functioning Condition; U=Unknown, more data needed.

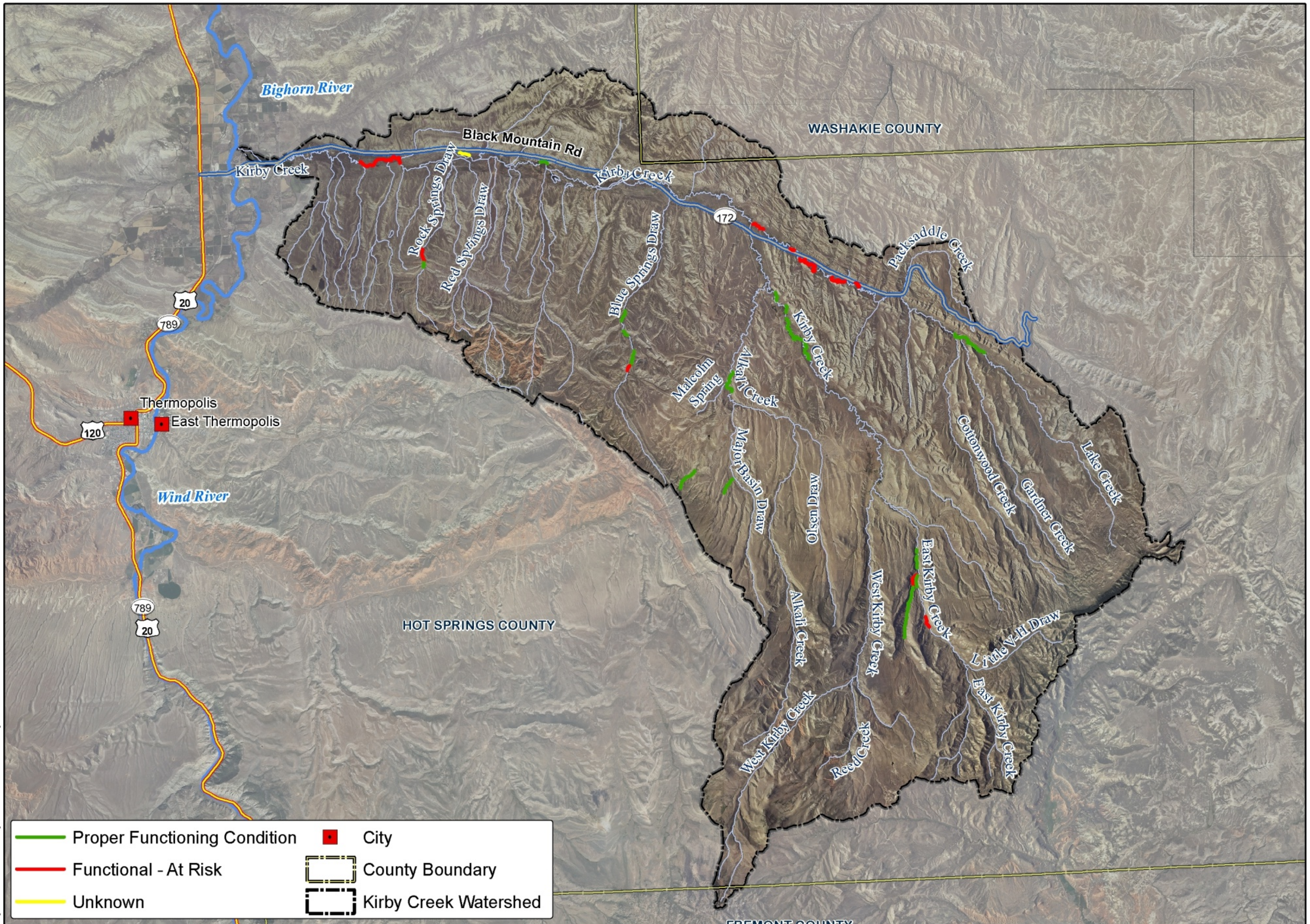

FIGURE 3.13	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Riparian\Aquatic Information Database System	
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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As discussed previously, riparian/wetland areas are transition zones between aquatic and terrestrial systems. As such, they frequently occupy important positions in the landscape for providing a variety of physical, chemical, and biological functions important to society. These functions are linked not only to processes occurring within the riparian/wetland area, but are also directly linked to watershed-scale processes. Functions commonly associated with freshwater riparian/wetland areas typically fall into the following categories:

- water storage
- flood flow attenuation
- water quality improvement
- nutrient cycling
- foodchain support
- wildlife/bird habitat

The U.S. Army Corps of Engineers has developed a system for classification and evaluation of riparian/wetland functions called the hydrogeomorphic (HGM) method. The HGM method is based on a riparian/wetland area's topographic position (i.e., geomorphic setting), its dominant water source, and the hydrodynamics of the site (i.e., dominant direction of flow) (Smith et al. 1995). The HGM riparian/wetland classes applicable to the Kirby Creek watershed are primarily depressional, riverine, and slope. Each of these HGM classes have certain functions associated with them (**Table 3.11**) and perform them at varying capacity levels depending on their HGM class as well as the individual site characteristics.

Table 3.11. Characteristics and primary functions of hydrogeomorphic riparian/wetland classes found in the Kirby Creek watershed, Hot Springs County, WY.

HGM Class	Examples in the watershed	Characteristics*	Primary Functions
Depressional	Twin Tubes, the "Duck Pond", stock ponds with hydrophytic plants.	Occurs in a topographic depression (e.g., shallow pond); Dominant water sources are precipitation, overland flow and/or groundwater; Water levels fluctuate vertically.	Water storage, nutrient cycling, foodchain support, wildlife/bird habitat.
Riverine	All perennial creeks in the watershed.	Occurs along streams and rivers; Dominant water source is from overbank flow from channel or alluvial aquifer; Flow is downstream and lateral away from channel.	Water storage, flood flow attenuation, water quality improvement, nutrient cycling, foodchain support, wildlife/bird habitat.
Slope	Springs on slopes, mostly in the upper portion of the watershed.	Occurs on a slope; Dominant water source is groundwater; Flow is down-gradient.	Water storage, nutrient cycling, foodchain support, wildlife/bird habitat.

*Smith et al. 1995.

The water storage function of wetlands and riparian areas is one of the key functions targeted by restoration and water development projects completed to date in the Kirby Creek watershed (see **Section 3.6.2**). Stock ponds and in-stream reservoirs clearly increase water storage through the impoundment of surface water. Water storage in restored riverine systems is improved by creating conditions that allow the stream better access to its floodplain so that floodwaters can spread out and infiltrate into the soil. In these instances temporary water storage can occur both on the surface, *and* within the floodplain alluvium. The effectiveness of floodplain water storage is dependent on how long the water stays within an area (i.e., residence time), as well as the soil texture. This is because the longer water stays in an area, the more opportunity it has to infiltrate into the soil. This residence time is affected by the floodplain gradient both longitudinally and perpendicularly to the channel, surface roughness, and floodplain size. In general, the flatter the floodplain, the more rough it is (e.g., lots of woody plants), and the larger (especially width) a floodplain is, the greater the residence time of floodwaters. Increased subsurface storage can have significant beneficial impacts to the abundance and vigor of riparian vegetation within the restored area, and help to maintain or improve base flows below the restored area (Hammersmark 2010).

In a typical incising channel, the streambed degrades until the critical bank height is exceeded and the bank fails, increasing channel width and sediment load. In severe cases, nick points and nick zones migrate upstream and destabilize a large part of the system, including tributaries. Over time, the stream will move toward a new equilibrium and incision will cease when one or a combination of the following conditions develops (Fischenich 2000):

1. Changes in the channel slope and geometry alter the hydraulic conditions such that sediment continuity is restored.
2. Fine sediments are selectively eroded, leaving only coarse sediments that armor the streambed and prevent further incision.
3. The degradation is arrested by bedrock or man-made structures prior to the compromise of bank stability.
4. Recovery of riparian vegetation increases streambank stability, and bed stability is provided by one or more of the above factors.

Under ideal conditions, channel rehabilitation through reconnection of the stream and the original floodplain is the most desirable option. In areas where significant incision has occurred, it may be cost prohibitive to reconnect the channel to the original floodplain and construction of an inset floodplain is often the most feasible approach.

One of the initial steps in channel/floodplain and general riparian area restoration is to protect the riparian area from overuse and prevent further degradation. This can be achieved by limiting or eliminating livestock access to the stream and riparian area through the use of fencing. In 2005 there were about 200 acres of riparian area in the Continuous Conservation Reserve Program (CCRP) (SEI 2005). Since that time several additional CCRP riparian fencing projects have been undertaken, resulting in an increase of 368 acres of fenced riparian area for a total of 568 acres of riparian area in CCRP (**Figure 3.14**).

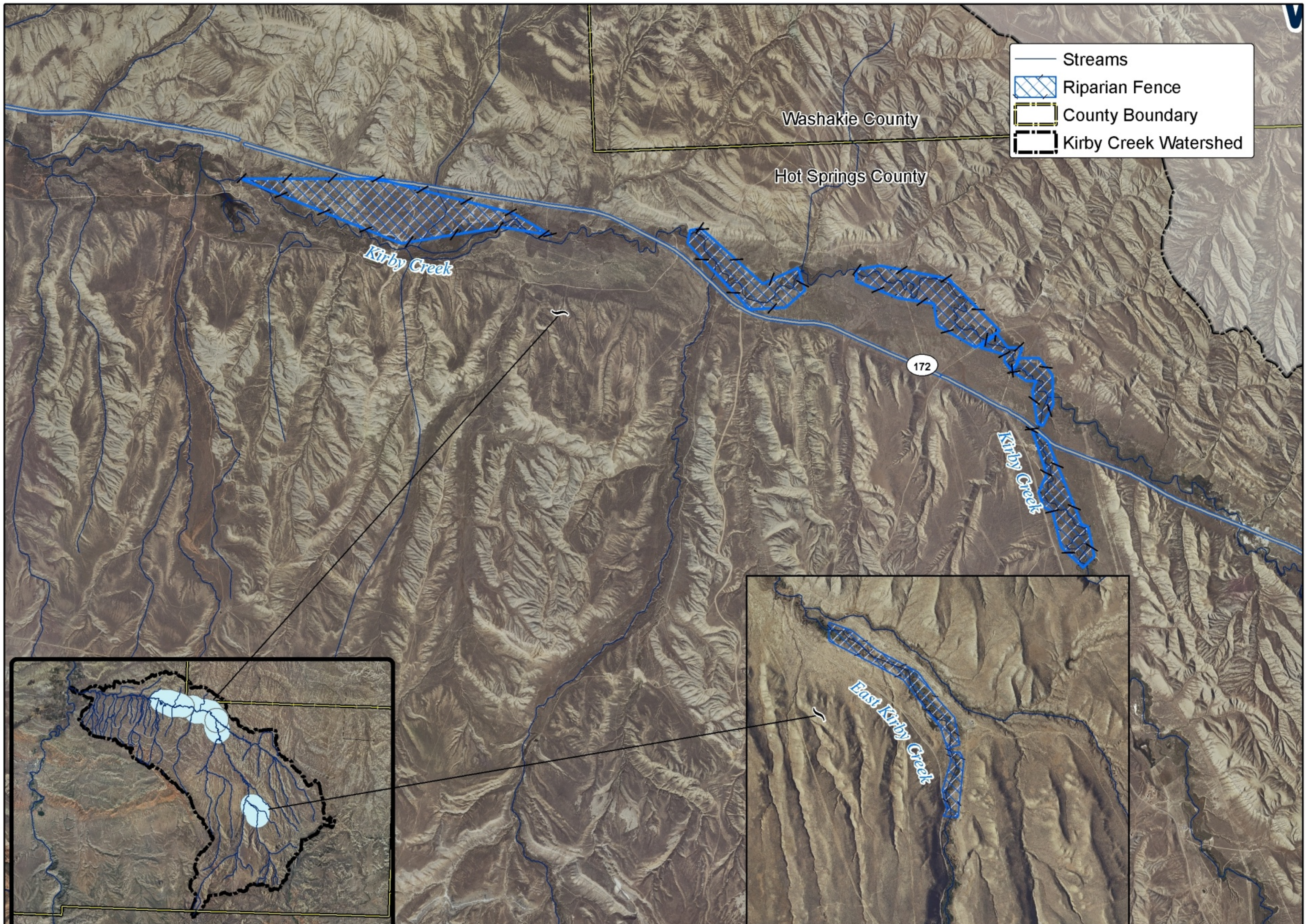

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FIGURE 3.14	PROJECT NAME Kirby Creek Watershed Study	FIGURE TITLE: Fenced Riparian Areas	
PROJ NO: *100008648*	PLOTTED: *06-07-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N

0 0.25 0.5 1 Miles

3.3 LAND USES AND MANAGEMENT ACTIVITIES

Historic and current land uses and management actions affect the natural environment described in the previous sub-section and influence future projects in the watershed. This sub-section provides an overview of these land uses and management activities.

3.3.1 Land Use History

The following is a brief history of the watershed taken from the Milek (2001) report entitled "Kirby Creek Country". Though Native Americans used and travelled through the Kirby Creek watershed for centuries prior to the arrival of white men, and trappers and explorers may have traversed the watershed in the early 1800's, the first documented visit to the Kirby Creek watershed probably occurred in May 1860 by the expedition led by Lt. Henry Maynadier. The Bridger Trail crosses through the watershed and was used as early as 1864 by wagon trains heading to Montana where gold had been discovered.

Settlement in the watershed first occurred in 1878-79 by Kris Kirby, a rancher from Texas. Settlement of the area continued through the late 1800's and early 1900's with homesteads being established and water rights being purchased. Many of the settlers homesteaded near the confluence of Kirby Creek and the Big Horn River, though several families and individuals homesteaded higher up in the watershed near sources of reliable water.

Though there were several roads in the area prior to this, the Kirby Creek road as it is known today was first constructed in 1913. The discovery of oil in 1914 on the C.W. Anderson farm and at the Murphy Dome escalated activity in the area. In 1918 Ohio Oil hit a 60 barrel a day gusher which further fueled development and exploration of the oil reserves in the watershed. Oil drilling in general died down in the watershed after 1924.

Prior to 1900 cattle were pastured in the upper watershed during the summer months, with the lower watershed reserved for winter feeding areas. Lower Kirby Creek is described as being approximately two feet deep and 20 feet wide, supporting a considerable amount of grass. When the creek would flood the water is reported to have extended almost a mile across the floodplain. Kirby Creek would dry up in some years, but other years would flow year round.

Large numbers of sheep were brought into the watershed in 1910. Wild horses were also numerous in the area at this time and likely contributed to overgrazing in the watershed. By 1915 Kirby Creek was starting to incise, now being approximately 4 feet deep and 20 feet wide. Between 1915 and 1923 a succession of drought and cloudbursts accelerated channel incision and headcutting of Kirby Creek. A severe flood in 1950 also accelerated erosion. Channel incision caused the loss of the ability to irrigate from the creek as early as 1923, though some areas were still being irrigated until at least the 1940's. Irrigated fields still occur in the watershed today, though they are much reduced from what was originally irrigated at the beginning of the 20th century. Channel incision and headcutting of creeks in the watershed continues today and continues to threaten what irrigation remains.

3.3.2 Land Ownership

Land ownership in the watershed is primarily (50 percent) public land administered by the BLM (**Table 3.12, Figure 3.15**). Private land comprises roughly 38 percent and State administered land roughly 12 percent of the land area in the watershed. At a sub-watershed level, the Upper Kirby Creek and Lake Creek –Kirby Creek sub-watersheds have comparatively less federal land and more private land (**Table 3.12**). Conversely, the Lower Kirby and Middle Kirby sub-watershed are comprised of 79 percent and 80 percent, respectively, of public land (Federal plus State).

Table 3.12. Summary of land ownership in the Kirby Creek watershed, Hot Springs County, WY.

	Land Ownership Status						**Total**
	Federal (BLM)		**State**		**Private**		
Sub-watershed	***Acres***	***% of sub-watershed***	***Acres***	***% of sub-watershed***	***Acres***	***% of sub-watershed***	***Acres***
Lower Kirby Creek	16,711	76%	703	3%	4,538	21%	21,952
Middle Kirby Creek	18,072	71%	2,368	9%	5,116	20%	25,556
Alkali Creek-Kirby Creek	9,995	51%	2,410	12%	7,095	36%	19,500
Lake Creek-Kirby Creek	9,637	38%	3,228	13%	12,436	49%	25,301
Upper Kirby Creek	9,438	26%	7,009	19%	19,815	55%	36,262
Total	63,853	--	15,719	--	48,999	--	128,571

3.3.3 Transportation, Energy, and Communication Infrastructure

There are approximately 345 miles of roads in the watershed, the majority of which are classified as "local" roads (**Table 3.13, Figure 3.16**). The Lower, Middle, and Upper Kirby Creek sub-watersheds contain the majority of the roads. Roads classified as "minor" are relatively limited in extent in all but the Lake Creek-Kirby Creek and Upper Kirby Creek sub-watersheds.

Table 3.13. Summary of road types and extent in the Kirby Creek watershed, Hot Springs County, WY.

	Road Type (miles)		
Sub-watershed	**Local**	**Minor**	**Total**
Lower Kirby Creek	73.8	0.3	74.1
Middle Kirby Creek	76.4	2.0	78.5
Alkali Creek-Kirby Creek	54.3	2.5	56.8
Lake Creek-Kirby Creek	42.6	12.3	54.9
Upper Kirby Creek	60.0	20.4	80.4
Total	307.3	37.5	344.8

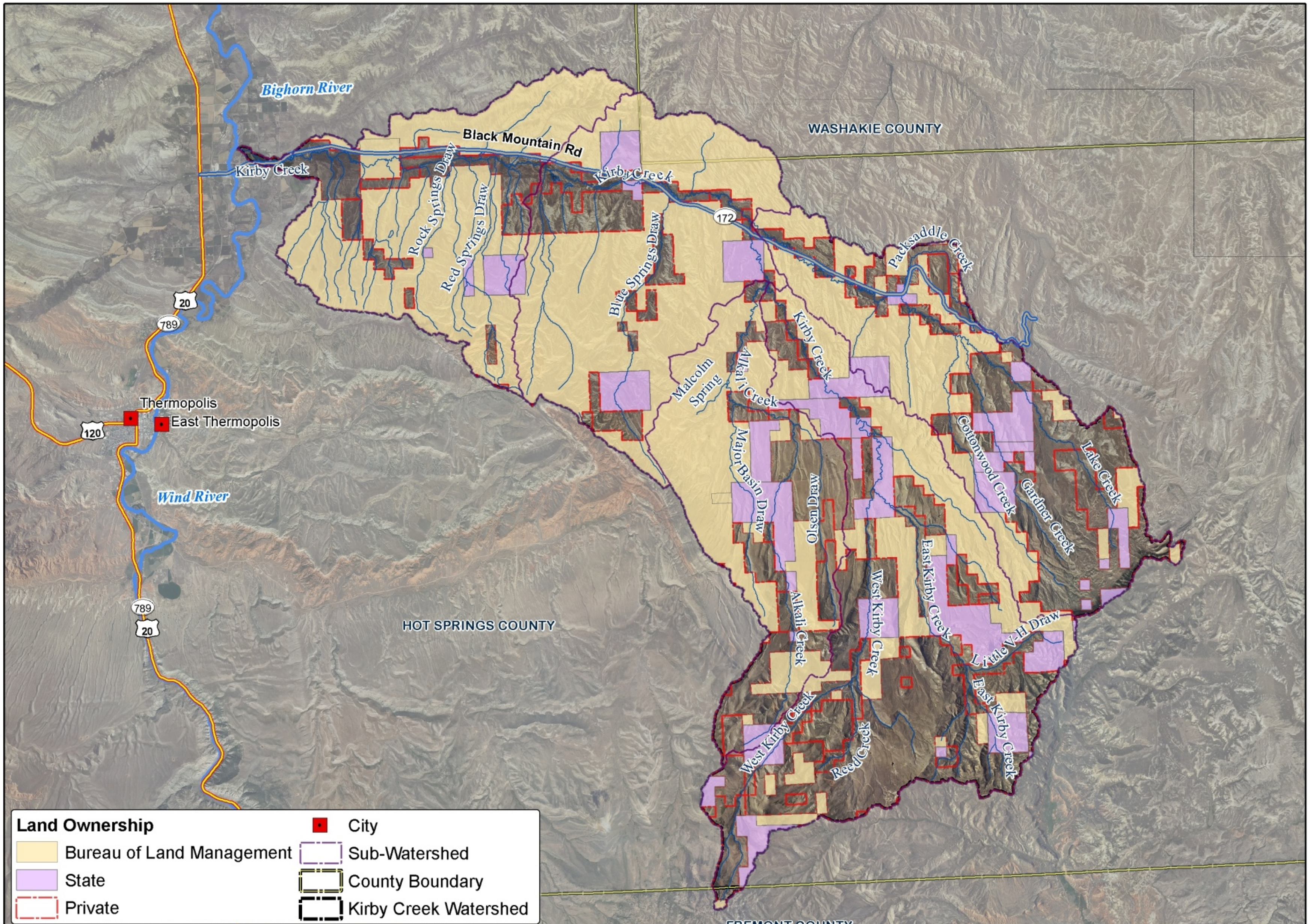

FIGURE 3.15

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE:

Land Ownership

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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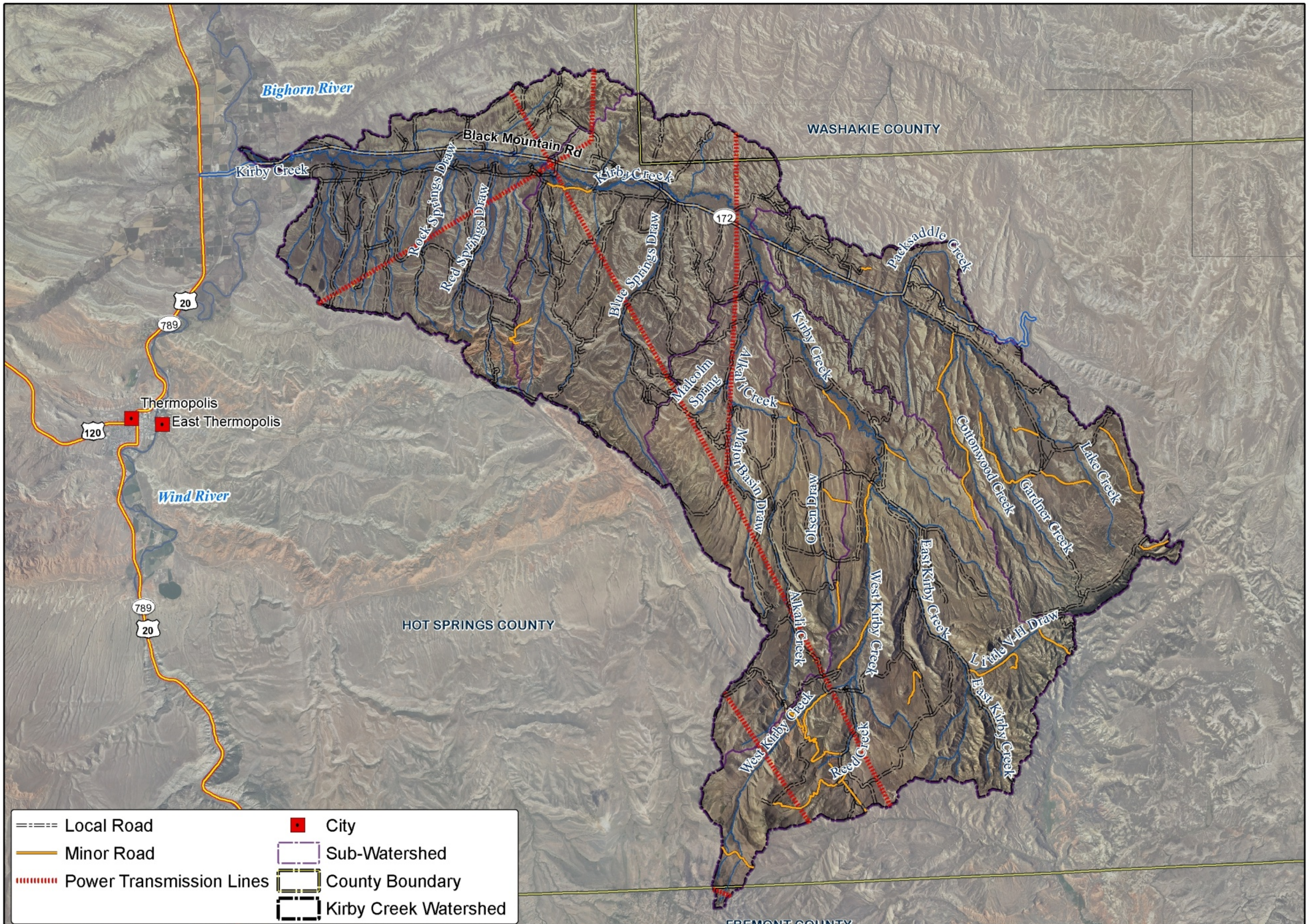

FIGURE 3.16	PROJECT NAME Kirby Creek Watershed Study	FIGURE TITLE: Transportation and Energy Infrastructure		N 0 1.5 3 6 Miles
	PROJ NO:*100008648*	PLOTTED:*07-15-2010*	LOCATION:*HOT SPRINGS COUNTY, WY*	PROJECT MGR:*MR*

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Roughly 20.6 miles of transmission lines traverse the watershed (**Table 3.14**, **Figure 3.16**). Transmission lines occur in all sub-watersheds except for the Lake Creek-Kirby Creek sub-watershed.

Table 3.14. Summary of transmission lines in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	Count	Miles
Lower Kirby Creek	3	10.0
Middle Kirby Creek	5	12.4
Alkali Creek-Kirby Creek	4	14.2
Lake Creek-Kirby Creek	0	0.0
Upper Kirby Creek	3	6.4
Total	7	20.6

There are no cell-phone towers in the watershed.

3.3.4 Rangeland Health/Grazing Practices

3.3.4.1 Grazing Allotments - BLM

The BLM manages a total of 38 grazing allotments in the watershed (**Figure 3.17, Table 3.15**) totaling over 127,000 acres. Thirty-six of these allotments are administered by the BLM's Worland Field Office (FO), the remaining two are administered by the Lander FO. The allotments encompass a mosaic of private, state, and federal lands. Significant portions of some of these allotments are located outside the Kirby Creek watershed boundary.

According to the Department of the Interior's final rule for grazing administration, effective August 21, 1995, the Wyoming Bureau of Land Management (BLM) State Director is responsible for the development of standards for healthy rangelands and guidelines for livestock grazing management on Wyoming's public rangelands. The development and application of these standards and guidelines are to achieve the four fundamentals of rangeland health outlined in the grazing regulations (43 CFR 4180.1). Those four fundamentals are: (1) watersheds are functioning properly; (2) water, nutrients, and energy are cycling properly; (3) water quality meets State standards; and (4) habitat for special status species is protected (BLM 2007).

Standards address the health, productivity, and sustainability of BLM-administered public rangelands and represent the minimum acceptable conditions for rangelands. The standards apply to all resource uses on public lands. Their application will be determined as use-specific guidelines are developed. Standards are synonymous with goals and are observed on a landscape scale. They describe healthy rangelands rather than important rangeland by-products. The achievement of a standard is determined by observing, measuring, and monitoring appropriate indicators. An indicator is a component of a system whose characteristics (for example, presence, absence, quantity, and distribution) can be observed, measured, or monitored based on sound scientific principles (BLM 2007).

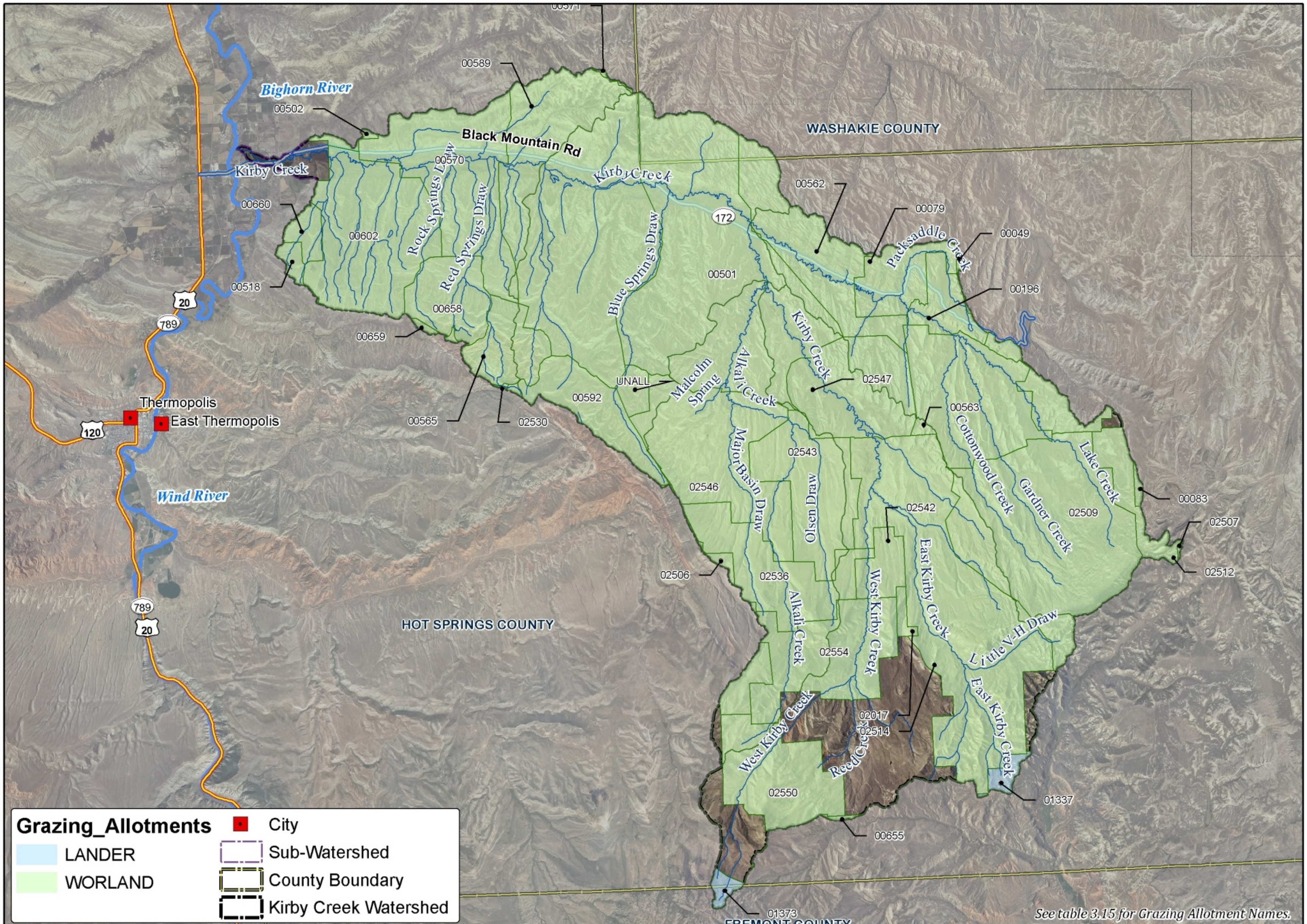

FIGURE 3.17

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: Grazing Allotments

PROJ NO: 100008648 | PLOTTED: 07-15-2010 | LOCATION: HOT SPRINGS COUNTY, WY | PROJECT MGR: MR

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Table 3.15. Grazing allotments within the Kirby Creek watershed, Hot Springs County, WY.

Allotment Name	Allotment Number	Acres
BILLYS FLATS	02512	1,315.1
BLACK WILLOW	00659	97.6
BLACK WILLOW DRAW	00624	7.4
BLUE HILL	02536	3,864.2
BLUE SPRINGS	00501	15,034.3
BRIDGER CREEK	02507	17.6
COPPER MOUNTAIN (Lander FO)	01373	263.6
COPPER MTN	00655	52.6
DE PASS RANCH (Lander FO)	01337	368.7
DYE	02506	888.5
GARDNER BADLANDS	00562	4,293.9
HALL BUTTE	02017	236.1
HOME PLACE	00518	305.0
K I S	00083	96.3
KIRBY CREEK	00589	14,515.1
LAKE CREEK	00196	1,361.6
MAJOR BASIN	02546	6,207.4
MELTON MOUNTAIN	02550	3,965.9
MUD CREEK	00050	966.8
MURPHY DOME	00049	269.9
NEILSON	02530	16.1
OUT	00000	8,426.8
PACK SADDLE CRK	00079	1,910.1
PEAK	02509	10,770.6
RED HOLE	00565	1,975.7
RED SPRINGS	00658	2,272.1
RED SPRINGS DRAW	00570	6,023.5
REED CREEK	02554	4,548.7
ROCK SPRINGS DRAW	00602	6,480.6
SOUTH LUCERNE GROUP	00502	171.9
STUMP	02542	1,081.5
SWALLOW	02543	4,153.9
V PASTURE	02547	4,345.8
V-H DRAW	02514	12,558.4
WEST	00660	590.4
WILD HORSE BUTTE	00592	2,425.8
WINTER CAMP	00563	5,338.1
ZIMMERMAN BUTTES	00571	36.7
Total		**127,254.4**

**Allotment Number is based on BLM Data.*

Livestock grazing on BLM-lands is managed to meet the standards for rangeland health, productivity, and sustainability. The BLM in Wyoming has established statewide guidelines to direct the development and implementation of, reasonable, responsible, and cost-effective management practices at the grazing allotment and watershed level (BLM 2007). These management practices will either maintain existing desirable conditions or move rangelands toward statewide standards within reasonable timeframes. Elements of the grazing management guidelines relevant to this watershed study include:

- Ensure that adequate amounts of vegetative ground cover remain after grazing use to support infiltration, maintain soil moisture storage, stabilize soils, allow the release of sufficient water to maintain system function, and to maintain subsurface soil conditions that support permeability rates and other processes appropriate to the site.
- Grazing management practices will restore, maintain, or improve riparian plant communities. Grazing management strategies consider hydrology, physical attributes, and potential for the watershed and the ecological site.
- Range improvement practices (instream structures, fencing, stock tanks, etc.) in and adjacent to riparian areas will ensure that stream channel morphology and functions appropriate to climate and landform are maintained or enhanced. The development of springs, seeps, or other projects affecting water and associated resources shall be designed to protect the ecological and hydrological functions, wildlife habitat, and significant cultural, historical, and archaeological values associated with the water source. Range improvements will be located away from riparian areas if they conflict with achieving or maintaining riparian function.
- Grazing management practices and range improvements will adequately protect vegetative cover and physical conditions and maintain, restore, or enhance water quality to meet resource objectives. The effects of new range improvements (water developments, fences, etc.) on the health and function of rangelands will be carefully considered prior to their implementation.
- Grazing will occur in a manner that incorporates adequate periods of rest at the appropriate times. The rest periods will provide for seedling establishment or other necessary processes at levels sufficient to move the ecological site condition toward the resource objective and subsequent achievement of rangeland health standards.
- Grazing management practices and range improvements will be designed to maintain or promote the physical and biological conditions necessary to sustain native animal populations and plant communities. This will involve emphasizing native plant species in the support of ecological function and incorporating the use of non-native species only in those situations in which native plant species are not available in sufficient quantities or are incapable of maintaining or achieving properly functioning conditions and biological health.

On a continuing basis, the Standards for Healthy Rangelands (BLM 2007) will direct on-the-ground management on the public lands. They will serve to focus the on-going development and implementation of activity plans toward the maintenance or the attainment of healthy rangelands. Quantifiable resource objectives and specific management practices to maintain or achieve the standards will be developed at the local BLM District and Resource Area levels and will consider all reasonable and practical options available to achieve desired results on a watershed or grazing allotment scale. The objectives shall be reflected in site-specific activity or implementation plans as well as in livestock grazing permits/leases for the public lands. These objectives and practices may be developed formally or informally through mechanisms available and suited to local needs (such as Coordinated Resource Management (CRM) efforts).

3.3.4.2 State Grazing Leases

Wyoming's trust lands are managed by the Office of State Lands and Investments (OSLI), which acts as the administrative and advisory arm of the Board of Land Commissioners. The Wyoming Constitution requires that the Board of Land Commissioners manages the land in a manner that will "realize the largest possible proceeds," subject to legislative direction. Much of the state-owned land in the Kirby Creek watershed is leased to private landowners for grazing. Grazing management and practices on state-owned lands are typically implemented by the grazing permittee.

3.3.4.3 Grazing on Private Lands

Management of grazing on private lands is controlled by the landowner. Technical assistance is available from the local NRCS office or private range consultants. Range improvement programs implemented under a variety of NRCS assistance programs typically funded through the Farm Bill, follow a plan of operations developed for the property and/or applicable NRCS technical guidelines, which can be modified for local, on-the-ground conditions.

3.3.4.4 Ecological Site Descriptions (ESDs)

Ecological Site Descriptions (ESDs) and associated information are used primarily to stratify the landscape for monitoring and assessment, interpretation of resource hazards and opportunities, and to prioritize and select management actions (NRCS 2010). An ESD can be used to evaluate existing vegetative cover on the land in comparison with what type of vegetation is expected for that particular ecological site. This comparison is one means of assessing overall health of the rangeland. Potential production of a given site is closely related to the ecological condition of that site.

An **ecological site** is defined by a distinctive kind of land with specific soil and physical 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. Unlike vegetation classification, ecological site classification uses climate, soil, geomorphology, hydrology, and vegetation information to describe the ecological potential of land areas. A particular ecological site may feature several plant communities (described by vegetation classification) that occur over time and/or in response to management actions (NRCS 2010)

Ecological Site Descriptions (**ESDs**) are reports that include the following types of data for a specific ecological site:

- Site Characteristics -- Identifies the site and describes the physiographic, climate, soil, and water features associated with the site.
- Plant Communities -- Describes the ecological dynamics and the common plant communities comprising the various vegetation states of the site. The disturbances that cause a shift from one state to another are also described.
- Site Interpretations -- Interpretive information pertinent to the use and management of the site and its related resources.
- Supporting Information – Provides information on sources of information and data utilized in developing the site description and the relationship of the site to other ecological sites.

Additional information regarding ESDs can be found at the following website: http://esis.sc.egov.usda.gov.

Ecological Sites are classified by precipitation zones and soil types. Practically the entire area within the Kirby Creek watershed falls within two precipitation zones for purposes of ESD classification: 1) 10" – 14" East, and 2) 15" – 19" Foothills and Mountains East. A very small area north of Black Mountain Road and west of the Kirby Creek/Lake Creek confluence falls within the 5" – 9" Big Horn Basin precipitation zone.

The NRCS has not completed a Soil Survey for Hot Springs County, and thus it was not possible to create a comprehensive map of ESDs for the watershed area. However, soils information available from the BLM survey in 1979 (**Section 3.2.4**, **Figure 9**, and **Appendix B**), can be used to approximate a site's soil type; it is, however, recommended that soil type for a specific location be field verified prior to selecting an ESD for that location.

Within the two dominant precipitation zones, a total of 32 different ESDs are potentially applicable depending on soil type. Complete descriptions of applicable ESDs can be found at the following website: http://esis.sc.egov.usda.gov/Welcome/pgApprovedSelect.aspx. Given that Loamy (Ly) soils are found over a large portion of the watershed, the two ESDs that likely cover the largest land area include:

1) Site Type: Rangeland
   Site Name: Loamy (Ly) 10" – 14" East
   Site I.D.: R032XY322WY

2) Site Type: Rangeland
   Site Name: Loamy (Ly) 15" -19" Foothills & Mtn. East
   Site I.D.: R043BY322WY

Copies of the complete ESD for these two Site Names are provided in **Appendix D** as examples.

An ESD provides the full range of physiographic and climatic features, influencing water features, representative soil features, plant communities, wildlife interpretations, grazing interpretations, hydrology functions, recreational uses and other information relevant to the site type. The NRCS office in Thermopolis is a good resource for additional information about ESDs.

3.3.4.5 Range Conditions

In the previous watershed study (SEI 2005), ninety-four (94) upland range points were assessed at "key sites" throughout the watershed. At each site, rangeland health data, vegetation transects, and digital photographs were recorded. The range points were scattered across all types of land ownership (BLM, state, private). As a means of evaluating current range conditions in the watershed and comparing them to those found in the previous study, thirteen (13) of the upland range points from the previous study were visited in the field to inventory range condition and trend.

Before a discussion of currently observed range conditions and trends are provided, it is important that a brief synopsis of the ranching history of the watershed be presented. The following historical accounts and observations come from a variety of sources. The accounts are provided exactly as written, including the spelling and vernacular of the time:

> Cal King in his book "*History of Wildlife in the Big Horn Basin of Wyoming" says that the Kirby Creek drainage is one area where noticeable successional changes have occurred. Dora Belle Harris told King that prior to 1900 in the summer cattle were ranged only in the upper country. Lower Kirby Creek pastures were reserved for winter feed. "At this time there was a considerable amount of grass in this area," King quotes Earl Enderly who stated that the creek was approximately two feet deep and 20 feet wide in the early part of the century. In an interview with Milek, Ed Enderly stated, "In the spring or during a flash flood it was often almost a mile wide." Harris recalled: "They could cross the creek on horseback at almost any location. The creek didn't have the cut banks that it has now." Ester Ann Long Pebbles says that her father, Russell Long, told her that when he was four or five years old, a grown man could step across the creek almost any place up to the head of the creek. When she was small, she would play in the creek right below their ranch. As she said, the water depth varied, of course, depending on the weather and the season. Some years it dried up completely and other years it flowed a fairly good head all year.*
>
> *By 1915, at the Loyd Walker place, according to Dick Walker as told to King, the creek had already started to erode, for it was approximately four feet deep and twenty feet wide. Drought hit Hot Springs County in 1919, followed by a hard winter. Walker noted that floods were common along Kirby Creek after that. Cloudbursts hit the region the summer of 1923. Severe flooding washed out railroad tracks, bridges and roads. Thermopolis was inundated. Cattle were drowned and crops were ruined. Rex Barclay, in a letter to King, stated that most of Kirby Creek was flooded. He believed that the walls of flood waters were high enough to gather brush and push it ahead of the water scouring the channel, and cutting deep gullies in it. Individual spots began to erode. Royal Corley in 2001 recalled that the creek started to wash real bad in 1923. This was a contributing factor in the failure of his father's sheep endeavor-they couldn't raise the wild hay crop after the creek washed out. On the Allard place, where he worked for a time, Dick Walker said a cut was started on the lower end of a hay field around 1935 and by the 1990s it was fourteen feet deep.*
>
> *Pebbles stated that a flood came down out of the country to the north in the 1950s, flooded out Bunch's and continued the damage to Kirby Creek. According to Charles H. Hembree, in a*

geological survey report, the fall in Kirby Creek was thirteen feet per mile in 1950. In the spring of 1978, Pebbles said, the water was running so high it was going over the bridge on the Black Mountain secondary and Mary Skelton Ready remarked that it had been over fifty years since the last big flooding.

Mrs. Harris felt the vegetation began to deteriorate after that disastrous 1919 year and Dick Walker agreed. Despite good original grass, the soil was fragile with little humus in its makeup. The deterioration on Kirby Creek was a dominoe-type of change. Massive numbers of sheep came in around 1910, leading to overgrazing. Root systems of grasses were damaged through overgrazing and trampling which lead to erosion from gully washers and flooding. Increaser and invader plants took over. Sagebrush increased, and blue bunch wheatgrass, the dominant climax grass, was replaced with thickspike wheatgrass. Sagebrush and Downy bromegrass infested the sheepgrounds. Other invader plants, such as blue gramma, plains pricklypear, and annual forbs increased. Esther Pebbles notes that there is a lot more greasewood on the creek than when she was little.

Erosion can be attributed to the soil itself as shown by the deep soap holes noted by Bob Milek, Jr. along the west side of East Kirby below Ackles Fork.

Herbert G. Fisser wrote in 1964 in a University of Wyoming range condition study:

The greasewood-dominated bottomlands of Kirby Creek are in poor to very poor condition. Annual weeds are abundant. Perennial forage species are present but sparse. Livestock concentration in the bottoms utilizes all available forage while moving to watering areas. The possibility of rehabilitation seems limited, however, because stock must be watered and because site characteristics are natural and rigid.

The low uplands, north of Kirby Creek, are in poor to fair condition. On the sagebrush-grass type, shrub is often excessive. Decreaser species are limited, and increasers and invaders are abundant. The saltbush type is often composed of less than five percent saltbush cover, although soils are relatively sandy and permeable. Some of the higher rangelands in the area of Zimmerman Butte and Cedar Mountain are in good condition. Lack of stockwater has apparently limited the intensity and period of utilization.

South of Kirby Creek conditions generally improve from poor to good with distance from the bottomland area. A few sites of high-good condition are found in areas limited to stock movement, as in Red Hole. Some increase in natural potential must be attributed to the elevational increase……

Sheep bedgrounds and areas adjacent to stockwater developments are generally in very poor condition. Much damage could be prevented by moving sheep to new bedgrounds more frequently.

The damage escalated. King tells that during the winter of 1979 "livestock on Kirby Creek stripped the greasewood, sagebrush and yucca. Approximately 500 head of cattle died in this area."

All of this happened in the bottomlands of Kirby Creek which were once lush with grass. Enderly told king, "Kirby Creek used to be good meadow land…..Charlie Jenks grew alfalfa, grain and potatoes in the area." Harris said that bluestem hay was put up on the Corley and Jens places;

and Cochran said that these fields produced flourishing stand of hay up until 1923. Enderly mentions the ditches that were built to irrigate hay fields. Royal Corley in 2001 remembered these fields and added that Andrew Larson raised over a ton of blue joint one year. By 1964 large spots in these sites were covered with sagebrush. Walker told King that bluestem grass was cut and stacked on the Loyd Walker place in 1915. As late as 1935 bluestem was harvested on the Allard homestead. Today cheat grass covers those sites. The Longs irrigated directly out of Kirby Creek. The flat area where the Charles Russell house stood had high hay which was cut into the 1940s. Pebbles remembers walking through it up to her waist when she would take lunch to the hay crews.

In 1904 the Thermopolis Record reported that there were several bunches of wild horses ranging between Kirby Creek and Nowood. "They are a constant annoyance to those who range their horses in that locality." Kirby Creek men, Vince Hayes, Tom Walsh, Frank Ber, their neighbor Frank James and others, decided to "raid" them, with relays of riders. Located at the head of Nowater the horses scattered in all directions and so did the riders. "The chase became the most exciting free-for-all that the range riders have experienced for many years." James corralled a bunch at Picard's winter camp. They broke down the fence and got away. The race lasted two days and three nights and took the riders over a hundred miles through rough country, wearing down their horses.

Tom Sanford was a rancher who ran lots of horses in the Kirby Creek country along with his partner, Arley Hart. They got into the business during the Depression. His biggest market was in the south where sharecroppers used the horses for farm work. Later Sanford went into the sheep business and at one time owned 70,000 acres and leased another 30,000, running in the Copper/Lysite Mountain area and on Owl Creek. His son Norma n still runs livestock in the area. Another Owl Creek rancher who has picked up- rangeland in the eastern part of the county in the later years is Matt Brown. His family was associated with the Embar Ranch.

Horses are tough on rangeland and those large herds had to be part of the deterioration of the Kirby Creek country.

No doubt recent studies have brought more light to the subject, but it appears that the soil itself is so fragile in the Kirby Creek area that any damage sustained will take a massive effort to reclaim the land. Work in this field has been done on the large bentonite claims to the south of Kirby Creek. New vegetative cover must satisfy many needs.

In winter big sage is high in protein, has a high moisture content and can carry on photosynthesis at freezing and below freezing temperatures. These features plus a low crude fiber make it a highly desirable browse plant on winter ranges. Since winter range controls the entire management of both wildlife and livestock, Kings says, "…. It is vitally important that sufficient-quantities of sagebrush be reserved especially for use in critical winter areas."

2009-2010 Findings:

Thirteen (13) rangeland sites in the Kirby Creek watershed were inventoried to determine condition and trend information (**Figure E.1, Appendix E**). The Ecological Site Descriptions (NRCS 2005-08) were used to update the range condition information. The sites were chosen at random and covered both the 10 - 14", and 15" - 19" precipitation zones. Soil texture and characteristics varied from loamy-clayey-saline and shallow sites. A copy of the range site inventory and condition for each point is included in **Appendix E**. Each write up includes the Historic Climax Plant Community (HCPC) for the site. The worksheets reflect the current status of each site and provide recommendations for future management.

Soil surface texture at the sites visited by PBS&J was compared to textures recorded in the previous watershed study (SEI 2005) as well as available soils data from BLM (1979). As shown in **Table 3.16**, most sites are similar in texture, however some variation is observed. This may be due to the highly non-homogenous nature of soils occurrence on the landscape. Typically, soils can be grouped based on similar morphological conditions at the landscape scale however, upon close examination, variance is observed at the project scale. An example of this occurs at point 79 where the BLM soil survey classifies the area as rock outcrop, and PBS&J and SEI assessed the soil as loamy. Soils have dominating influence on the type of vegetation community that establishes in an area. Based on PBS&J's soil texture analysis and the precipitation zone in which the point occurs, an ESD is assigned to each point (**Table 3.16**). Complete descriptions for two of the ESDs listed in the table that are most common to the watershed are provided in **Appendix D**.

Table 3.16. Comparison of soil texture classifications at inventoried rangeland sites.

	Soil Surface Texture			
Upland Point No. (SEI 2005)	PBS&J (2010)	SEI (2005)	BLM (1979)	PBS&J ESD No.
7	loamy	clay loam	loam	032XY322WY
43	clayey	sandy loam	loam	032XY304WY
63	shallow loamy	sandy loam	loam	032XY362WY
66	shallow loamy, gravelly	loam	loam	R043BY362WY/308WY
75	loamy	clay loam	clay	032XY322WY
79	loamy	clay loam	rock	032XY322WY
84	loamy	clay loam	loam	032XY322WY
89	loamy	gravelly loam	loam	R043BY322WY
92	shallow loamy	gravelly loam	loam	R043BY362WY
103	loamy	silt loam	loam	R043BY322WY
105	shallow loamy	gravelly loam	clay	R043BY362WY
108	clayey, saline upland	clay loam	loam	032XY304WY/344WY
125	clayey	silty clay	loam	032XY304WY

Most likely, other areas of a ranch or grazing allotment not field surveyed will be of interest to ranch owners and operators. For a general sense of which ESD a piece of land is located in, a ranch operator will first need to determine in which precipitation zone the land occurs. The dominant soil types in the Kirby Creek watershed are loams, with some siltier and clayier varieties, as well. A soils manual should be consulted for guidance on determining local soil textures and classifications. Landowners are also directed to the following website, where detailed information for all of the ESD's that occur in a given precipitation zone (also called a Major Land Resource Area (MLRA) by the NRCS) is provided: http://esis.sc.egov.usda.gov/

In general, range conditions appear to be slowly improving since the mid to late 1990's. This sampling is by no means an indication of the overall range management of the ranches visited. However, these findings should serve as a caution for sites not meeting "HCPC" in 2010.

3.3.5 Oil and Gas Activities

There are a total of 43 oil and gas wells currently active in the watershed (**Table 3.17, Figure 3.18**). Over 80 percent of these active oil and gas wells are located in the Middle Kirby and Lake Creek-Kirby Creek sub-watersheds (**Figure 3.18**).

Table 3.17. Summary of oil and gas wells found in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	No. of Oil Wells		
	Active	**Inactive**	**Total**
Lower Kirby Creek	3	69	72
Middle Kirby Creek	19	81	100
Alkali Creek-Kirby Creek	2	31	33
Lake Creek-Kirby Creek	16	32	48
Upper Kirby Creek	3	42	45
Total	43	255	298

There are five main oil and gas pipelines in the watershed totaling approximately 118 miles in length (**Table 3.18**, **Figure 3.19**); two are gas and three are crude oil and range in size from four inches to 16 inches in diameter (SEI 2005). The owners of the pipelines are Amoco, Colorado Interstate Gas, Express Sponsors, Williston Basin Interstate, and Cenex (SEI 2005). Three pipelines enter the watershed from the east, while two enter from the north. All five pipelines exit the watershed to the south through the upper end of the East Kirby Creek catchment. Based on miles of pipeline, approximately 60 percent of the pipelines in the watershed carry crude oil, and 40 percent carry natural gas.

Table 3.18. Summary of oil and gas pipelines in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	Type	Miles
Lower Kirby Creek	Crude Oil	12.6
Lower Kirby Creek	Natural Gas	7.4
Middle Kirby Creek	Natural Gas	10.3
Middle Kirby Creek	Crude Oil	11.8
Lake Creek-Kirby Creek	Crude Oil	4.2
Lake Creek-Kirby Creek	Natural Gas	3.2
Alkali Creek-Kirby Creek	Crude Oil	2.9
Alkali Creek-Kirby Creek	Natural Gas	2.3
Upper Kirby Creek	Crude Oil	38.5
Upper Kirby Creek	Natural Gas	25.2
Total	Crude Oil	70.0
Total	Natural Gas	48.4
Total	All	118.3

3.3.6 Mining and Mineral Resources

There are 299 mineral leases within the Kirby Creek watershed (Federal Mining Claims, BLM 2009) (**Table 3.19, Figure 3.20**). The majority of these (68 percent) are for clay/bentonite mining in the lower portions of the watershed. Uranium leases are also found in the Upper Kirby Creek sub-watershed. Petroleum mineral leases are relatively minor (1.7 percent) and occur in the Alkali Creek-Kirby Creek and Upper Kirby Creek sub-watersheds.

Table 3.19. Summary of mineral leases found in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	Mine Lease Type	Count
Lower Kirby Creek	Clay, Bentonite	17
Middle Kirby Creek	Clay, Bentonite	41
Lake Creek-Kirby Creek	Clay, Bentonite	37
Alkali Creek-Kirby Creek	Clay, Bentonite	78
Alkali Creek-Kirby Creek	Petroleum	2
Upper Kirby Creek	Clay, Bentonite	31
Upper Kirby Creek	Petroleum	3
Upper Kirby Creek	Uranium	90
Total	--	299

Source: Federal Mining Clams, BLM, 2006

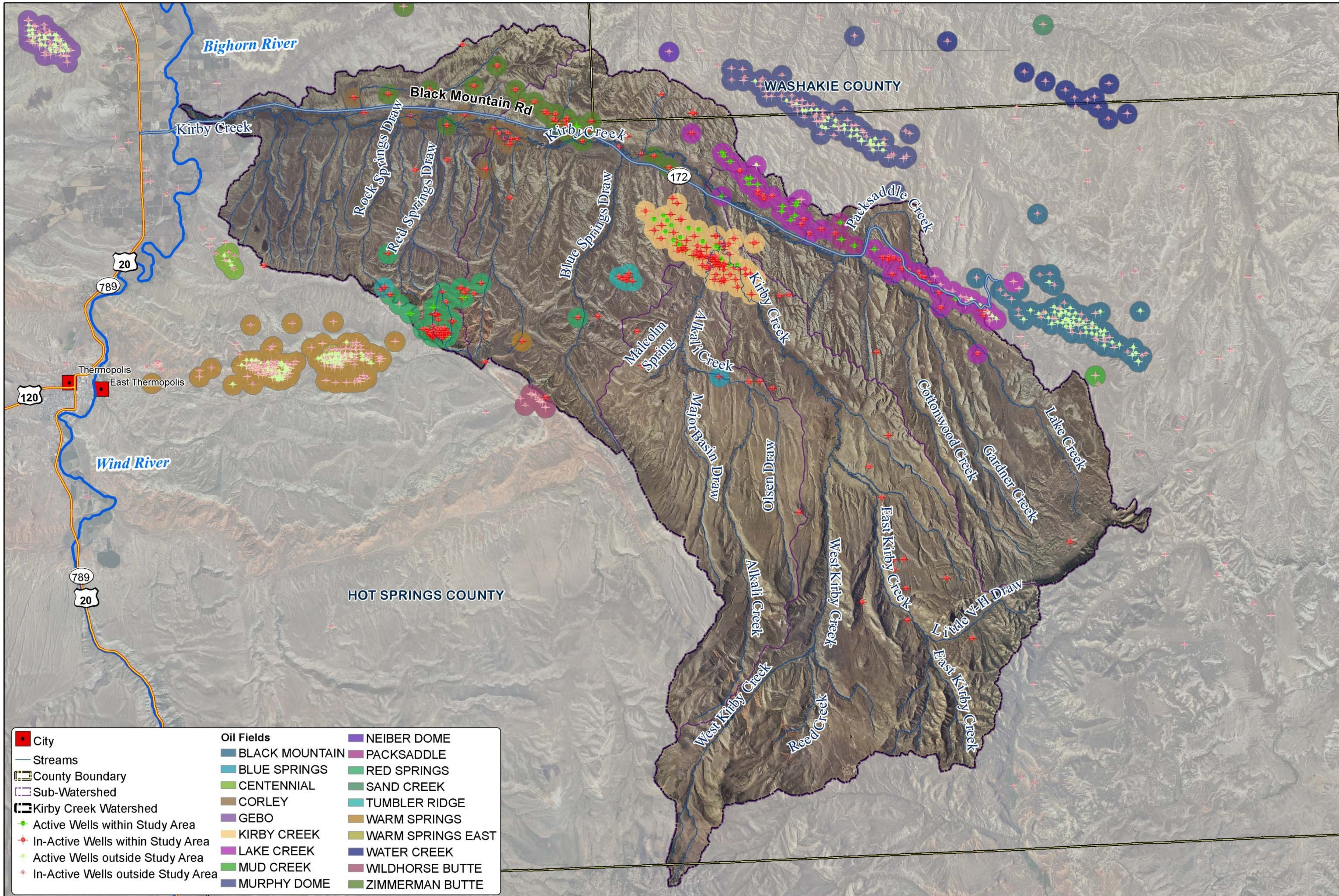

FIGURE TITLE: Oil and Gas Wells

PROJECT MGR: MR

LOCATION: HOT SPRINGS COUNTY, WY

PLOTTED: 07-15-2010

PROJECT NAME: Kirby Creek Watershed Study

PROJ NO: 100008648

FIGURE 3.18

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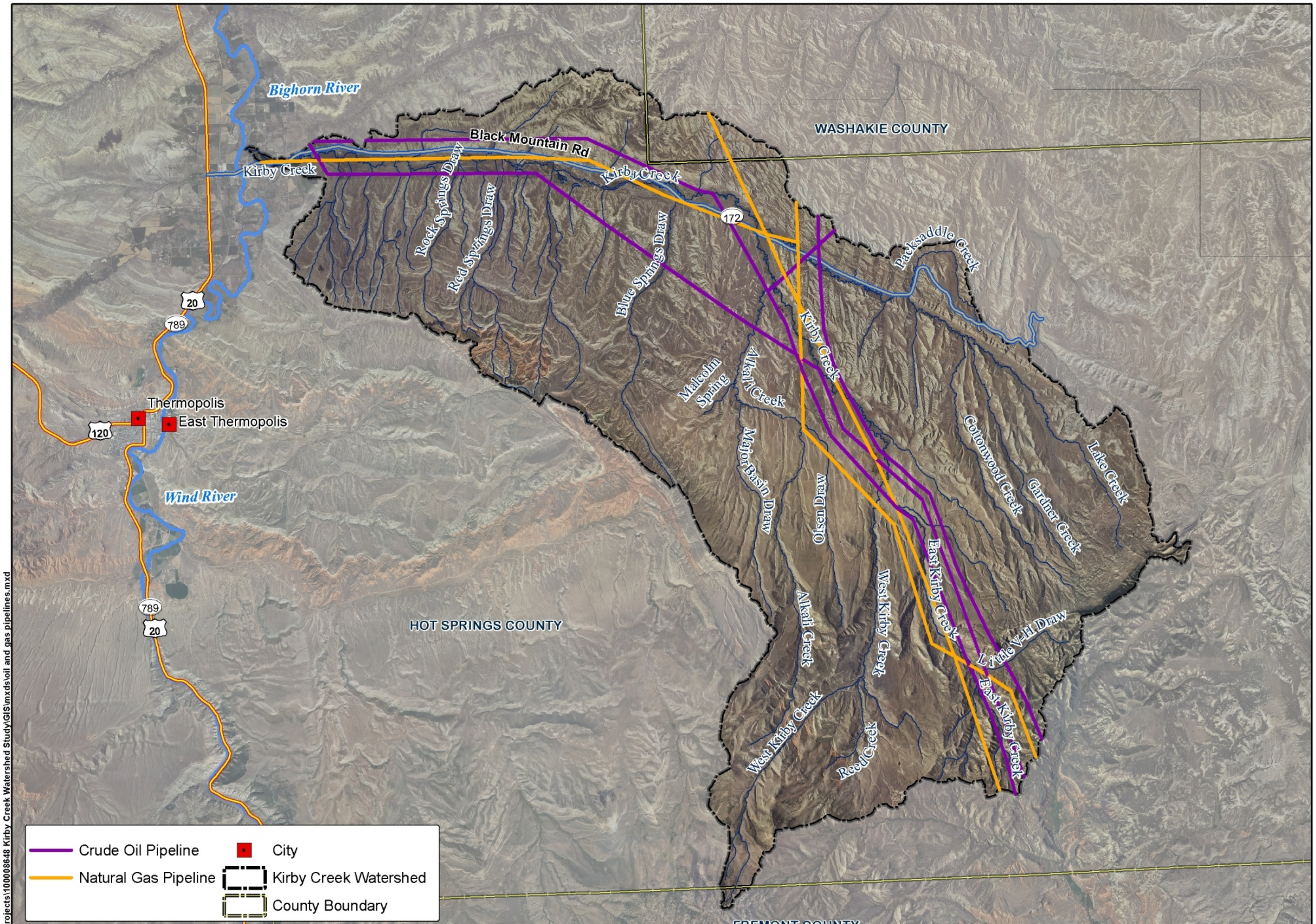

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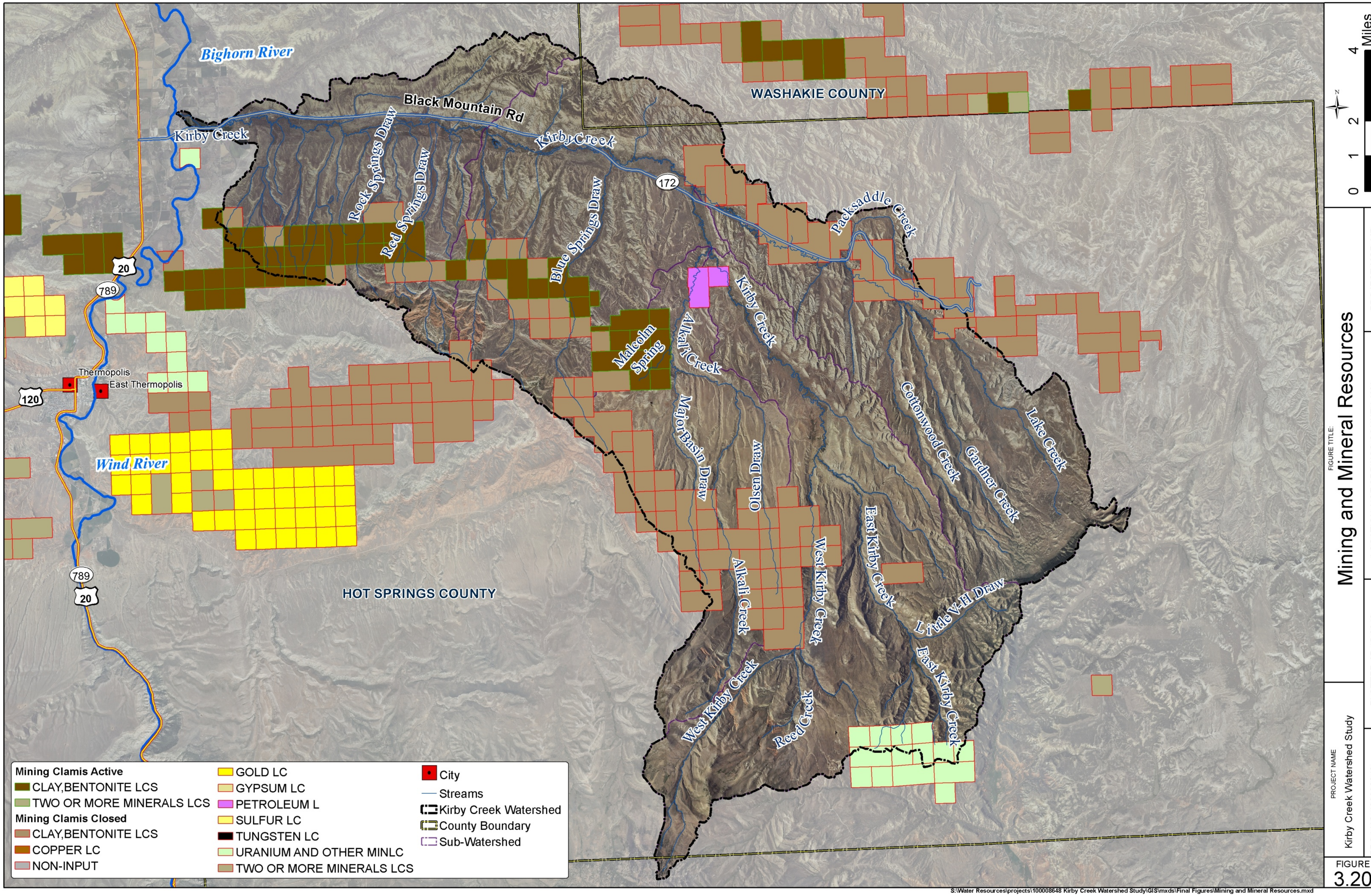
FIGURE 3.19	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Oil and Gas Pipelines		N 0 1.5 3 6 Miles
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*



Bighorn River
Black Mountain Rd
Kirby Creek
Kirby Creek
172
WASHAKIE COUNTY
Rock Springs Draw
Red Springs Draw
Blue Springs Draw
Packsaddle Creek
Kirby Creek
Malcolm Spring
Alkali Creek
Major Basin Draw
Olsen Draw
Cottonwood Creek
Gardner Creek
Lake Creek
East Kirby Creek
Little V-H Draw
West Kirby Creek
Alkali Creek
West Kirby Creek
Reed Creek
East Kirby Creek
Thermopolis
East Thermopolis
Wind River
HOT SPRINGS COUNTY
20
789
120
789
20
0 1 2 4 Miles
Mining Clamis Active
CLAY,BENTONITE LCS
TWO OR MORE MINERALS LCS
Mining Clamis Closed
CLAY,BENTONITE LCS
COPPER LC
NON-INPUT
GOLD LC
GYPSUM LC
PETROLEUM L
SULFUR LC
TUNGSTEN LC
URANIUM AND OTHER MINLC
TWO OR MORE MINERALS LCS
City
Streams
Kirby Creek Watershed
County Boundary
Sub-Watershed
FIGURE TITLE:
Mining and Mineral Resources
PROJECT MGR:MR
LOCATION:HOT SPRINGS COUNTY, WY
PLOTTED:07-15-2010
PROJECT NAME
Kirby Creek Watershed Study
PROJ NO:100008648
FIGURE
3.20
S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\Mining and Mineral Resources.mxd

3.4 WATER RESOURCES

3.4.1 Sub-Watersheds

The Kirby Creek watershed covers approximately 200 square miles in central Wyoming and is located within the Upper Big Horn River Sub-basin. The Kirby Creek watershed is comprised of five 6th level hydrologic unit codes (HUC), which are termed 'sub-watersheds'. These sub-watersheds include: Lower Kirby Creek, Middle Kirby Creek, Upper Kirby Creek, Alkali Creek, and Lake Creek (**Table 3.20**, **Figure 3.21**). East Kirby Creek and West Kirby Creek are located in the Upper Kirby Creek sub-watershed.

Table 3.20. Kirby Creek Sub-watersheds.

Name	HUC ID	Acres	Square Miles
Lower Kirby Creek	100800070505	21,948	34.3
Middle Kirby Creek	100800070504	25,552	39.9
Lake Creek-Kirby Creek	100800070503	25,278	39.5
Alkali Creek-Kirby Creek	100800070502	19,490	30.5
Upper Kirby Creek	100800070501	36,263	56.7

3.4.2 Water Rights

Water rights are an important consideration for any project involving water in the watershed. The Wyoming State Engineer's Office (WYSEO) maintains a comprehensive database of surface water and groundwater rights. This database is available on the internet (http://seo.state.wy.us/wrdb/) and can be searched using a variety of parameters, including stream name, permit number, and legal description, among others.

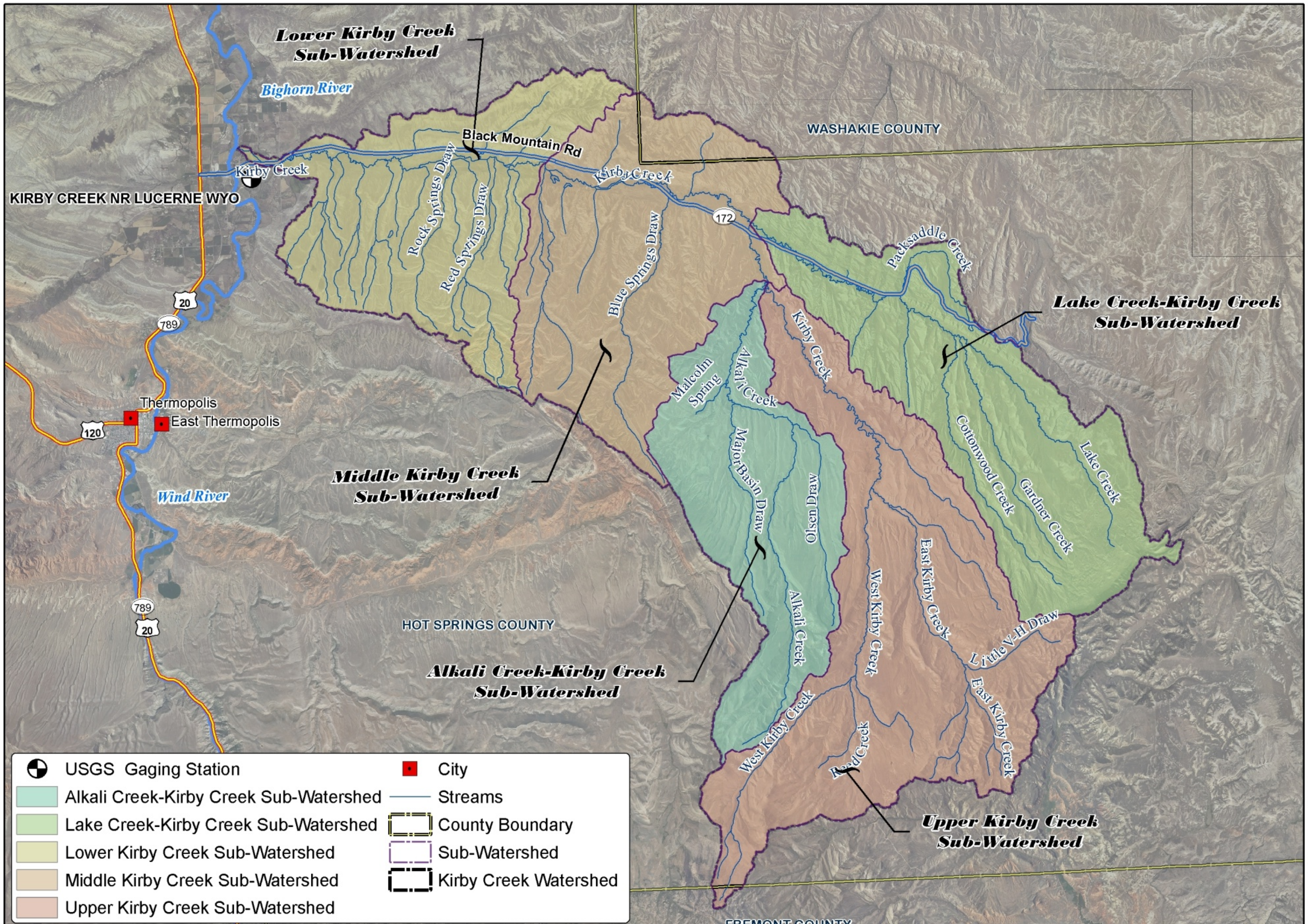


FIGURE 3.21	PROJECT NAME Kirby Creek Watershed Study	FIGURE TITLE: Sub-Watersheds and Stream Networks	
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N

0 1.5 3 6 Miles

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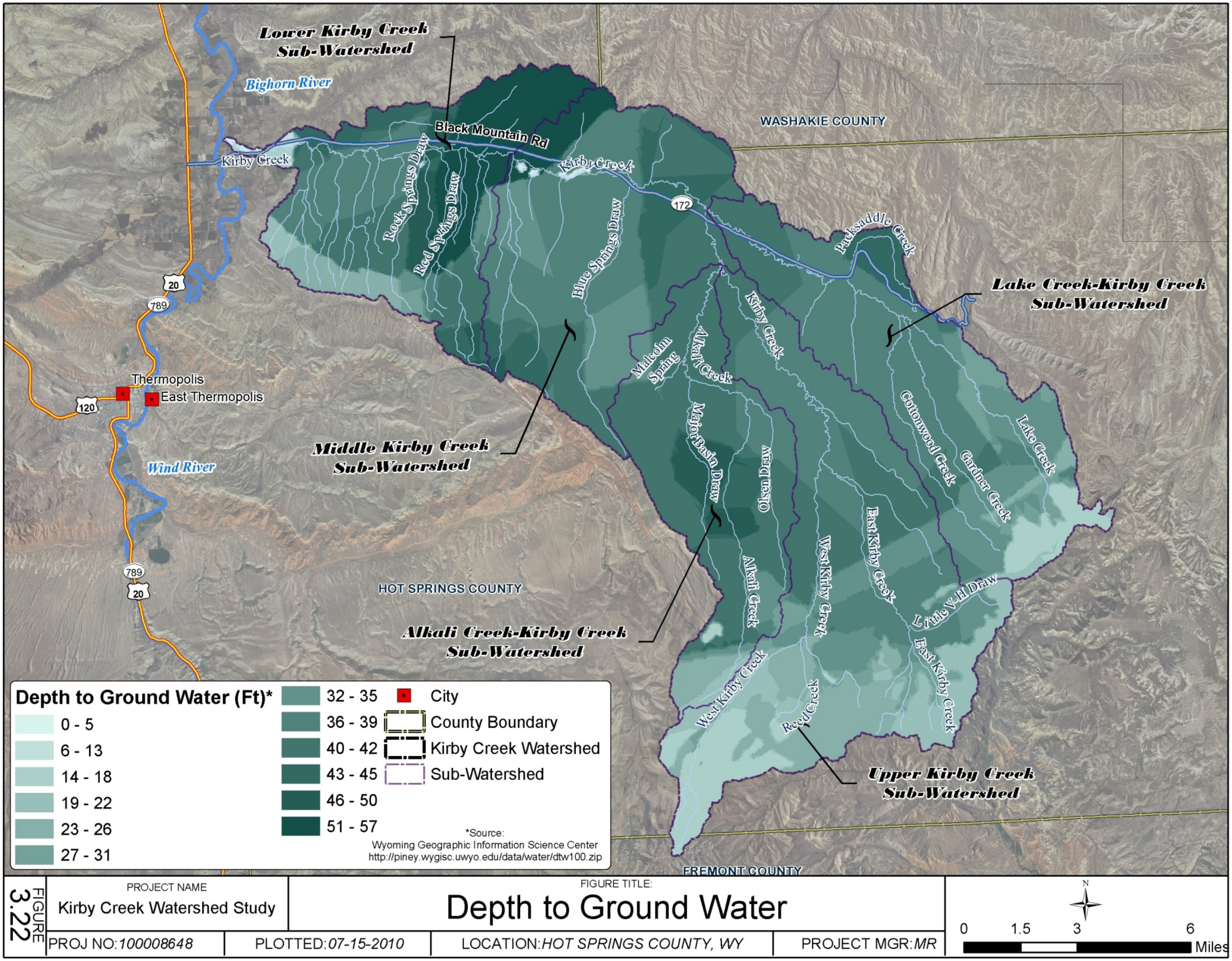
3.4.3 Groundwater Resources

3.4.3.1 Groundwater

The depth to groundwater below the land surface were estimated for the entire state of Wyoming using water well information and a process called "kriging" that interpolates between known points. The age of the data was not considered in the analysis (WYGISC 1997). Despite these limitations, it seems that groundwater depths vary considerably throughout the watershed, ranging from roughly 5 feet to 57 feet below the ground surface (WYGISC 1997). The shallowest depths to groundwater occur in the upper portions of the Upper Kirby Creek and Lake Creek-Kirby Creek sub-watershed and generally increase in depth as one moves down the watershed (**Figure 3.22**) (WYGISC 1997). This conclusion is corroborated by the higher density of springs in the upper portions of these sub-watersheds, when compared to other portions of the watershed. The deepest depths to groundwater occur in the Lower Kirby Creek and Middle Kirby Creek sub-watersheds. Groundwater depths then trend closer to the surface at the western end of the watershed as the influence of the Big Horn River's alluvial aquifer becomes more pronounced (WYGISC 1997).

Groundwater-level changes in response to precipitation are affected by the hydraulic properties of the geologic unit in which the well is completed. Plafcan and Ogle (1994) compared precipitation at the Thermopolis weather station and water-level changes in four wells that were completed in Quaternary alluvium and terrace deposits, the Cody Shale, and the Frontier Formation along Owl Creek. Their comparison indicates that water levels in all four wells fluctuate in response to changes in precipitation (Plafcan and Ogle 1994). Water permeability in Quaternary unconsolidated deposits can be quite high. Conversely, the Frontier Formation's ability to transmit water is several orders of magnitude less than that of the Quaternary unconsolidated deposits. This is because the Frontier Formation is a consolidated geologic unit composed of lenticular fine- to medium-grained sandstone that results in a delayed and subdued response to precipitation. Similarly, the Cody shale formation is not as permeable as Quarternary unconsolidated deposits (Plafcan and Ogle 1994).

Net annual groundwater recharge from natural sources has also been estimated for the state. As one might expect given the amount of precipitation and soil types found in the watershed, the amount of net annual groundwater recharge occurring in the Kirby Creek watershed is extremely limited. Based on their analysis, only a small portion of the upper extent of the Upper Kirby Creek sub-watershed provides groundwater recharge (WYGISC 1998). There is also a portion of the western end of the Lower Kirby Creek sub-watershed that also provides some minimal groundwater recharge. However, overall, there is very little groundwater recharge occurring in the Kirby Creek watershed (WYGISC 1998).


Lower Kirby Creek Sub-Watershed
Bighorn River
Black Mountain Rd
Kirby Creek
WASHAKIE COUNTY
Rock Springs Draw
Red Springs Draw
Blue Springs Draw
172
Packsaddle Creek
Lake Creek-Kirby Creek Sub-Watershed
20
789
Malcolm Spring
Alkali Creek
Kirby Creek
Thermopolis
East Thermopolis
120
Wind River
Middle Kirby Creek Sub-Watershed
Major Basin Draw
Olsen Draw
Cottonwood Creek
Gardner Creek
Lake Creek
789
20
HOT SPRINGS COUNTY
Alkali Creek
West Kirby Creek
East Kirby Creek
Little V-H Draw
Alkali Creek-Kirby Creek Sub-Watershed
West Kirby Creek
Reed Creek
East Kirby Creek
Upper Kirby Creek Sub-Watershed
FREMONT COUNTY
Depth to Ground Water (Ft)*
0 - 5
6 - 13
14 - 18
19 - 22
23 - 26
27 - 31
32 - 35
36 - 39
40 - 42
43 - 45
46 - 50
51 - 57
City
County Boundary
Kirby Creek Watershed
Sub-Watershed
*Source:
Wyoming Geographic Information Science Center
http://piney.wygisc.uwyo.edu/data/water/dtw100.zip
FIGURE 3.22
PROJECT NAME
Kirby Creek Watershed Study
FIGURE TITLE:
Depth to Ground Water
PROJ NO: 100008648
PLOTTED: 07-15-2010
LOCATION: HOT SPRINGS COUNTY, WY
PROJECT MGR: MR
N
0 1.5 3 6
Miles
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3.4.3.2 Springs and Water Wells

According to Plafcan and Ogle (1994) of the wells and springs they inventoried, most commonly originate from Quaternary alluvium, Quaternary terrace deposits, Fort Union and Mesaverde Formations, Cody Shale, and the Frontier and Chugwater Formations. The largest discharges they measured were from the Quaternary terrace deposits (400 gal/min) and the Phosphoria Formation (1,000 gal/min). They found that discharges from other geologic units varied, but most springs and wells originating in these formations yielded less than 50 gal/min (Plafcan and Ogle 1994).

Based on a review of USGS maps and the 2009 aerial photographs, a total of 34 springs occur in the watershed (**Table 3.21**, **Figure 3.23**). No springs were identified in the Lower Kirby Creek sub-watershed. Nearly 74 percent (25) of the springs in the watershed occur in the Lake Creek-Kirby Creek and Upper Kirby Creek sub-watersheds.

Table 3.21. Springs found in the Kirby Creek watershed,
Hot Springs County, WY.

Sub-watershed	No. of Springs
Middle Kirby Creek Sub-Watershed	5
Lake Creek-Kirby Creek Sub-Watershed	9
Alkali Creek-Kirby Creek Sub-Watershed	4
Upper Kirby Creek Sub-Watershed	16
Total	34

Based on information from the WYSEO (2005), there are a total of 94 water wells in the watershed (**Table 3.22, Figure 3.23**). The least number of water wells are found in the Lake Creek-Kirby Creek sub-watershed and the most number of water wells are found in the Upper Kirby Creek sub-watershed.

Table 3.22. Water wells found in the Kirby Creek watershed,
Hot Springs County, WY.

Sub-watershed	No. of wells
Lower Kirby Creek	18
Middle Kirby Creek	20
Lake Creek-Kirby Creek	7
Alkali Creek-Kirby Creek	19
Upper Kirby Creek	30
Total	94

Source: WYSEO 2005

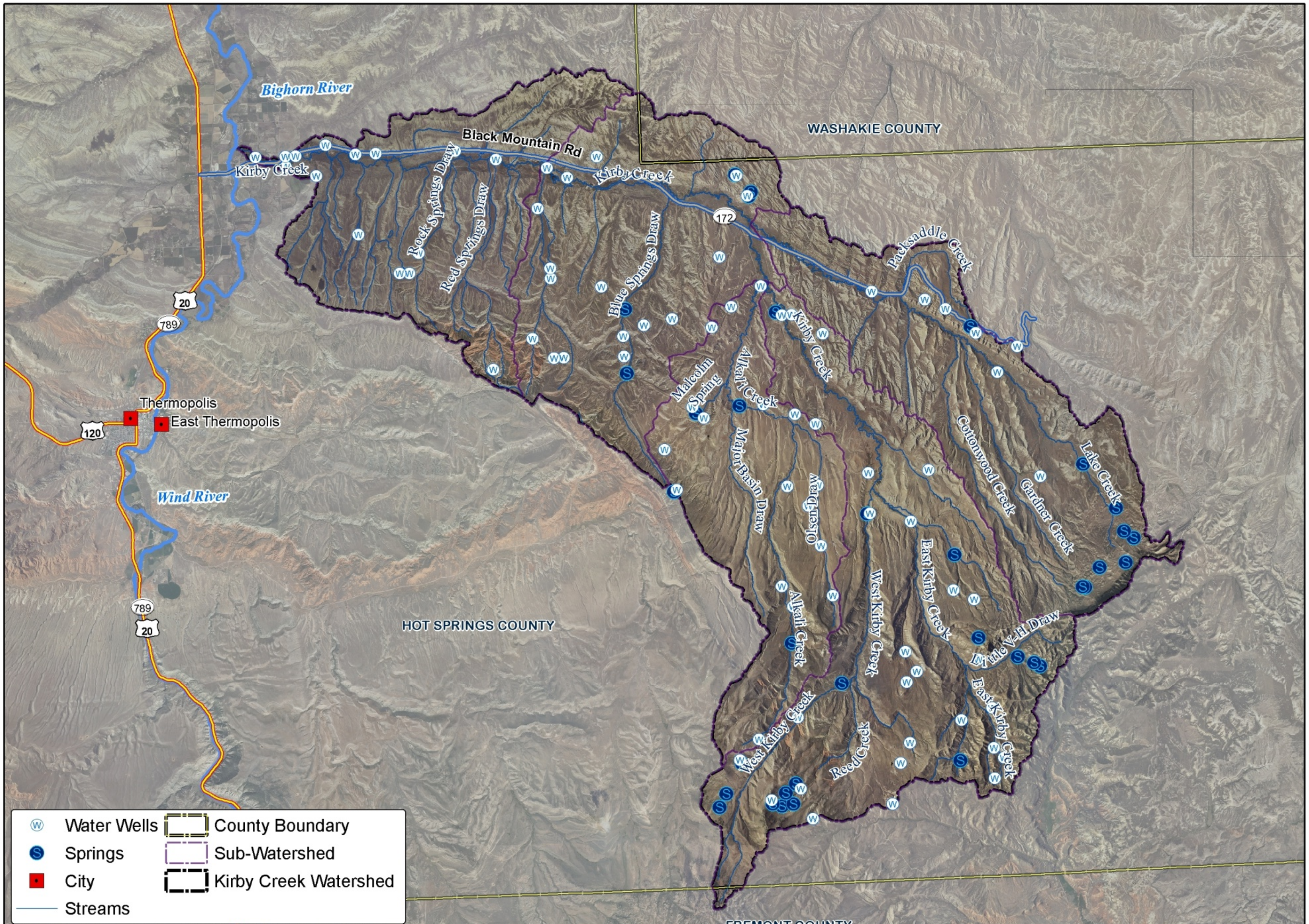

FIGURE 3.23

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE:

Springs and Water Wells

PROJ NO: 100008648 | PLOTTED: 07-15-2010 | LOCATION: HOT SPRINGS COUNTY, WY | PROJECT MGR: MR

N

0 1.5 3 6 Miles

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3.4.3.3 Groundwater Quality

Groundwater quality in the Kirby Creek watershed varies based on the geologic formation it originates as well as varying within these geologic formations. Plafcan and Ogle (1994) collated all available groundwater quality data for Hot Springs County. **Table 3.23** summarizes the groundwater quality information they included from the Kirby Creek watershed. Groundwater is generally alkaline with pH values ranging from 7.2 to 9.3. Specific conductance values indicate that the purest groundwater originates from Paleozoic rock formations in the watershed, such as the Bighorn Dolomite formation. Groundwater temperatures are surprisingly high in the Frontier formation. The Frontier also contains some of the softest water, whereas many of the other formations yield hard to very hard water, with unconsolidated quaternary deposits having some of the hardest water. Sodium concentrations are lowest in the Paleozoic formations and highest in the Mesozoic Frontier formation. Sulfate concentrations are very high in the unconsolidated quaternary deposits and Frontier formations. In fact some wells exceed water quality standards for domestic, agricultural or livestock use. Similarly, total dissolved solids are also high in the Frontier formation; with some wells exceeding water quality standards. Total dissolved iron is higher in Mesozoic formations than in Cenozoic or Paleozoic formations (**Table 3.23**).

Table 3.23. Summary of selected groundwater quality information for the Kirby Creek watershed, Hot Springs County, WY*.

Geologic Era	Geologic Formation	No. of Wells/ Springs	Depths (ft)	Specific Conductance (µS/cm)	pH	Temp. (°C)	Hardness (mg/L $CaCO_3$)	Sodium, dissolved (mg/L)	Sodium Adsorption Ratio	Sulfate, dissolved (mg/L)	Dissolved solids (sum)	Boron, dissolved (mcg/L)	Iron, dissolved (mcg/L)
Cenozoic	Quaternary unconsolidated deposits	1	15	2,080	7.8	11.0	760	160	2	5,800	1,490	20	--
Mesozoic	Frontier	7	254 – 1,490	1,170 – 10,300	8.3 – 9.3	13 – 19.5	3 - 57	340 – 3,400	56 - 200	150 – 5,900	758 – 9,960	30 – 1,400	20 – 100
Mesozoic	Mowry Shale	2	Spring; 150	565 – 1,750	7.2 – 7.9	9.5 – 10.5	75 - 400	89 - 220	4 - 5	120 - 590	362 – 1,150	20 – 370	20 - 310
Mesozoic	Thermopolis Shale and Muddy Sandstone Member of the Thermopolis Shale	4	Spring; 1,240	965 – 1,750	7.4 – 9.1	12.0 – 17.0	2 - 250	120 - 450	3 - 93	180 - 250	599 – 1,100	80 – 1,000	4 – 520
Mesozoic	Chugwater	1	210	1,300	7.5	10.0	450	20	0.4	240	569	100	10
Paleozoic	Bighorn Dolomite	2	Springs	370 - 530	7.7 – 9.0	7.5 – 9.5	210 - 240	1.5 – 2.0	0.1	6 - 7	196 - 237	10	8 – 40

**Source:* Plafcan and Ogle (1994)

Table Notes:

Specific conductance: indicates degree of mineralization. The lower the value, the purer the water.
pH: A pH of 7.0 is neutral, >7.0 is alkaline; <7.0 is acidic.
Hardness: ≤60 mg/L considered soft; 61 – 120 mg/L considered moderately hard; 121 – 180 mg/L considered hard; >180 mg/L considered very hard.
Dissolved sodium: A large sodium concentration may limit the use of water for irrigation.
Dissolved sulfate: ≤250 mg/L for domestic use; ≤200 mg/L for agricultural use; ≤3,000 mg/L for livestock use.
Total dissolved solids: ≤500 mg/L for domestic use; ≤2,000 mg/L for agricultural use; ≤5,000 mg/L for livestock use.
Dissolved boron: ≤750 mcg/L for domestic and agricultural use; ≤5,000 mcg/L for livestock use.
Dissolved iron: ≤300 mcg/L for domestic use; ≤5,000 mcg/L for agricultural use.
Above standards taken from WYDEQ 2005.

3.4.4 Surface Water Resources

3.4.4.1 Stream Network

Within the Kirby Creek watershed, there are approximately 250 miles of stream identified on the 1:100,000 NHD layer. Primary named streams within the Kirby Creek watershed include Kirby Creek, East Kirby Creek, West Kirby Creek, Reed Creek, Alkali Creek, Lake Creek and Blue Springs Draw. There are a total of 16 named streams and draws on the USGS 1:24,000 scale topographic map (**Figure 3.21**).

3.4.4.2 USGS Gage Station Data

There is only one USGS streamflow gaging station in the Kirby Creek watershed and it is inactive. The period of record for USGS gaging station 0626500 (Kirby Creek near Lucerne Wyoming) extends from July of 1941 through September of 1945 (**Figures 3.21** and **3.24**). Over the period of record, mean monthly streamflows tended to be greatest between March and June (**Table 3.24**). Between 1942 and 1945, peak streamflows ranged from 166 cfs in March of 1943 to 570 cfs in March of 1942, with peak streamflows occurring between March and June.

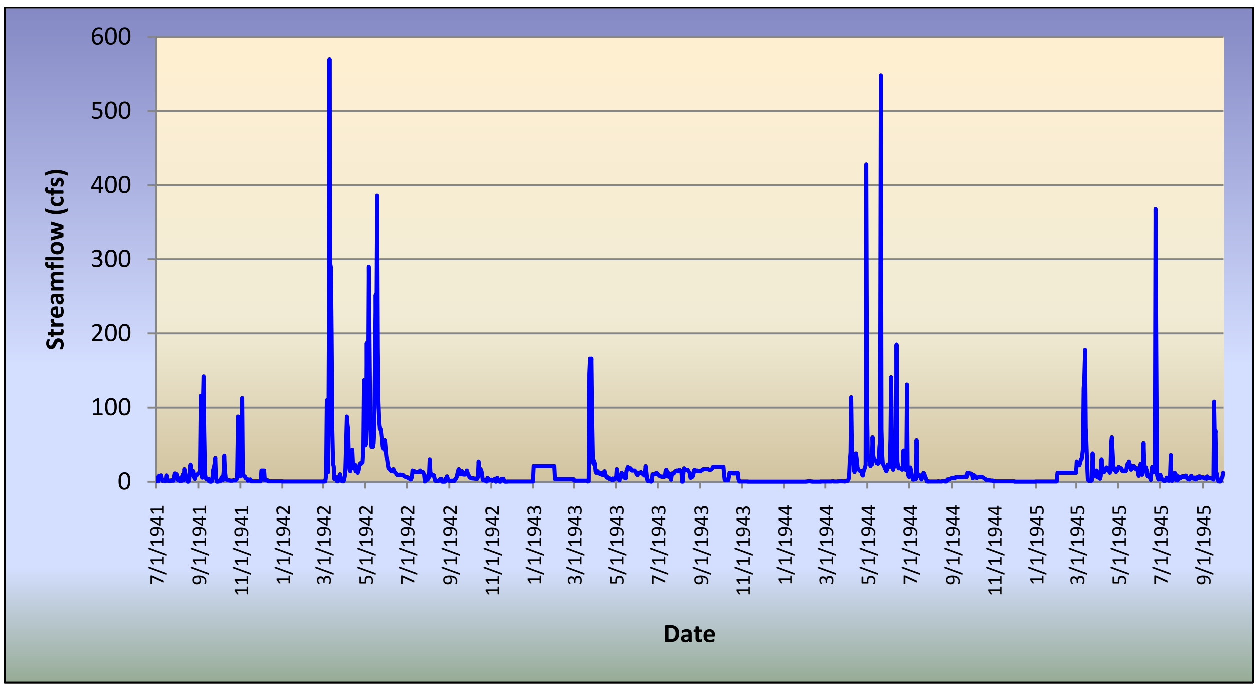

Figure 3.24. USGS Gaging Station 06265000 Mean Daily Streamflow Data, 1941-1945.

Table 3.24. USGS Gaging Station 0626500 Mean Monthly Discharge (cfs).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Discharge	5.4	4.0	30.0	25.0	46.0	22.0	7.3	6.3	13.0	6.8	2.3	0.9

3.4.4.3 Modeled Water Availability

Water availability in the Kirby Creek watershed was estimated as part of the recently completed Draft Wind-Bighorn Basin Plan Update (MWH 2010). Water availability for surface water resources is defined as the amount of water that is physically and legally available for new water uses. Water availability was estimated for dry years, average years, and wet years using measured streamflows where data were available and linear regression techniques using regional equations when streamflow gages had incomplete records (MWH 2010). The 2010 updates to the Wind-Bighorn River Basin Plan spreadsheet model include the addition of streamflow data from 2002 through 2008, which includes several dry years. Over the 1973-2008 study period, the driest 20 percent of the years are considered dry years, the wettest 20 percent are considered wet years, and the middle 60 percent are considered average years (MWH 2010). Over the study period, the 2001-2007 timeframe represents dry years and the 1995-1999 timeframe represents wet years, while the 1973-1994 timeframe was a mix of dry, average and wet years (MWH 2010). Kirby Creek is included in the spreadsheet model for the Upper Bighorn as Reach 410 (MWH 2003). In the 2010 Wind-Bighorn Basin Plan Update, Reach 410 is attributed 7,840 acre feet of available surface water during dry years, 17,982 acre feet during average years, and 31,988 acre feet during wet years (MWH 2010).

3.4.4.4 Potential Streamflow Gage Sites

Since streamflow data for Kirby Creek is relatively old, additional streamflow measurements within the watershed would likely be beneficial for future water development planning. To adequately evaluate water availability in the Kirby Creek watershed the following five sites are recommended for streamflow gaging (**Figure 3.25**):

- Kirby Creek at mouth
- Kirby Creek upstream of Lake Creek
- Lake Creek at mouth
- West Kirby Creek at mouth
- East Kirby Creek at mouth

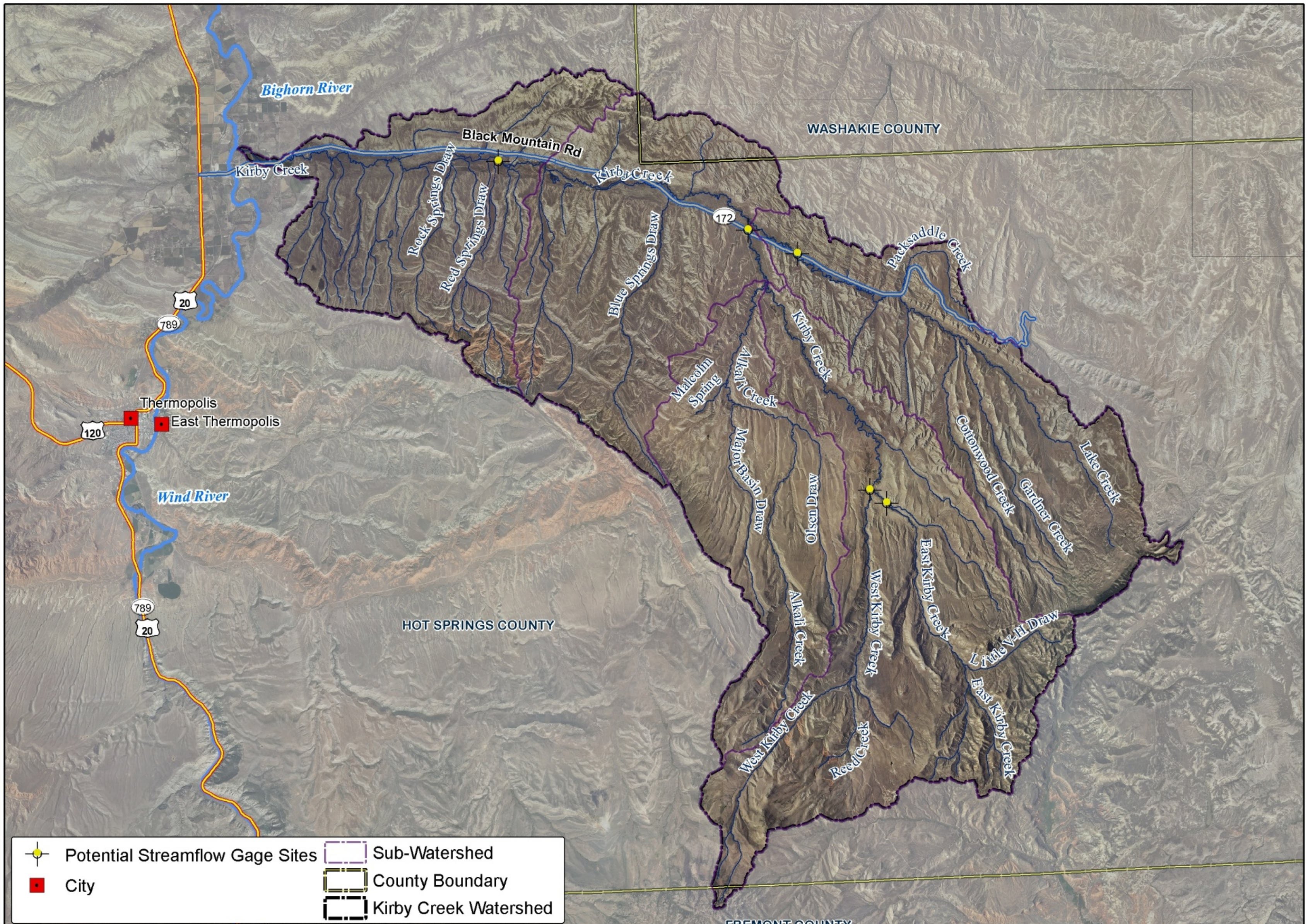

FIGURE 3.25

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: Potential Streamflow Gage Sites

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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3.5 WATER QUALITY

The following is a discussion of surface water quality. Groundwater quality is discussed in section 3.4.3.3.

3.5.1 Stream Classifications

In the Kirby Creek watershed, Kirby Creek, Blue Springs Draw, Lake Creek, Alkali Creek, West Kirby Creek and Hayson Draw are classified on Wyoming's Surface Water Classification List (WDEQ 2001). Lake Creek and West Kirby Creek are classified as 2AB waters, indicating they support all use designations and are designated as a cold water game fishery (**Table 3.25**). Kirby Creek is classified as a 2C water, which indicates it supports all use designations except drinking water and game fish and is designated as a warm water fishery. (**Figure 3.26)** Blue Springs Draw, Alkali Creek, and Hayson Draw are classified as 3B waters, indicating they support all uses except drinking water, game fish, non-game fish and fish consumption. Note that Hayson Draw is included in the Kirby Creek watershed on the Wyoming Surface Water Classification List (WDEQ 2001), though it was not identified in the Kirby Creek watershed during a thorough review of USGS 1:24,000 topographic maps.

Table 3.25. Surface Water Classes and Use Designations.

Surface Water Classes	Use Designations									
	Drinking water	Game Fish	Non-Game Fish	Fish Consumption	Other Aquatic Life	Recreation	Wildlife	Agriculture	Industry	Scenic Value
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes

3.5.2 WYPDES Permitted Discharges

A summary of Wyoming Pollutant Discharge Elimination System (WYPDES) permitted discharge locations was obtained from the Wyoming Department of Environmental Quality. A total of three WYPDES permitted discharges were identified in the Kirby Creek watershed (**Figure 3.27**). All three permits are for oil treaters (**Table 3.26**).

Table 3.26. WYPDES Permitted Discharge Locations.

Permit Number	Permittee	Permit Type	Receiving Water
WY0039217	Endeavor Energy, LLC	Oil Treaters	Kirby Creek (2C) via an unnamed drainage (3B), Big Horn River Basin
WY0002984	Fidelity Exploration and Production Company	Oil Treaters	Lake Creek (2AB), Big Horn River Basin
WY0027308	Carol Holly Oil Corporation	Oil Treaters	Lake Creek (2AB) via Kirby Creek (2C), via Alkali Creek via an unnamed drainage (3B), Big Horn River Basin

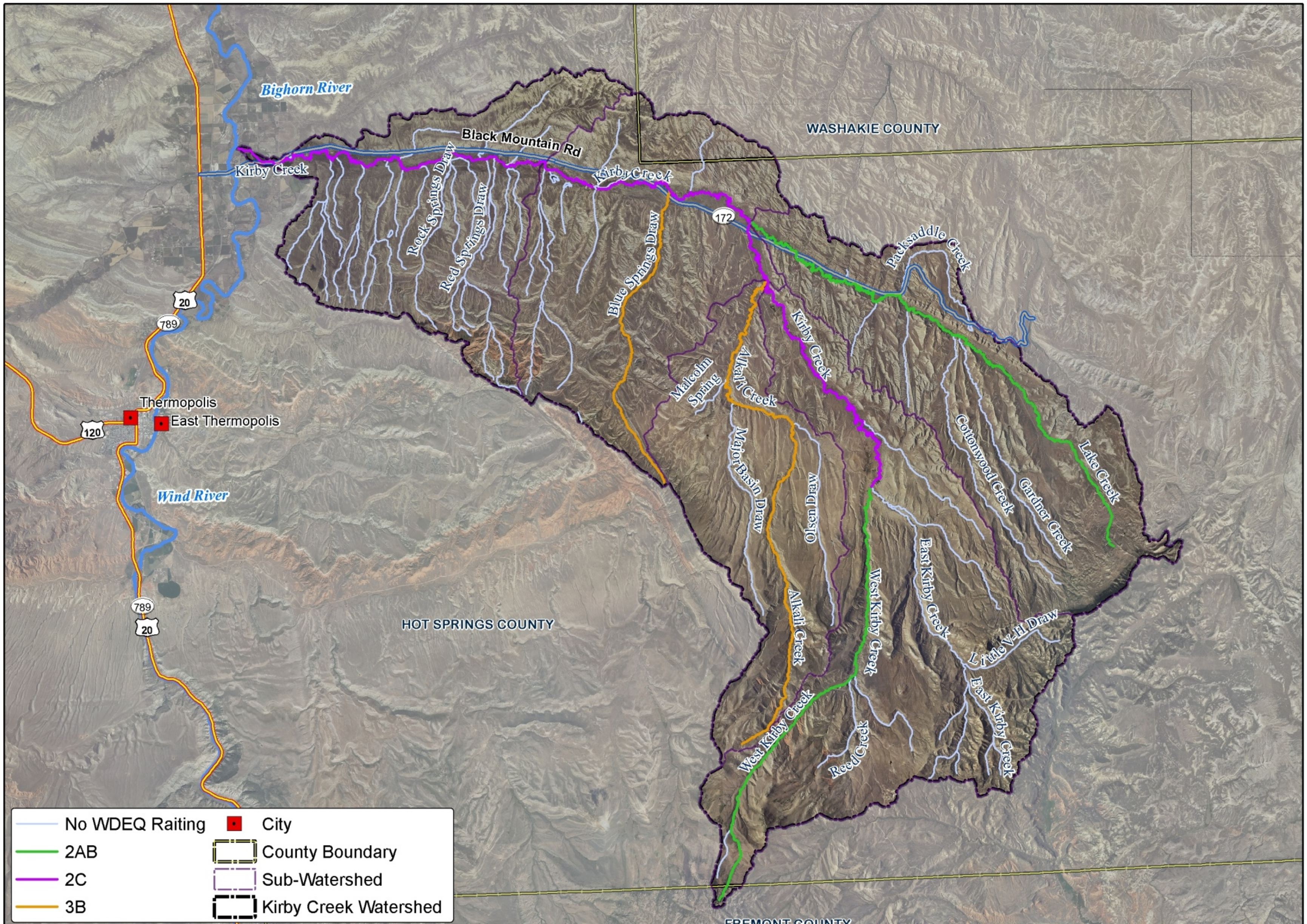

FIGURE 3.26

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: WDEQ Stream Classifications

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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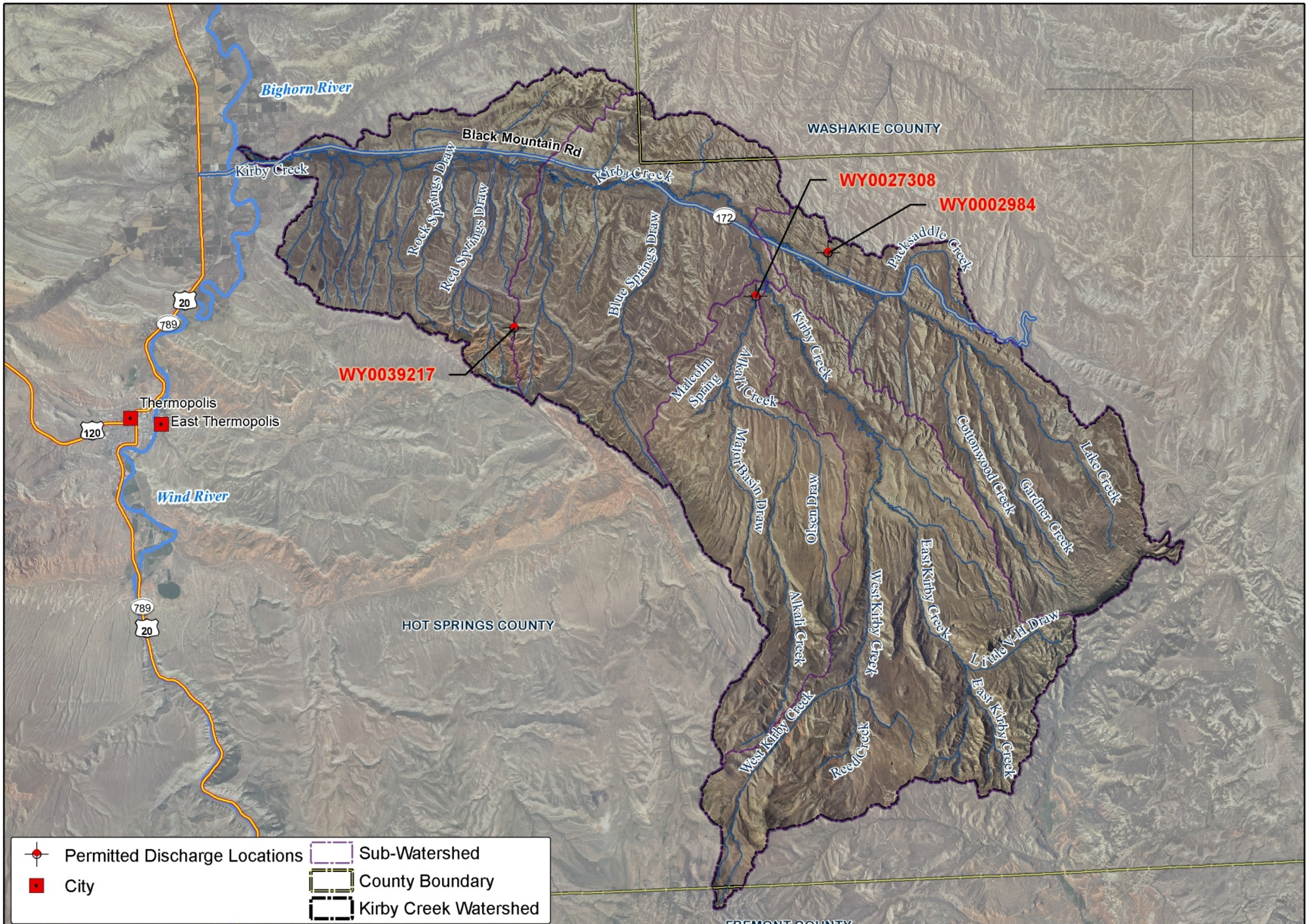

FIGURE 3.27	PROJECT NAME Kirby Creek Watershed Study	FIGURE TITLE: **WYPDES Permitted Discharge Locations**	N 0 1.5 3 6 Miles
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*
			PROJECT MGR: *MR*

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3.5.3 TMDLs

According to Wyoming DEQ's 2010 303(d) list, Kirby Creek is listed as "threatened" in supporting its designated recreation water use due to fecal coliform bacteria (WDEQ 2010). The "threatened" section of Kirby Creek extends from the confluence with the Big Horn River upstream an undetermined distance above the confluence with Lake Creek (WDEQ 2010). The TMDL for fecal coliform impairment listings in Kirby Creek will be developed using Wyoming's recently adopted numeric water quality standards for *E. coli*. The Wyoming standard for *E. coli* specifies that a geometric mean concentration shall not exceed 126 organisms per 100 milliliters between May 1 and September 30 and shall not exceed 630 organisms per 100 milliliters between October 1 and April 30 (**Table 3.27**). The Hot Springs Conservation District (HSCD) has been collecting *E.coli* data in Kirby Creek over the past several years and this data will likely provide the foundation for TMDL development in the Kirby Creek watershed. Note that a Use Attainability Analysis (UAA) for Kirby Creek has recently been completed to reclassify Kirby Creek from primary to secondary contact recreation use. The Wyoming DEQ recently posted a public notice for this proposed change. This re-classification may influence how TMDLs are completed in the Kirby Creek watershed.

Table 3.27. Pathogen Water Quality Standards for Streams in Wyoming.

Applicable Period	**Standard**	**Geometric mean of 5 samples collected over a 30-day time period**	**No more than 10% of the samples shall exceed:**
April 1 - October 31	The geometric mean number of ***E-coli*** may not exceed 126 colony forming units per 100 milliliters and 10% of the total samples may not exceed 252 colony forming units per 100 milliliters during any 30-day period.	<126 cfu/100mL	252 cfu/100mL
November 1 - March 31	The geometric mean number of ***E-coli*** may not exceed 630 colony forming units per 100 milliliters and 10% of the samples may not exceed 1,260 colony forming units per 100 milliliters during any 30-day period.	<630 cfu/100mL	1,260 cfu/100mL

3.6 STREAM GEOMORPHOLOGY

3.6.1 Level I Classification

A Rosgen Level 1 analysis was performed to evaluate stream geomorphology within the Kirby Creek watershed. The previous watershed study (SEI 2005) provided a Rosgen Level 1 classification for the primary streams in the Kirby Creek watershed, including Kirby Creek, West Kirby Creek, East Kirby Creek, Reed Creek, Alkali Creek, and Blue Springs Draw. The Rosgen Level 1 analysis resulted in no adjustments to the previous study's classifications; an assessment of Lake Creek was added since this stream was excluded from the previous study. The Rosgen Level 1 evaluation for Lake Creek involved dividing the stream into reaches with different stream types. The analysis was performed for each reach based primarily on slope and sinuosity measurements performed in GIS, along with observations made using color aerial imagery and on-the-ground reconnaissance. USGS DEM elevation data was used to evaluate stream slope, while the 1:100,000 NHD stream layer was use to measure stream lengths. The following sections review and discuss the stream classification results from the previous study, summarize the results of the Lake Creek analysis, and provide a discussion of geomorphic changes observed at sites where stream restoration projects have recently been completed. Additional information regarding the Rosgen stream classification system is provided in **Appendix F**.

3.6.1.1 Summary of Level I Classification in Previous Watershed Study (2005)

All of Kirby Creek and Blue Springs Draw, along with the lower portions of Alkali Creek, West Kirby Creek, and East Kirby Creek were considered an E stream type in the previous watershed study. The upper portions of Alkali Creek, West Kirby Creek and East Kirby Creek were considered G stream types, while all of Reed Creek was considered a G stream type (**Figure 3.28**). Diagrams of the different Rosgen stream types are shown in **Figure 3.29**. These diagrams show how entrenchment affects the ability of floodwaters to spread out and be stored in the floodplain alluvium. In addition, the greater the entrenchment the more difficult livestock access is to the water source. For example, in some areas of the watershed, severely entrenched reaches are entirely unavailable for livestock watering, prevent access to pasture on the opposite bank, and can pose significant risks by trapping livestock in the channel bottom.

While portions of Kirby Creek are Rosgen E stream types, these sections tend to be in a state of recovery in which a new E type channel has formed within an area that has become entrenched. These reaches no longer have access to the extensive floodplain described as the historical condition in the previous study, though a small floodplain does exist in localized areas (**Figure 3.30**). When overbank flows cannot access the floodplain, Kirby Creek is either a Rosgen F stream type or Rosgen Gc stream type, depending on the width-to-depth ratio (**Figure 3.30**). Rosgen F stream types have a high width-to-depth ratio, while Rosgen Gc stream types have a low width-to-depth ratio. As observed in Kirby Creek, the process of incision generally progresses from an E to Gc to F to E stream type as a stream downcuts, then erodes away its banks, and finally develops a new floodplain at a lower elevation from the original floodplain (Rosgen 1996). Similarly, tributary streams generally classified as Rosgen E and G stream types in the previous study, tend to have a range of stream types within the delineated Rosgen Level 1 stream type.

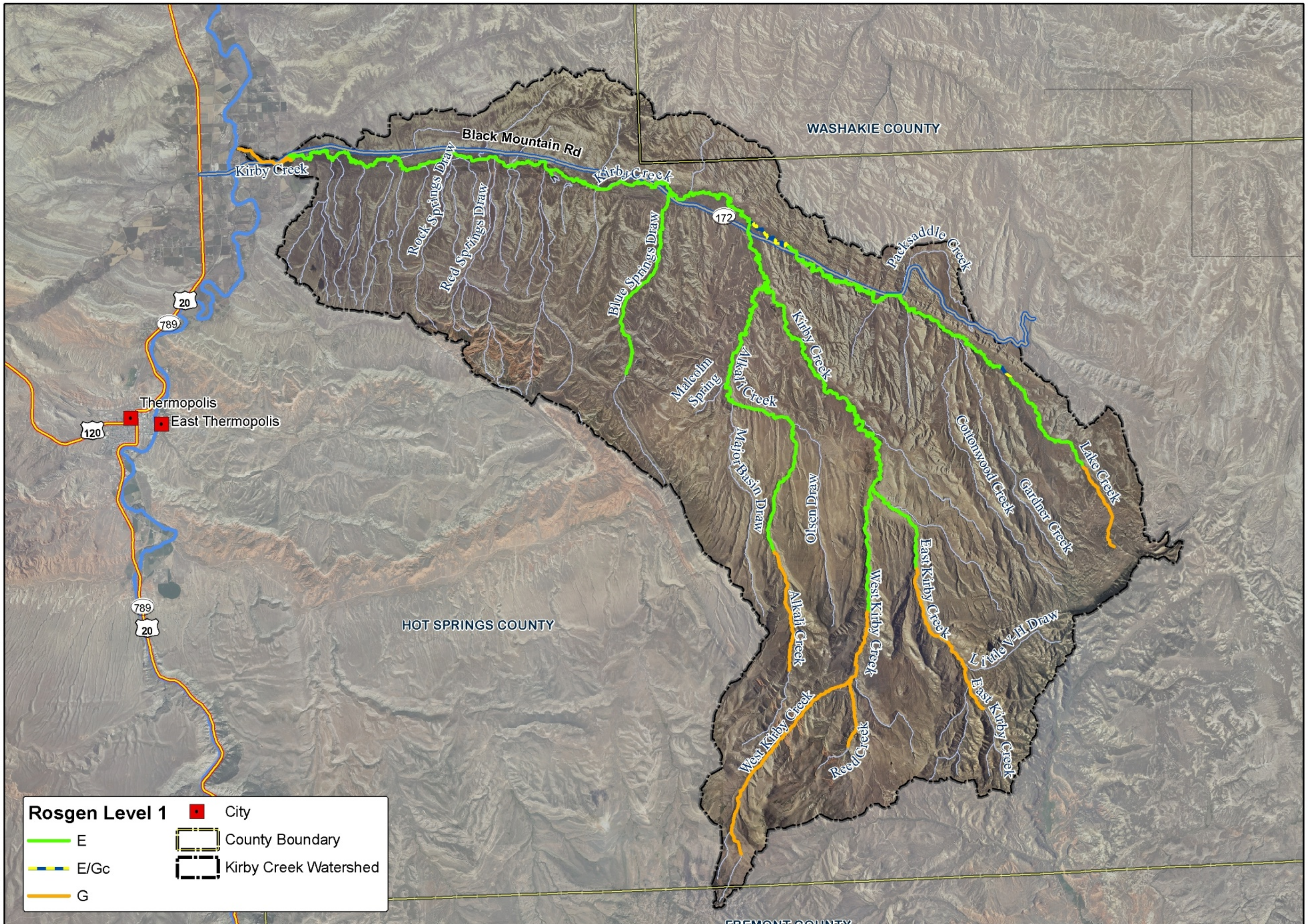

FIGURE 3.28

PROJECT NAME	FIGURE TITLE:	
Kirby Creek Watershed Study	Rosgen Level 1 Classifications	
PROJ NO: *100008648*	PLOTTED: *06-07-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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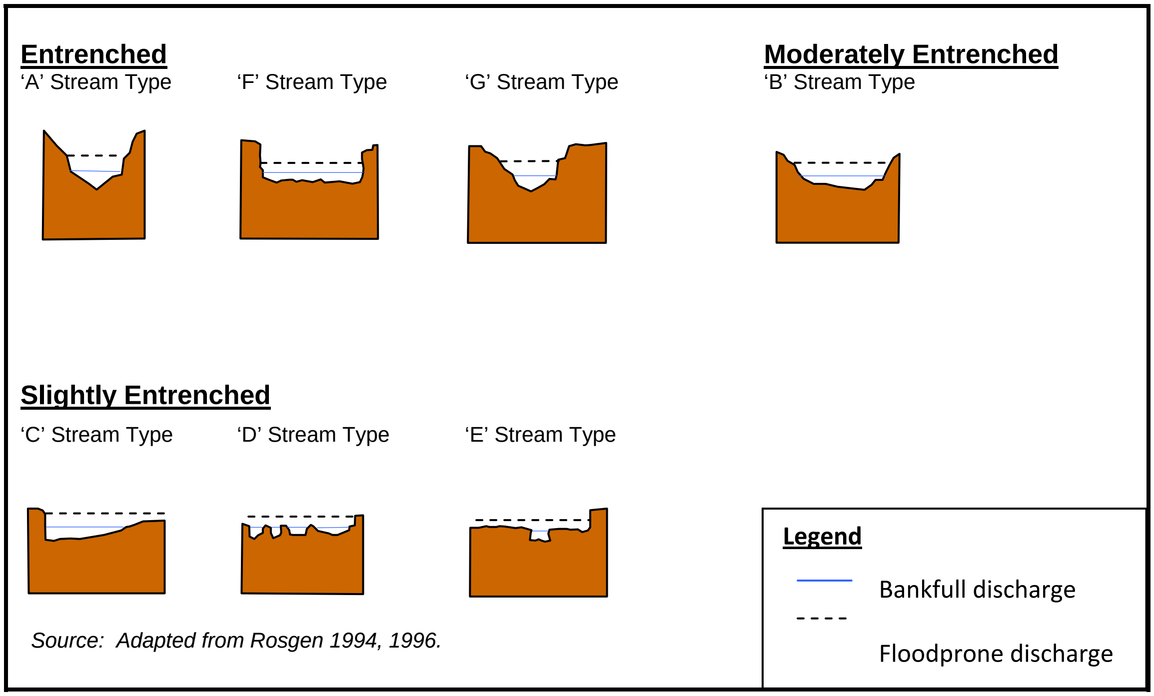
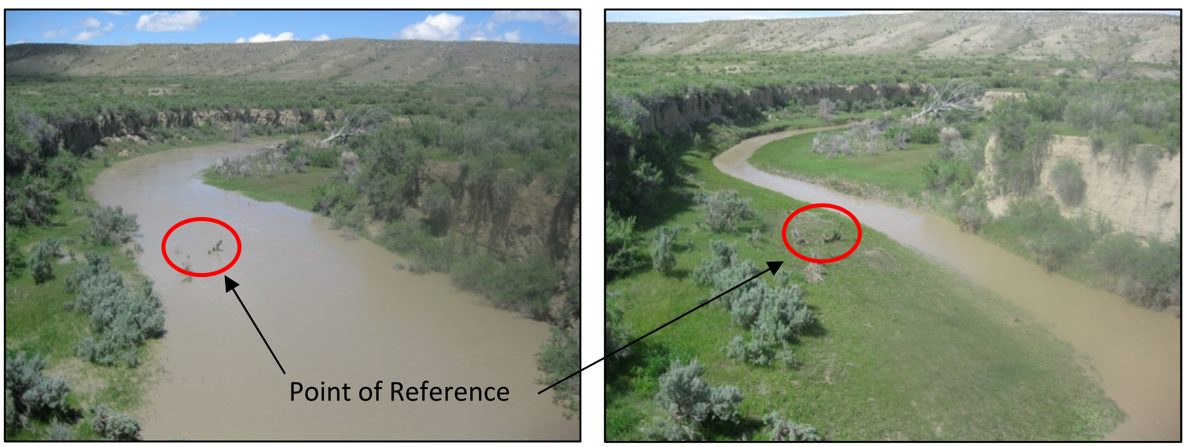


Source: Adapted from Rosgen 1994, 1996.

Figure 3.29. Generalized entrenchment diagrams for different Rosgen stream types.



Rosgen E Channel Type along Kirby Creek upstream of Lake Creek, with overbank flows (left) and bankfull flows (right).

Rosgen Gc Channel Type (left) and F Channel Type (right).

Figure 3.30. Photo examples of different Rosgen stream types within Kirby Creek watershed.

3.6.1.2 Lake Creek

A more detailed assessment of Lake Creek is provided since this stream was excluded from the previous watershed study. During this assessment, reach breaks were assigned in GIS based on Rosgen stream type and valley characteristics as observed in color aerial imagery from 2009 and during field reconnaissance. A reach break was also placed were Lake Creek becomes a second order stream at the confluence with Packsaddle Creek. In addition, Reach LAKE08 was delineated based on field observations of an area where the channel has been excavated to facilitate streamflow under the road. A total of nine reaches were delineated along Lake Creek (**Figure 3.31** and **Table 3.28**). Based on this assessment, Lake Creek follows a similar trend to the other tributary streams within the Kirby Creek watershed, consisting of a G stream type in the headwaters and an E stream type in its lower reaches. Two reaches of Lake Creek were classified E/Gc stream types since they were observed to be somewhat entrenched with little floodplain access and relatively low slopes. **Figures 3.32** and **3.33** are photos of Lake Creek within Reaches 7, 8, and 9.

Table 3.28. Lake Creek Rosgen Level 1 Evaluation.

Reach Number	Reach ID	Sinuosity	slope	Rosgen Stream Type	Comment
1	LAKE01	1.1	5.4%	G	
2	LAKE02	1.1	3.6%	G	
3	LAKE03	1.2	1.9%	E	
4	LAKE04	1.3	1.2%	E	
5	LAKE05	1.2	1.3%	E/Gc	headcut at upstream end of reach
6	LAKE06	1.5	0.8%	E	
7	LAKE07	1.7	0.5%	E	
8	LAKE08	1.4	0.6%	E	stream channel dredged
9	LAKE09	1.4	0.4%	E/Gc	entrenchment observed upstream of Kirby Creek

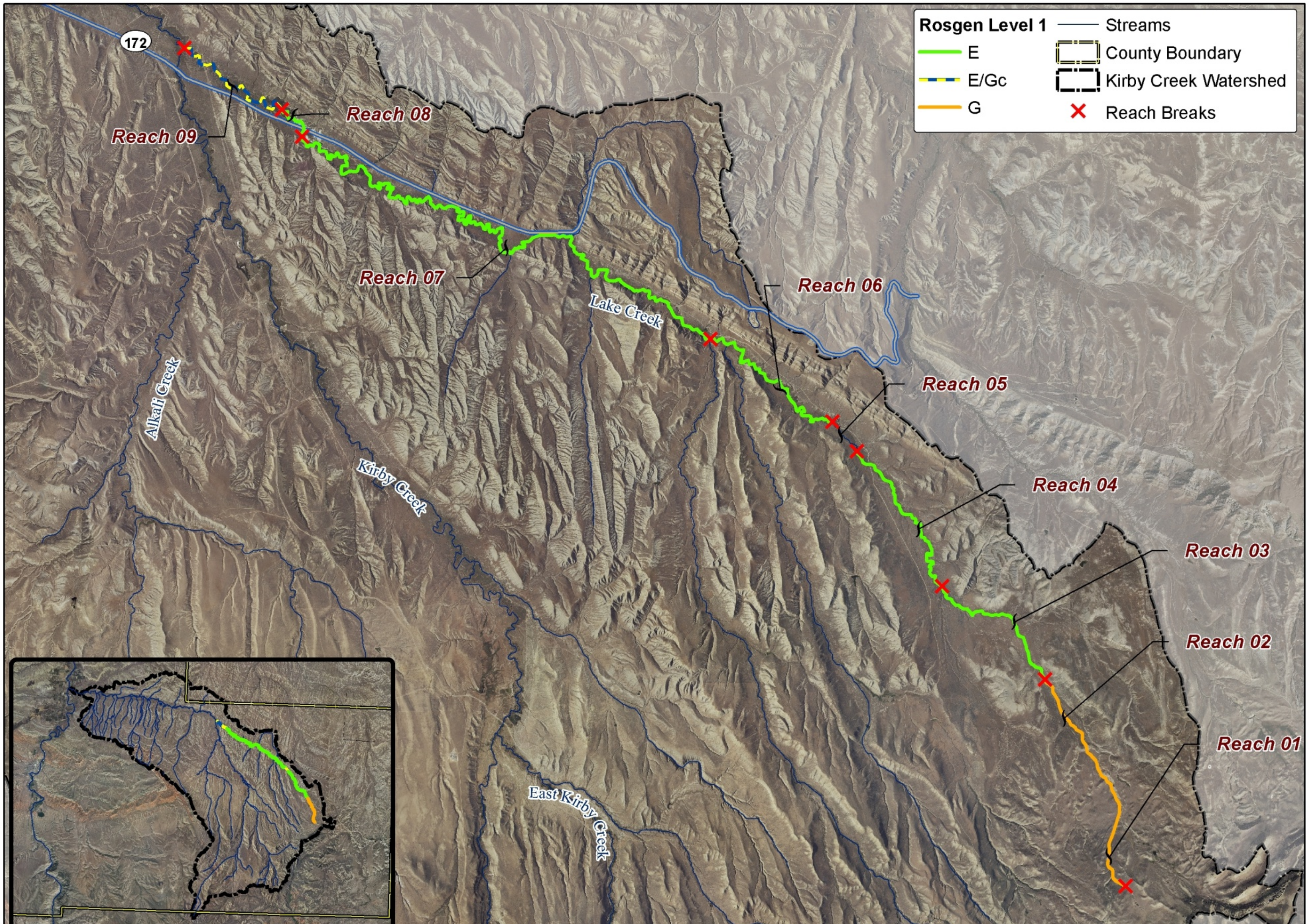


FIGURE 3.31	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Rosgen Level 1 Classifications - Lake Creek		
	PROJ NO: *100008648*	PLOTTED: *06-07-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N

0 0.5 1 2 Miles

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Figure 3.32. Lake Creek in Reach 7 (LAKE07, top left), Reach 8 (LAKE08, top right).

Figure 3.33. Lake Creek in Reach 9 (LAKE09) at the Confluence with Kirby Creek.

3.6.2 Stream Channel Restoration and In-stream Pond Development

Several stream channel restoration and in-stream pond development projects have recently been completed in the Kirby Creek watershed. As mentioned in **Section 3.2.5.2**, increased water storage has been one of the primary goals of these projects. On West Kirby Creek, two stream channel restoration projects were completed: West Kirby Grade Stabilization and Terasen Stream Stabilization. The West Kirby Grade Stabilization project involved adding drop structures to West Kirby Creek. In the Terasen Stream Stabilization project, an entirely new channel was constructed with several drop structures added in an area that had become incised. These two projects highlight the difference in approaches to floodplain reconnection and in an incised channel environment (see **Section 3.2.5.2**).

The West Kirby Creek project was implemented to provide vertical channel stabilization and prevent further channel incision and sediment input to the stream. This was accomplished by constructing a series of rock weirs (total of eight weirs) across the channel to control channel grade and arrest the incision process. Each of the weirs created a 1’ – 2’ drop in the channel profile, resulting in a significantly reduced channel gradient between each weir as compared to the pre-project channel gradient. The reduction in channel gradient between the weirs decreases the erosional power of the stream and promotes a more stable channel profile. Eventually, as the incision process is halted and the channel profile becomes stable, an inset floodplain can become established and stabilized though development of appropriate riparian vegetation (i.e., native grasses and shrubs).

The Terasen Stream Stabilization project is an example of a more complete channel/floodplain restoration project, whereby the channel and its original floodplain are reconnected. This type of project can involve a substantial amount of earthwork depending on the degree of channel incision present. At the location of the Terasen project, the pre-project channel exhibited incision in the range of 8’ – 10’. The restoration project involved connecting the non-incised channel upstream with the incised channel downstream over a distance of roughly 500’. To accomplish this, the incised channel bed was raised (filled) several feet in the upper portion of the project to re-connect with the surrounding floodplain. The raised channel elevation at the upstream end of the project was gradually stepped-down through a series of rock weirs until reaching the incised channel elevation at the downstream end of the project. The end result provides a more fully-functional channel/floodplain relationship (at least in the upstream portion of the project) that can serve a variety of potential needs, including water being more readily accessible for uses such as irrigation and stock/wildlife watering.

On Kirby Creek, the Lucy Moore project was completed in 2006 and involved creating a series of in-stream ponds within the existing channel and restoring flow to a historic channel. Also on Kirby Creek, the Twin Tubes project was completed in 2006 at the site described as the Norman Sanford Reservoir in the previous watershed study (SEI 2005). This project created an in-stream pond, which has been extended upstream through the creation of beaver dams. These projects have decreased channel entrenchment and sediment loading from eroding streambanks, increased floodplain access, created opportunities for expanded riparian areas, improved water sources for wildlife and livestock, and increased water retention within the Kirby Creek watershed.

3.6.2.1 West Kirby Grade Stabilization Project

The West Kirby Grade Stabilization project consisted of adding eight drop structures on West Kirby Creek. Drop structures along West Kirby Creek were designed to improve stream function and floodplain access in an area that was incised, with the project covering approximately 900 feet of stream (**Figure 3.34**). Downstream of the project, the existing channel is a Rosgen G4/B4a stream type, which describes entrenched conditions with little to no floodplain access (**Figures 3.35** and **3.36**). The addition of the drop structures has increased channel width and increased floodplain access, creating a Rosgen E4b/C4b stream type (**Figures 3.37** and **3.38**). In addition to the work on West Kirby Creek, an additional four drop structures were added to a tributary draw entering this reach of stream as part of the Red Cut Sedimentation Abatement project. Drop structures in this draw were added to reduce debris flows, which have repeatedly buried a developed spring at the mouth of the draw with debris. The West Kirby Grade Stabilization project has resulted in decreased channel entrenchment and sediment loading from eroding streambanks, increased floodplain access, and created opportunities for an expanded riparian area. The Red Cut Sedimentation Abatement project has decreased debris flows and reduced impacts to a nearby spring.

Figure 3.34. West Kirby Grade Stabilization Project Overview.

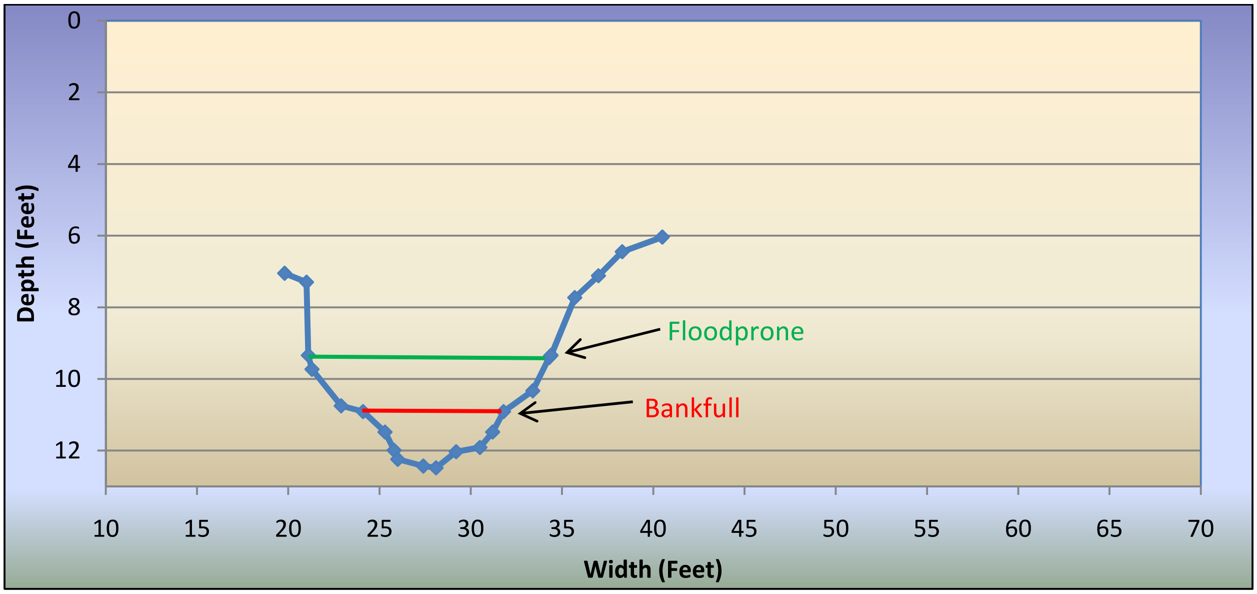


Figure 3.35. West Kirby Grade Stabilization Cross-Section Downstream of Restoration Project.

Figure 3.36. Overview of West Kirby Grade Stabilization Cross-Section Downstream of Restoration Project.

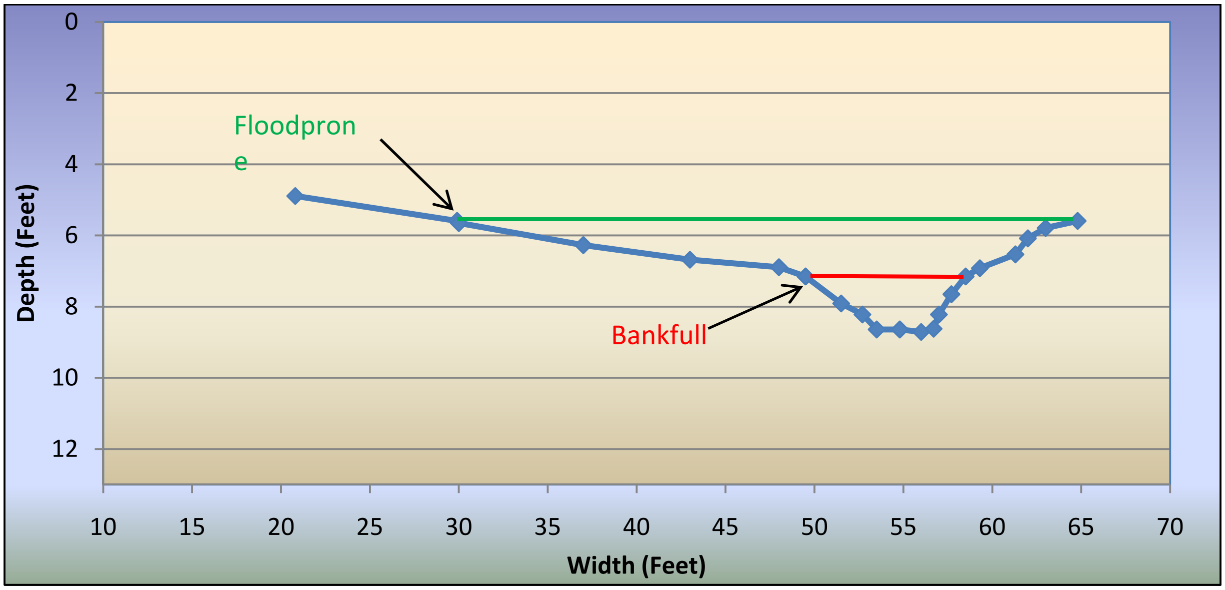


Figure 3.37. West Kirby Grade Stabilization Cross-Section within Restored Channel.

Figure 3.38. Overview of West Kirby Grade Stabilization Cross-Section within Restored Channel.

3.6.2.2 Terasen Stream Stabilization Project

The Terasen Stream Stabilization project on West Kirby Creek involved the addition of six drop structures in a re-constructed channel, extending along approximately 500 feet of stream. The old channel was completely filled in. Drop structures along West Kirby Creek were intended to improve stream function and floodplain access in an area that became entrenched following the installation of a pipeline across the channel (**Figure 3.39**). Downstream of the project area, a historic channel bed was observed at an elevation approximately nine feet higher than the existing channel bed. The stream is still deeply entrenched downstream of the project area, with a Rosgen F4/B4c stream type (**Figures 3.40** and **3.41**). Within the project area, the stream can now access its floodplain and is a Rosgen C4b stream type, with relatively flat pools between each of the drops (**Figures 3.42** and **3.43**). This restoration project has resulted in decreased channel entrenchment and sediment loading from eroding streambanks, increased floodplain access, and created opportunities for an expanded riparian area.

Figure 3.39. Terasen Stream Stabilization Project Overview.

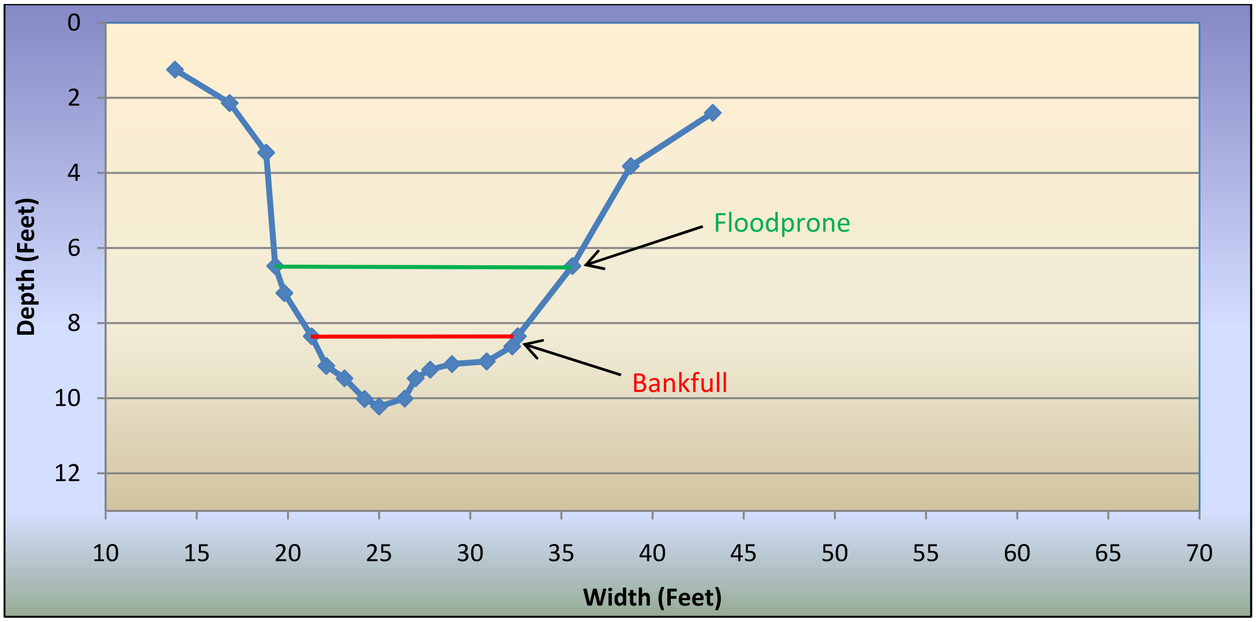


Figure 3.40. Terasen Stream Stabilization Cross-section Downstream of Restoration Project.

Figure 3.41. Overview of Terasen Stream Stabilization Cross-Section Downstream of Restoration Project.

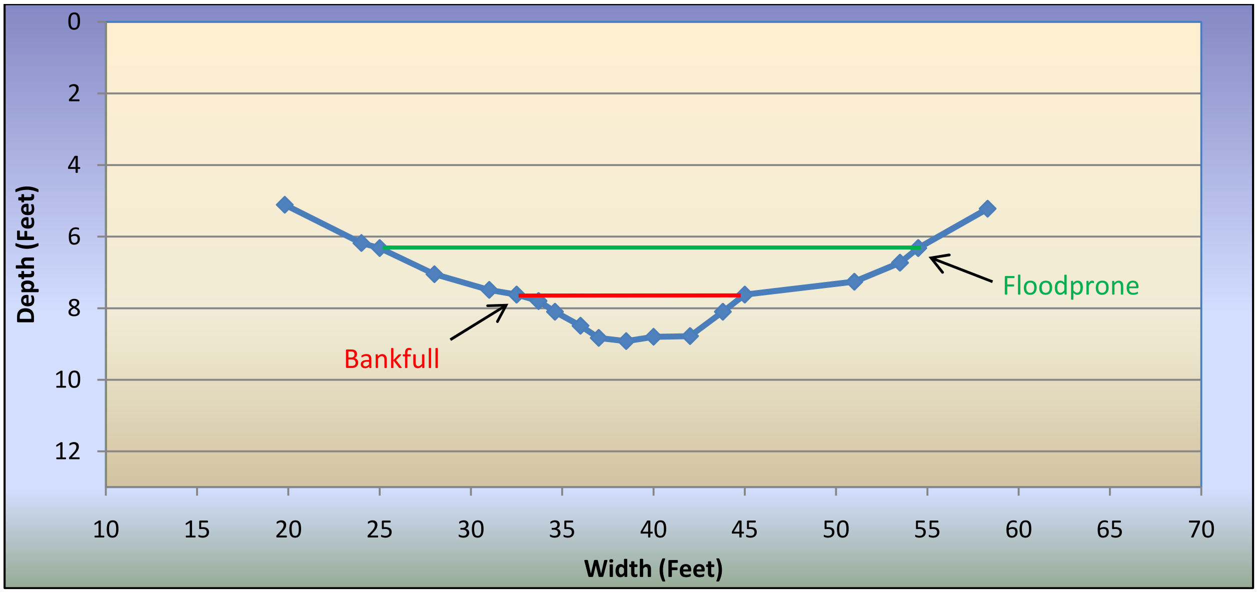


Figure 3.42. Terasen Stream Stabilization Cross-section within Restored Channel.

Figure 3.43. Overview of Terasen Stream Stabilization Cross-Section within Restored Channel.

3.6.2.3 Lucy Moore In-stream Pond Development and Channel Restoration Project

The Lucy Moore project on Kirby Creek consists of three dikes and one primary drop structure. The three dikes were constructed within the existing channel and approximately 1,750 feet of historic channel along the left side of the stream was restored (**Figures 3.44** and **3.45**). The dikes create a series of in-stream ponds along the right side of the stream, with the two flows converging at the downstream end of the project area. Downstream of the project area, the channel is an entrenched stream in a transitional condition that was rated a Rosgen G5c/E5 with very little potential to access the floodplain (**Figures 3.46** and **3.47**). Within the project area, the restored channel was a Rosgen E5 stream type, with a low width/depth ratio and extensive access to the floodplain (**Figures 3.48** and **3.49**). There are some large cottonwoods along this reach, though no new seedlings were observed. There were signs of beavers, with one large cottonwood toppled into the restored channel, though no beaver dams were observed. This restoration project has decreased channel entrenchment and sediment loading from eroding streambanks, increased floodplain access, created opportunities for expanded riparian areas, improved water sources for wildlife and livestock, and increased water retention along Kirby Creek. A common element to this type of restoration project is the resulting grade differential between the existing, degraded channel and the restored channel. At the location where the two channels become confluent, it is often necessary to construct a drop structure to address the difference in channel grades (**Figure 3.50**)

Figure 3.44. Overview of Lucy Moore Project Area.

FIGURE 3.45	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Lucy Moore Project	
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N

0 75 150 300 Feet

S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\Figure 3-X. Lucy Moore In-stream Pond Development and Channel Restoration Project.mxd

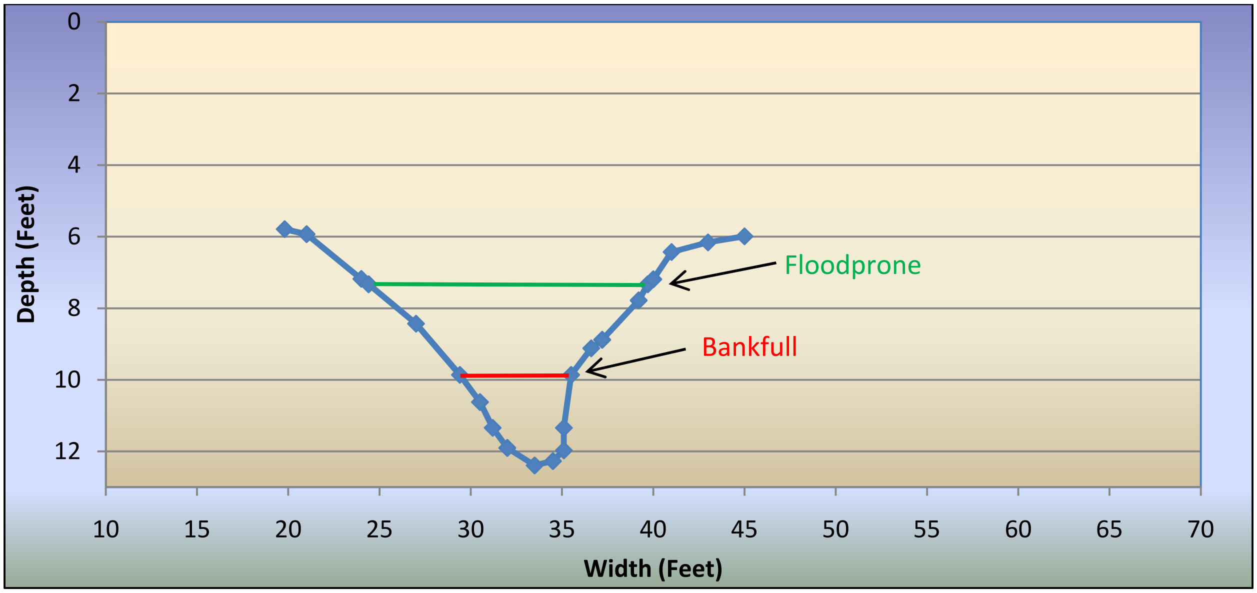


Figure 3.46. Cross-Section Downstream of Lucy Moore Restoration Project.

Figure 3.47. Overview of Cross-Section Downstream of Lucy Moore Restoration Project.

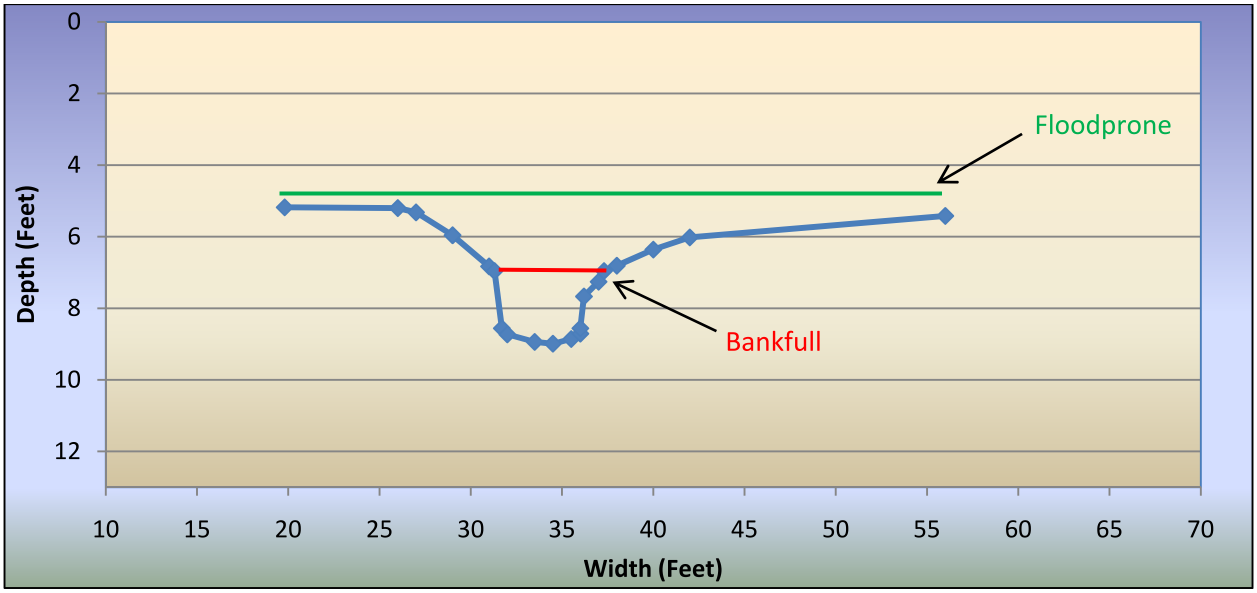


Figure 3.48. Cross-Section within Lucy Moore Restoration Project.

Figure 3.49. Overview of Cross-section within Lucy Moore Restoration Project.

Figure 3.50. Drop structure located at downstream end of Lucy Moore Project.

3.6.2.4 Twin Tubes In-stream Pond Development

The Twin Tubes project on Kirby Creek was completed in 2006. In this project, an existing in-stream pond was re-constructed and the outlet and overflow channel was improved. One large beaver dam has been constructed upstream of this in-stream pond, which increases the amount of channel influenced by this project. A second beaver dam is currently under construction upstream of the first. Considering the influence of the beaver dams, this impoundment backs up water for approximately 1,400 feet and has increased the amount of riparian and wetland vegetation along both sides of the channel. Overflow water from this project feeds the "wildlife ponds", which are located downstream along the left side of the river. Upstream of the ponded area, Kirby Creek contains a small meandering Rosgen E type channel that has a narrow floodplain. This project has increased floodplain access, expanded riparian habitat, improved water sources for wildlife and livestock, and increased water retention along Kirby Creek.

Figure 3.51. Twin Tubes Project Overview.

3.7 IRRIGATION INFRASTRUCTURE

Irrigation diversions and ditch networks within the Kirby Creek watershed were mapped in GIS using color aerial imagery from 2009. Information for existing points of diversion was obtained from the previous watershed study (SEI 2005) which included a total of 13 points of diversion. Each of these points of diversion was reviewed using color aerial imagery from 2009 and the location of the associated ditch was mapped (**Figure 3.52**). In addition, the Irrigation Points of Diversion for Wyoming (at 1:24,000 scale) data layer prepared for the Statewide Framework Water Plan was obtained from the Wyoming Water Development Office (WWDO 2007), though no diversions were identified within the Kirby Creek watershed. Thus, this assessment is primarily based on observed irrigation ditches using aerial imagery supplemented by the GIS irrigation diversion layer from the previous watershed study and on-the-ground reconnaissance. Irrigation diversions and the associated ditch networks were assigned names based on the nearest point of diversion on the irrigation diversion dataset included in the previous study and by information provided from watershed stakeholders.

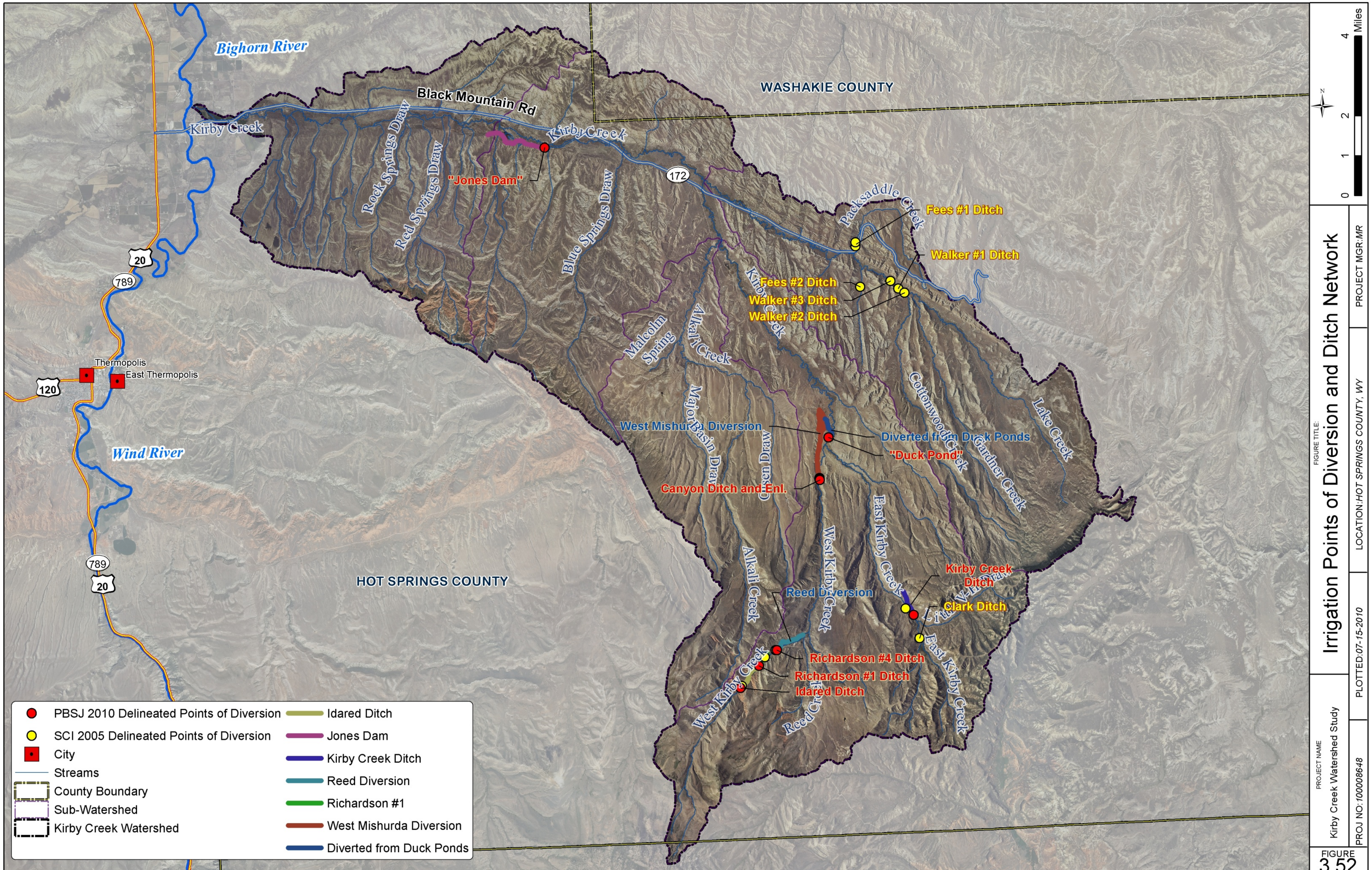
3.7.1 Irrigation Points of Diversion and Ditch Characterization

Out of the 13 irrigation points of diversion identified in the Kirby Creek Watershed Plan (SEI, 2005), five unique ditches were identified in the Kirby Creek watershed including: Kirby Creek Ditch, Idared Ditch, West Mishurda Diversion, Richardson #1 Ditch, and the Reed Diversion. Out of these five ditches, only the West Mishurda Diversion and the Reed Diversion appeared to be actively used for irrigation (**Table 3.29**). No irrigation ditches were observed for the following irrigation diversions identified in the previous study: Clark Ditch, Fees #1 Ditch, Fees #2 Ditch, Walker #1 Ditch, Walker #2 Ditch, or Walker #3 Ditch. Two additional irrigation diversions were also identified through aerial imagery review, resulting in seven total irrigation diversions with associated ditches. Active ditches include the West Mishurda Diversion, the Reed Diversion, the irrigation network associated with the Jones Dam, and the irrigation network associated with the Duck Ponds. The Kirby Creek Ditch, Idared Ditch, and Richardson #1 Ditch all appeared to be inactive and there may be the potential to re-activate portions of these ditches.

Table 3.29. Irrigation Points of Diversion.

Irrigation Diversion	Stream	Comment
West Mishurda Diversion	West Kirby Creek	Also called Canyon Ditch and Enl.*
Reed Diversion	West Kirby Creek	Also called Richardson #4 Ditch*
"Jones Dam"	Kirby Creek	
"Duck Ponds"	Kirby Creek	
Idared Ditch	West Kirby Creek	
Richardson #1 Ditch	West Kirby Creek	
Kirby Creek Ditch	East Kirby Creek	
Fees #1 Ditch	Lake Creek	no ditch observed on aerial imagery
Fees #2 Ditch	Lake Creek	no ditch observed on aerial imagery
Walker #1 Ditch	Lake Creek	no ditch observed on aerial imagery
Walker #2 Ditch	Lake Creek	no ditch observed on aerial imagery
Walker #3 Ditch	Lake Creek	no ditch observed on aerial imagery
Clark Ditch	East Kirby Creek	no ditch observed on aerial imagery

*As identified on the point of diversion GIS layer compiled for the Kirby Creek Watershed Plan (SEI, 2005).



S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\Irrigation Points of Diversion and Ditch Network.mxd

3.7.1.1 Reed Diversion

The Reed Diversion is located along the left bank of West Kirby Creek (**Figure 3.53**). The inlet to this ditch was recently improved through the addition of one drop structure and is currently active. This ditch leads to a series of three stock reservoirs, with a large wetland complex between the second and third reservoirs, before flowing back into West Kirby Creek.

Figure 3.53. Reed Diversion.

3.7.1.2 West Mishurda Diversion

The inlet to the West Mishurda Diversion is near the site of the proposed West Mishurda Diversion Project on West Kirby Creek, which is designed to maintain this point of diversion and arrest the upstream migration of a headcut (**Figure 3.54**). After crossing underneath Kirby Creek Road, this ditch splits into two ditches, with the more westerly branch leading into a pond at the Mishurda residence. Water flows out of this pond at two locations and is used for flood irrigation. This flood irrigation network drains into a wetland area that forms into a small channel leading into Kirby Creek.

Figure 3.54. West Mishurda Diversion.

3.7.1.3 Jones Dam

The Jones Dam on Kirby Creek was improved in 2007. Flow through the dam is now controlled by two headgates, which feed three 48” culverts (**Figure 3.55**). At the Jones Dam water is diverted out of the main channel by a large earthen berm situated across the channel. It appears that the water is delivered to a holding reservoir downstream, out of which the water is used for flood irrigation, eventually draining back towards Kirby Creek. Kirby Creek downstream of this diversion dam was dewatered at the time of the site visit in late-April of 2010. Kirby Creek is highly entrenched downstream of the Jones Dam, though a meandering channel with a small floodplain has developed within the entrenched sides of the valley walls in localized areas.

Figure 3.55. Jones Dam Outlet Structure (left), and emergency spillway (right).

3.7.2 Water Pipelines

Well-planned livestock water systems are especially important in riparian areas, in or near stream corridors and around lakes or ponds. They reduce sediment and nutrient loading in streams and ponds by preventing bank and shore erosion and limiting the amount of livestock waste deposited directly in the water. Development of alternate water sources may allow increased stocking rates by lengthening the season of use, spreading moisture usage more evenly over the range, or opening up more range to grazing. Stocking rates must also be evaluated in terms of adequate drinking water for livestock. Maximum livestock gains can be obtained only when both forage and water needs are met. Numerous water supply pipelines exist in the Kirby Creek watershed, with an increased rate of pipeline construction having occurred in recent years. These pipelines are typically utilized to convey stock water to rangeland areas that lack a water source. In this way, livestock are moved out of riparian areas, resulting in two beneficial consequences. The first is an overall increase and more consistent utilization of available forage in the area. The second is a reduction in impact by livestock to the riparian areas, allowing more time for these areas to recover.

Source water generally originates from a groundwater well and is typically pumped to large storage tanks that serve as reservoirs for the pipeline system. Water is distributed via gravity-flow and, where needed, is assisted with booster pumps. Over 225,000 feet (42.6 miles) of water pipeline have been installed in the watershed since 1999 with funding assistance coming from a variety of federal and state sources (HSCD, 2009). (**Figure 3.56)** shows the locations of existing water supply pipelines used to distribute water for stock watering and other agricultural purposes. Information regarding the locations of pipelines shown in this figure was obtained from landowners or was recorded during field visits to the watershed using a GPS unit.

Pipeline systems are generally considered to be the best method for distribution of flows from a water source due to the degree of flexibility they offer in delivering water where and when it is needed. Several recently installed pipeline projects have benefitted producers by opening-up rangeland areas and allotments that were previously not viable for grazing due to lack of water. Benefits to the watershed as a whole, resulting from pipeline project implementation, are largely anecdotal. However recent improvements in water quality, as determined from measured levels of *E.Coli.* bacteria, may in part be the result of improved livestock distribution within the watershed. Observed increases in streamflow levels in the late-summer and fall may also be related to distribution of livestock water sources away from stream and riparian corridors.

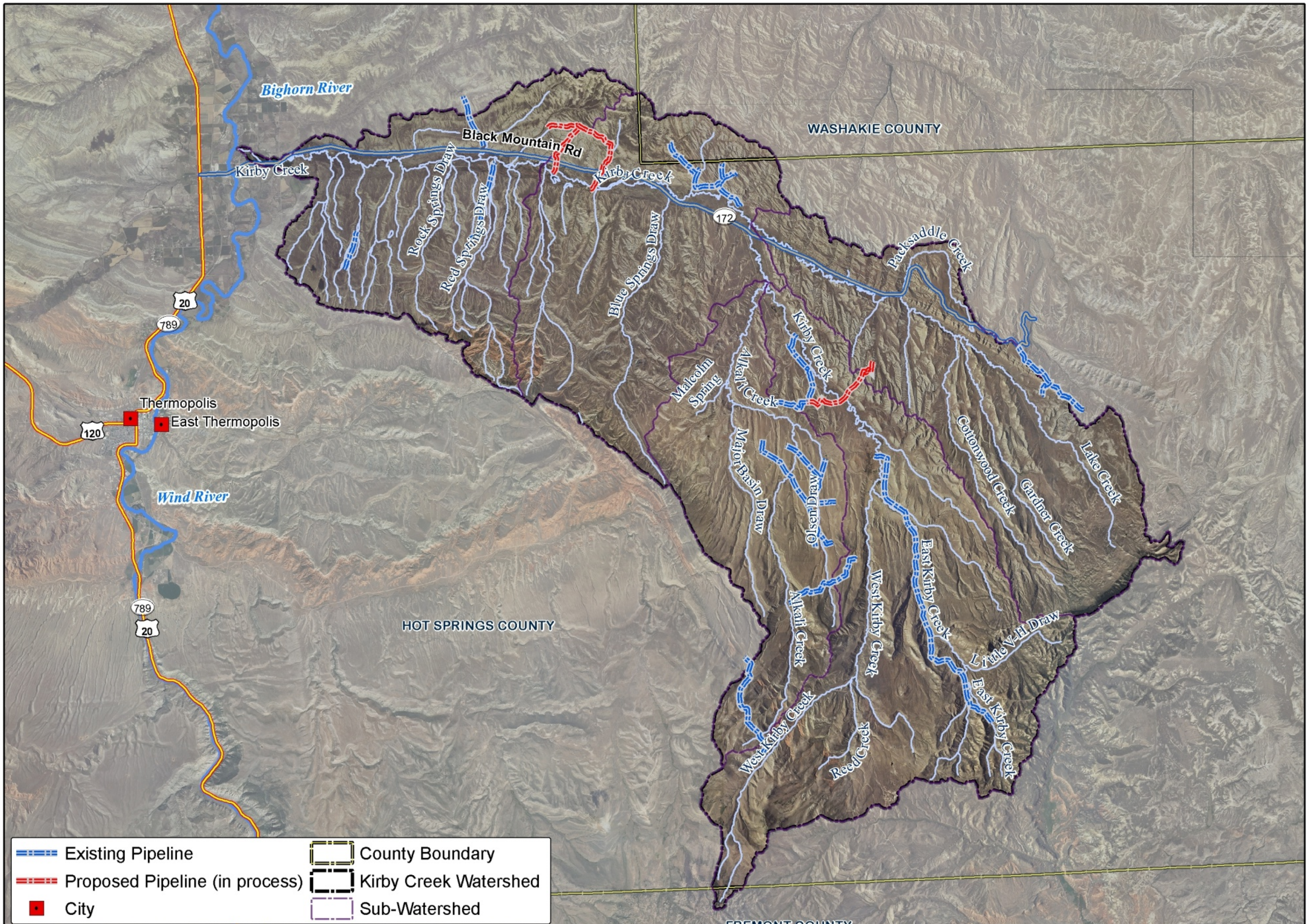


FIGURE 3.56	PROJECT NAME Kirby Creek Watershed Study	FIGURE TITLE: Water Pipelines		
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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0 1.5 3 6 Miles

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3.8 Water Storage and Retention

Surface water storage and retention in the watershed was evaluated in order to identify potential opportunities for new or improved water sources for livestock/wildlife in the watershed. Upland stock ponds differ from onstream reservoirs by occurring in upland areas or within ephemeral drainages. Onstream reservoirs occur on more perennial streams and so are, as a group, more reliable sources of water than the majority of stock ponds in the watershed.

3.8.1 Existing Upland Stock Ponds and Stock Tanks

A total of 233 stock ponds were identified in the watershed, of which 24 were apparently breached and not capable of holding water (**Figure 3.57**). The sizes of the remaining 209 'viable' stock ponds were estimated by placing different sized buffer rings around each stock pond and classifying each stock pond into different size categories. The size categories were (in acres): <0.1, 0.1 – 0.2, 02 – 0.3, 03 – 0.4, 0.4 – 0.5, 05 – 0.6, 0.6 – 0.7, 0.7 – 0.8, 0.8 – 0.9, 0.9 – 1.0, and >1.0. When calculating the estimated median and average size of the stock ponds in each of the watersheds the mid-point value (i.e., 0.05, 0.15, 0.25, 0.35, etc.) of each of the size categories were used. The purpose of this exercise was to provide a rapid estimate of the amount of surface storage the stock ponds represent in each of the sub-watersheds. This yielded a rough estimate in the amount of 56.9 acres of surface water storage in upland stock ponds in the watershed (**Table 3.30**).

Table 3.30. Summary of upland stock ponds in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	No. of Stock Ponds	Estimated Size (acres)*				
		Min	Max	Median	Average	Total
Lower Kirby Creek	39	0.05	>1.0	0.15	0.25	9.7
Middle Kirby Creek	44	0.05	0.95	0.15	0.24	10.5
Alkali Creek - Kirby Creek	32	0.05	>1.0	0.15	0.28	9.05
Lake Creek - Kirby Creek	31	0.05	>1.0	0.15	0.32	9.8
Upper Kirby Creek	63	0.05	>1.0	0.15	0.31	17.85
Total	209	--	--	--	--	56.9

*Stock ponds were classified into size categories. The statistics were run on the midpoint of each size category. Size categories used are (in acres): <0.1, 0.1-0.2, 0.2-0.3, 0.3-0.4, 0.4-0.5, 0.5-0.6, 0.7-0.8, 0.8-0.9, 0.9-1.0, >1.0.

If different depths of water are used an estimate of the potential water volume stored within the watershed in these stock ponds can be estimated (**Table 3.31**). For example, if an average water depth in the stock ponds is estimated to be 1-foot deep, the total water volume stored would be approximately 56.9 acre-feet. **Table 3.31** provides estimates of potential water storage if different average depths are assumed. It should be understood that not all stock ponds will contain water at any given time, and that some will contain much more water than others. For this reason, ***the estimates provided in Table 3.31 should not take the place of on-the-ground surveys, and should only be used conservatively when planning so that water available to livestock is not overestimated.***

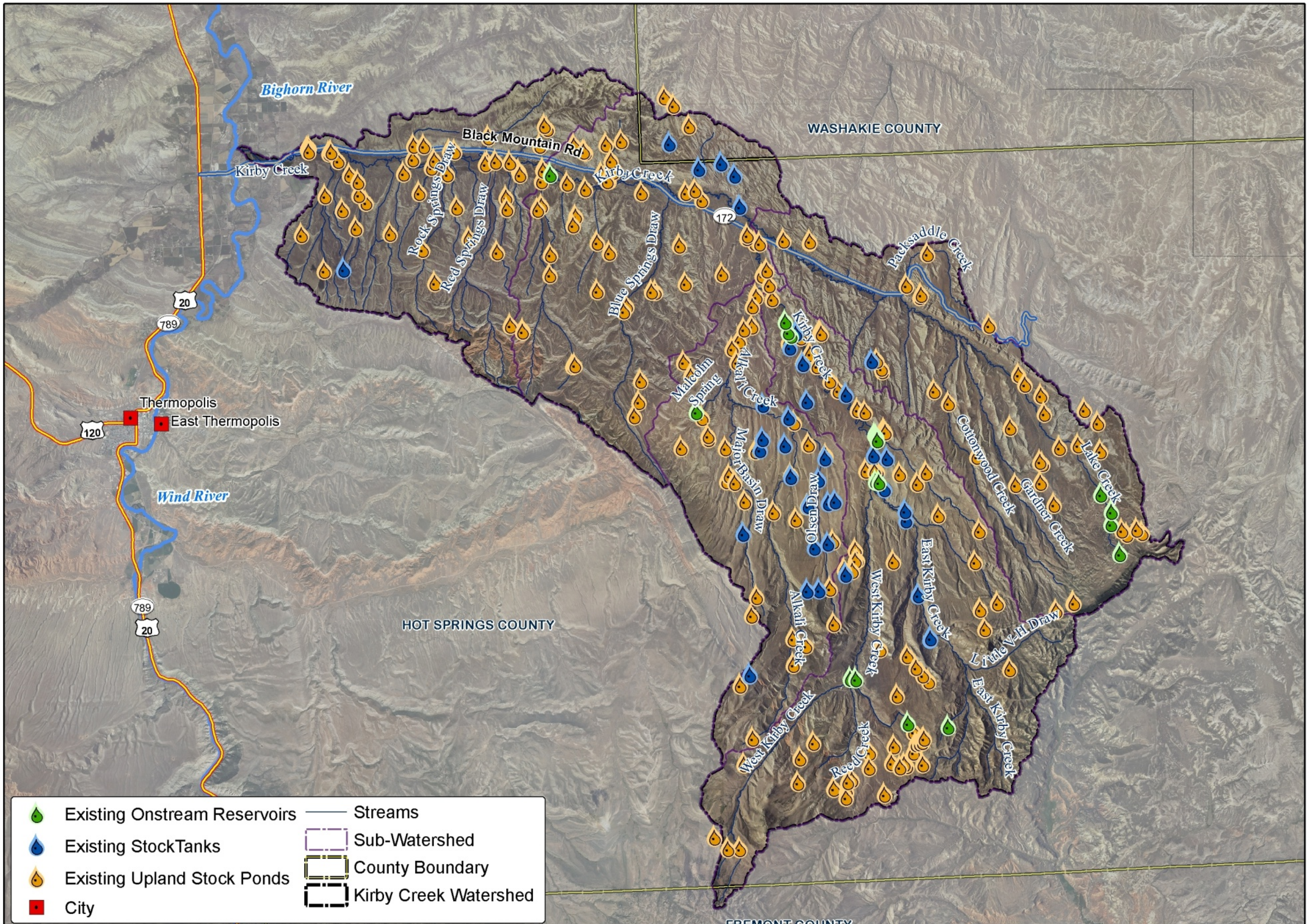

FIGURE 3.57

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: Existing Upland Stock Ponds/Tanks and Onstream Reservoirs

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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Table 3.31. Rough estimates of potential water storage in upland stock ponds in the Kirby Creek watershed, Hot Springs County, WY.

		Estimated Storage Volume at Different Depths (ac-ft)*				
Sub-watershed	**Acres**	***1 ft deep***	***1.5 ft deep***	***2 ft deep***	***2.5 ft deep***	***3 ft deep***
Lower Kirby Creek	9.70	9.70	14.55	19.40	24.25	29.10
Middle Kirby Creek	10.50	10.50	15.75	21.00	26.25	31.50
Alkali Creek - Kirby Creek	9.05	9.05	13.58	18.10	22.63	27.15
Lake Creek - Kirby Creek	9.80	9.80	14.70	19.60	24.50	29.40
Upper Kirby Creek	17.85	17.85	26.78	35.70	44.63	53.55
Total	56.90	56.90	85.35	113.80	142.25	170.70

* The intent of this table is to provide a rough estimate of potential water storage in each sub-watershed. These rough estimates of water volumes should not take the place of on-the-ground surveys of water availability in a given area.

During site visits and with the help of landowners PBS&J identified a total 39 stock tanks in the watershed (**Figure 3.57**). With 18 stock tanks, the Alkali Creek-Kirby Creek sub-watershed contains the most stock tanks, followed by 14 in the Upper Kirby Creek sub-watershed.

3.8.2 Existing Onstream Reservoirs

There are a total of 18 onstream reservoirs in the watershed (**Table 3.32, Figure 3.57**). The size of onstream reservoirs was estimated in the same way that stock ponds were (see above). These onstream reservoirs represent roughly 13.7 acres of potential water storage.

Table 3.32. Summary of onstream reservoirs in the Kirby Creek watershed, Hot Springs County, WY.

Sub-watershed	No. of Onstream Reservoirs	Approximate Total Acreage
Lower Kirby Creek	0	0
Middle Kirby Creek	1	1.45
Alkali Creek-Kirby Creek	1	0.05
Lake Creek-Kirby Creek	4	1.0
Upper Kirby Creek	12	11.2
Total	18	13.7

4.0 WATERSHED RESTORATION AND MANAGEMENT PLAN

4.1 OVERVIEW

Several options for enhanced watershed management have been explored through discussions with landowners and other watershed stakeholders, field investigations and computer based analysis. This rehabilitation plan outlines a strategy for enhancing water resources in the Kirby Creek watershed and includes project types within the following categories:

- **Irrigation Infrastructure Improvements** - An inventory of inactive irrigation ditches was completed and recommendations for re-activation and/or other improvements were identified.
- **Upland Wildlife/Livestock Watering Opportunities** - The locations of existing, reliable upland water sources (springs, stock ponds, wells, and stock tanks) were inventoried, and the results used to identify areas that lack adequate water supply and which could benefit from potential upland water development projects.
- **In-stream Pond Opportunities** - Potential locations for in-stream pond development projects via re-activation of historic meanders and oxbows were evaluated. This type of water development project has been successfully implemented at several locations within the watershed.
- **Stream Channel Restoration Opportunities** - Restoration opportunities are identified to improve the function and stability of stream channels within the watershed. Primary project types include headcut stabilization and entrenched channel restoration.
- **Grazing Management Strategies and Opportunities** - Using Ecological Site Descriptions (ESDs) as a means of characterizing and measuring range condition and health, various approaches to grazing management are presented.
- **Other Upland Management Opportunities** – Additional management strategies and tools, including weed and pest control and the use of prescriptive fire, are discussed.

Potential projects and strategies for developing water resources and improving the overall health of the Kirby Creek watershed are described in the following sections. The projects have been conceptualized with the intent of addressing identified resource concerns or management issues.

Each individual project is assigned a name and, in cases where there are numerous projects of a given type (e.g., upland water development), an alphanumeric descriptor for reference purposes throughout the remainder of this report.

4.2 IRRIGATION INFRASTRUCTURE

Irrigation infrastructure in the Kirby Creek watershed is primarily comprised of a series of ditches used to flood irrigate small areas and to provide water to upland wildlife/livestock ponds. Very few ditches remain active today, mainly due to the incised nature of stream channels throughout a large portion of the watershed (Chapter 3, **Section 3.7**). Irrigation (ditch) systems currently in use, namely the ditches that flow from the West Mishurda and Reed diversions, which are both located on West Kirby Creek, were not evaluated from an operational or efficiency standpoint. Three inactive ditches were identified during this assessment as having the potential to be rehabilitated either for flood irrigation or for the development of upland wildlife/livestock ponds.

4.2.1 Ditch Rehabilitation

Three ditches in the Kirby Creek watershed were identified as inactive with the potential to be re-activated, including the Richardson #1 Ditch, the Kirby Creek Ditch and the Idared Ditch. The Richardson #1 Ditch and Idared Ditch are on West Kirby Creek, while the Kirby Creek Ditch is on East Kirby Creek. Out of these three ditches, the Richardson #1 Ditch is thought to have the highest potential as a water resource development project.

4.2.1.1 Richardson #1 Ditch

Downstream of the recently completed West Kirby Grade Stabilization project on West Kirby Creek, an abandoned ditch was observed coming off of the left side of the channel (**Figure 4.1**). This ditch was identified as the Richardson #1 irrigation diversion in the previous Kirby Creek watershed study (SEI 2005). The streambed is now approximately four feet below the entrance of the ditch (**Figure 4.2**). It appears that this ditch could be re-activated relatively easily through the addition of one or two drop structures. This may be a good site to create a series of upland wildlife/livestock ponds at the outlet of the ditch, similar to ponds created by the Reed Diversion, which is located downstream (**Figure 4.1**).

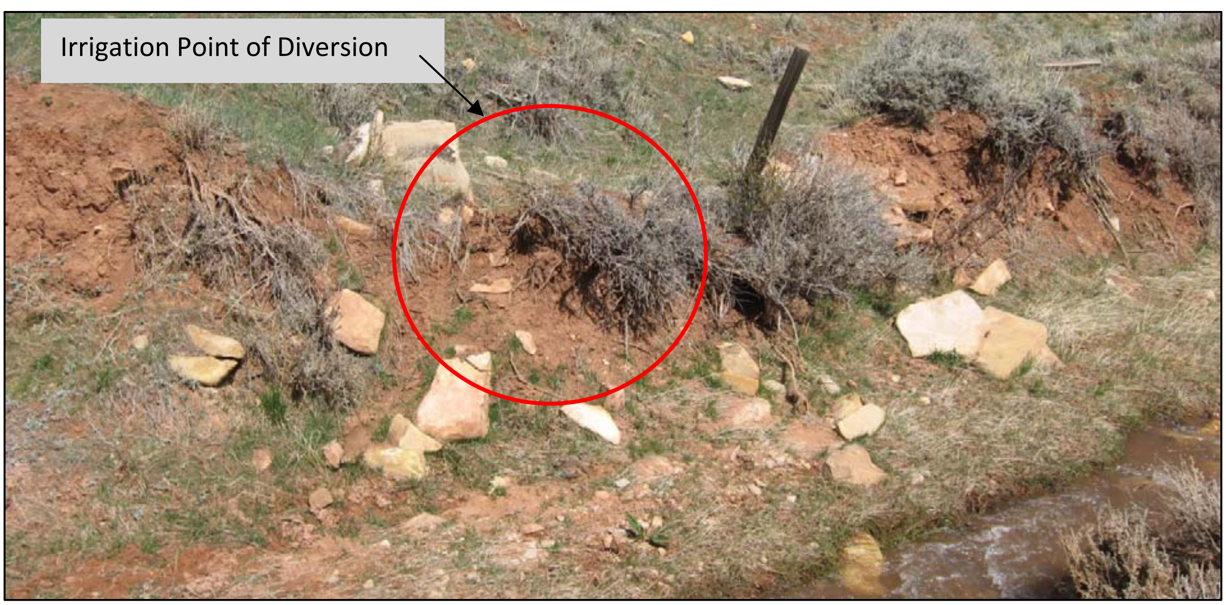

Figure 4.2. Richardson #1 Irrigation Point of Diversion.


SEI Points of Diversion
Delineated Points of Diversion
Reed Diversion
Richardson #1
0 0.5 1 2 Miles
FIGURE TITLE:
Richardson #1 Ditch and Reed Diversion
PROJECT MGR: MR
LOCATION: HOT SPRINGS COUNTY, WY
PLOTTED: 07-15-2010
PROJ NO: 100008648
PROJECT NAME
Kirby Creek Watershed Study
FIGURE
4.1
S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Irr Ditches Identified_1_Reed and Richardson Ditch.mxd\MapBook-Richardson#1

4.2.1.2 Idared Ditch

The Idared Ditch on West Kirby Creek was not examined on-the-ground, though a review of aerial imagery indicates that there may be some potential to re-activate a portion of this ditch. The Idared ditch comes off the left side of the channel and then parallels the toe of a hill slope near the recently completed West Kirby Grade Stabilization project (**Figure 4.3**). It appears that a gulch intercepts this ditch mid-way down its length and this may be a limiting factor in how far the ditch can be re-activated. Headcutting moving up the gulch may have cut through this ditch and there may have historically been issues with this gulch washing debris into the ditch. This ditch could potentially be re-activated and return flow could be used to form upland wildlife/livestock ponds.

4.2.1.3 Kirby Creek Ditch

The Kirby Creek Ditch is located along the right side of East Kirby Creek and leads under Kirby Creek Road and into an area that appears to have been utilized for flood irrigation at one time, though it is now dry (**Figure 4.4**). The historic ditch is crossed by a gulch in the middle of the previously irrigated field. The ditch is now approximately 6-8 feet above the existing streambed at the potential point of diversion (**Figure 4.5**). There may be some potential to reactive this ditch for use in flood irrigation or to develop upland wildlife/livestock ponds. Water could potentially be routed down the gulch in a series of ponds, assuming the gulch doesn't carry too much flow periodically to threaten constructed infrastructure.

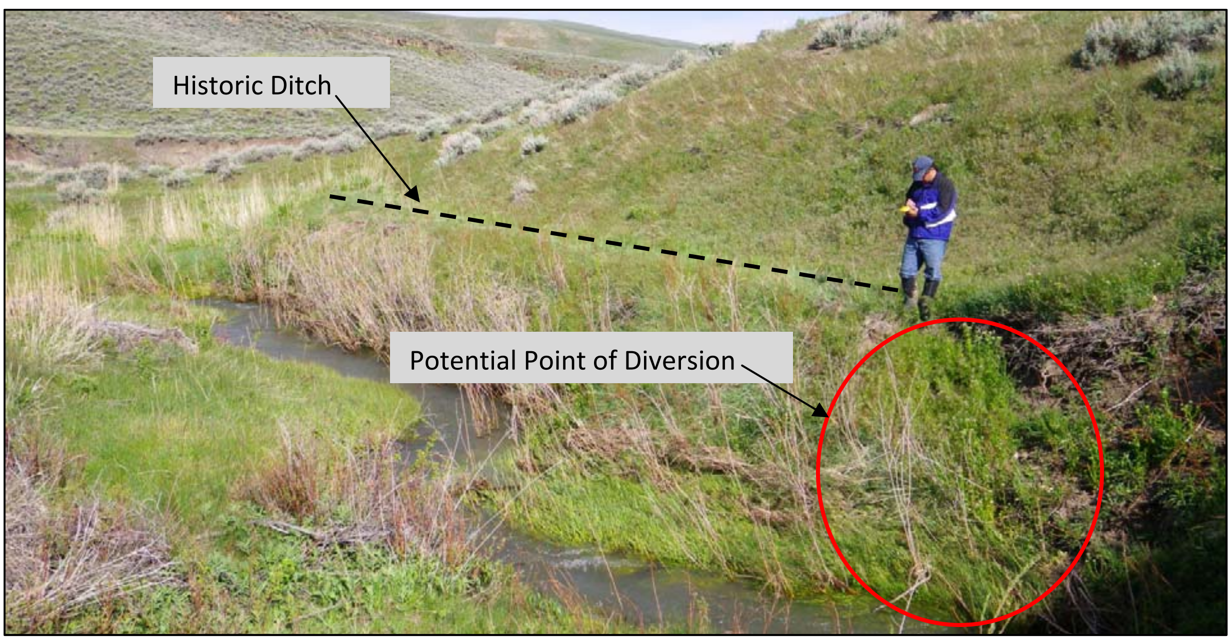

Figure 4.5. Kirby Creek Ditch.


SEI Points of Diversion
Delineated Points of Diversion
Idared Ditch
0 0.5 1 2 Miles
FIGURE TITLE:
Overview of Idared Ditch
PROJECT MGR: MR
LOCATION: HOT SPRINGS COUNTY, WY
PLOTTED: 07-15-2010
PROJECT NAME
Kirby Creek Watershed Study
PROJ NO: 100008648
FIGURE
4.3

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4.3 UPLAND WILDLIFE/LIVESTOCK WATERING OPPORTUNITIES

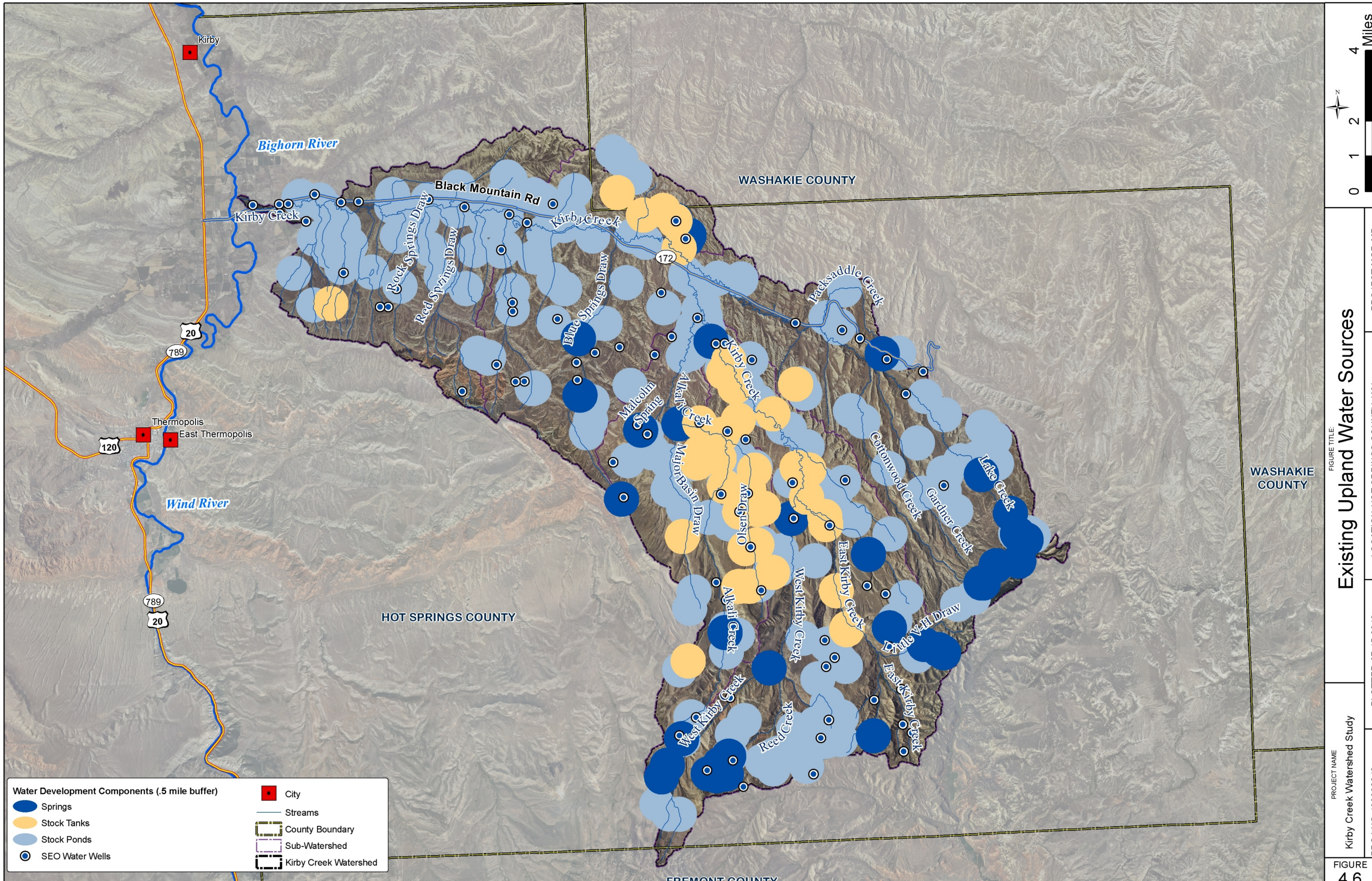
4.3.1 New Upland Wildlife/Livestock Watering Opportunities

Landowners and operators within the Kirby creek watershed have implemented numerous water development projects within the past decade. Many of these projects have been geared towards greater distribution of water into upland areas that lacked adequate or reliable water supplies. This in turn has opened up areas to livestock grazing that previously had either no water or unreliable sources of water. Although a significant number of upland water development projects have been placed into operation, there is ample opportunity for additional upland water development in the watershed. Water sources available to supply upland water developments include springs, wells (both existing and new), and stock ponds. Springs and wells represent the most reliable potential water sources to support individual watering sites (stock tank) or multiple watering sites using a pipeline/tank system. Depending upon area topography and the location of the water source, pumps may be required for adequate water distribution. Pumps can be powered by a variety of methods including standard electrification from a local power source (if available) or by means of solar and wind-powered pumps. Upland stock ponds can also provide a water source (at least seasonally) in areas where wells or springs are not available or practical. This could include rehabilitation of existing ponds as well as construction of new ponds.

As a means of determining areas within the watershed that are short of water, which can also be related to underutilized rangeland, all of the existing, reliable water sources in the watershed were located on a map using data from the project GIS**.** **Figure 4.6** provides a map of the following water sources:

- Stock ponds classified as *viable* (see **Section 3.8**);
- Spring locations determined by review of USGS topographic maps and 2009 aerial photography;
- Water wells, based on data from the WYSEO (2005); and
- Existing stock tanks, as determined during site visits with landowners and from the 2009 aerial photo.

Although much of the Lower Kirby Creek sub-watershed includes fairly gentle terrain, upper portions of the watershed are considerably steeper. Therefore, the recommended spacing of water sources across the watershed for livestock is a half-mile. Based on this recommendation for distance between water sources, a half-mile buffer was placed around each *existing* water source. This included stock ponds classified as viable (whether or not they held water at the time of a field visit or in the aerial photo), springs, and stock tanks (**Figure 4.6**). Existing stream channels and on-stream reservoirs were not mapped as potential water sources due to the fact they are located in valley bottoms and typically outside of upland areas. Also, it is an objective of this watershed rehabilitation plan to recommend and evaluate water sources outside of riparian areas and, therefore, streams were not considered in this analysis.



Kirby
Bighorn River
Black Mountain Rd
Kirby Creek
Rock Springs Draw
Red Springs Draw
Blue Springs Draw
Packsaddle Creek
WASHAKIE COUNTY
Thermopolis
East Thermopolis
Wind River
Malcolm Spring
Alkali Creek
Major Basin Draw
Olsen Draw
Kirby Creek
Cottonwood Creek
Gardner Creek
Lake Creek
East Kirby Creek
West Kirby Creek
Little V-H Draw
Reed Creek
HOT SPRINGS COUNTY
WASHAKIE COUNTY
FREMONT COUNTY
Water Development Components (.5 mile buffer)
Springs
Stock Tanks
Stock Ponds
SEO Water Wells
City
Streams
County Boundary
Sub-Watershed
Kirby Creek Watershed
Miles
0 1 2 4
FIGURE TITLE:
Existing Upland Water Sources
PROJECT MGR: MR
LOCATION: HOT SPRINGS COUNTY, WY
PLOTTED: 07-15-2010
PROJECT NAME
Kirby Creek Watershed Study
PROJ NO: 100008648
FIGURE
4.6
S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\Water Development Componets.mxd

Close inspection of **Figure 4.6** reveals that much of the watershed has at least seasonal water sources. However stock ponds can be an unreliable water source, which makes a rotational system of grazing management questionable from a planning perspective.

A variety of water supply improvements/developments are described in greater detail in **Appendix G**. These include the following:

- Spring developments,
- New wells,
- Existing wells, using wind and/or solar power,
- Pipeline/tank systems, and
- Stock ponds.

4.3.2 Upland Wildlife/Livestock Water Development Projects

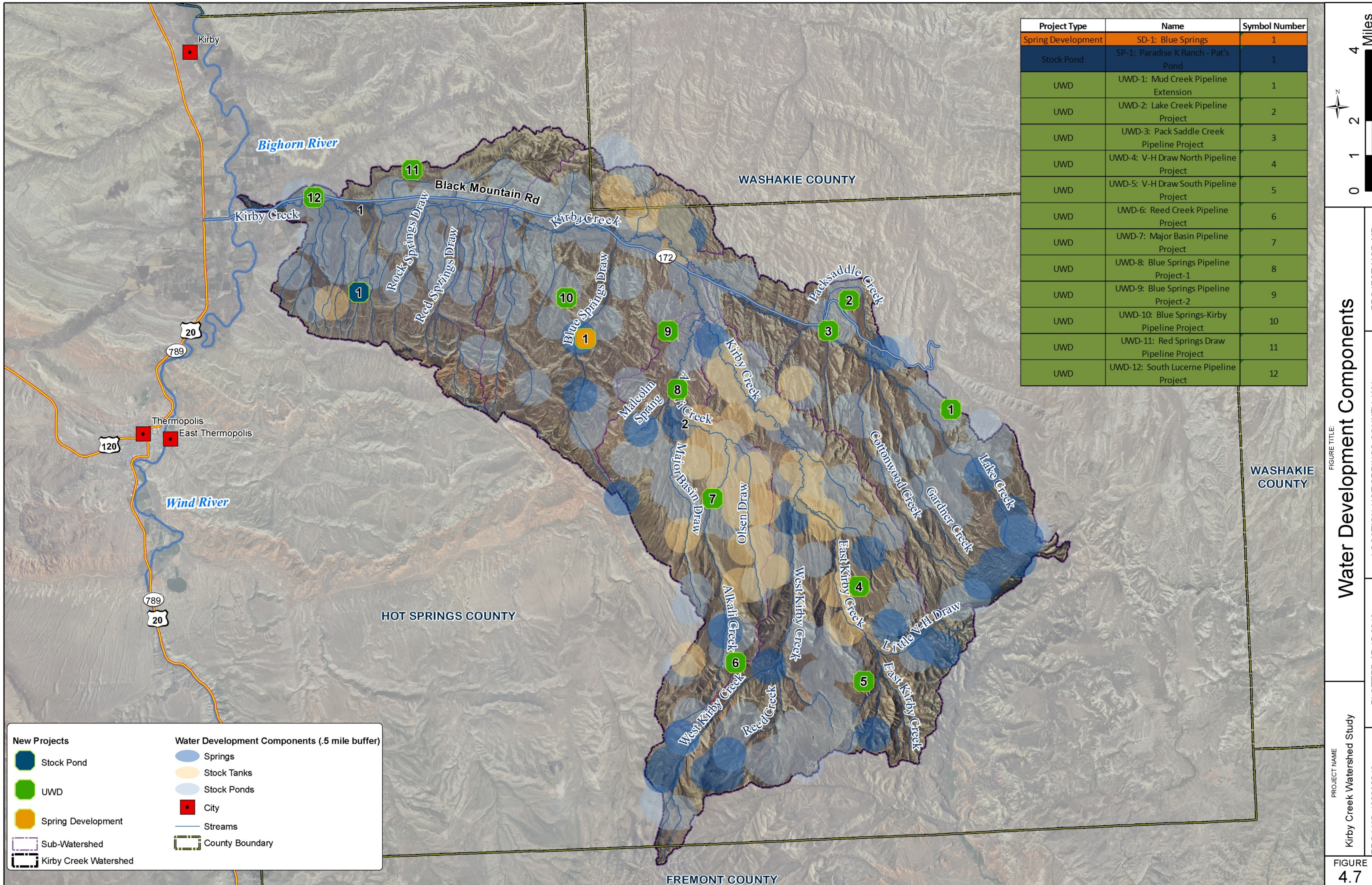
Field meetings were conducted with most of the landowners and operators in the watershed to inventory existing upland water developments and gain first-hand information regarding their grazing operations. Using this information, coupled with the graphical representation of water availability in **Figure 4.6**, a number of conceptual water development projects were identified. These included several pipeline/stock tank projects (including additions to existing pipeline systems and completely new pipeline systems), a spring development project at Blue Springs, and a new stock pond on the Paradise K Ranch. **Table 4.1** presents a list of these conceptual projects, along with an alphanumeric descriptor for each project which will be referenced in the overall watershed plan.

Table 4.1. List of Upland Wildlife/Livestock Water Development Projects.

Project Identifier	Project Name *
UWD-1	Mud Creek Pipeline Extension Project
UWD-2	Lake Creek Pipeline Project
UWD-3	Pack Saddle Creek Pipeline Project
UWD-4	V-H Draw North Pipeline Project
UWD-5	V-H Draw South Pipeline Project
UWD-6	Reed Creek Pipeline Project
UWD-7	Major Basin Pipeline Project
UWD-8	Blue Springs Pipeline Project - 1
UWD-9	Blue Springs Pipeline Project - 2
UWD-10	Blue Springs-Kirby Creek Pipeline Project
UWD-11	Red Springs Draw Pipeline Project
UWD-12	South Lucerne Pipeline Project
UWD-13	Blue Springs Development
UWD-14	Pat's Pond – Paradise K Ranch

*Names are typically based on the BLM allotment or private ranch served by the project.

Figure 4.7 presents general locations of all the upland wildlife/livestock water development projects.



Project Type	Name	Symbol Number
Spring Development	SD-1: Blue Springs	1
Stock Pond	SP-1: Paradise K Ranch - Pat's Pond	1
UWD	UWD-1: Mud Creek Pipeline Extension	1
UWD	UWD-2: Lake Creek Pipeline Project	2
UWD	UWD-3: Pack Saddle Creek Pipeline Project	3
UWD	UWD-4: V-H Draw North Pipeline Project	4
UWD	UWD-5: V-H Draw South Pipeline Project	5
UWD	UWD-6: Reed Creek Pipeline Project	6
UWD	UWD-7: Major Basin Pipeline Project	7
UWD	UWD-8: Blue Springs Pipeline Project-1	8
UWD	UWD-9: Blue Springs Pipeline Project-2	9
UWD	UWD-10: Blue Springs-Kirby Pipeline Project	10
UWD	UWD-11: Red Springs Draw Pipeline Project	11
UWD	UWD-12: South Lucerne Pipeline Project	12

Implementation for all but two (Pat's Pond and Mud Creek Pipeline) of the upland water development projects would require coordination with the BLM. Ownership liability and maintenance responsibility would need to be defined in written agreements for each project. Environmental clearances would also be required to address impacts associated with the projects. BLM will usually complete these assessments; however, other agencies (e.g., NRCS, WYGFD) may provide input during the process. Therefore, project approval and construction would be dependent on BLM staff completing the environmental analysis and reporting.

4.3.2.1 Mud Creek Pipeline Extension Project

This project would tie into an existing pipeline system already in place along the northeast watershed boundary (Lake Creek divide area). An existing branch of this system already provides water from the bench top down to a stock pond in the Lake Creek drainage (Mud Creek Allotment). **Figure 4.8** shows the addition of two branch pipelines that would convey water to two proposed stock ponds located to the northwest and south of the existing stock pond. The Mud Creek Allotment would be the primary beneficiary from this proposed increase in stock water distribution. The proposed stock ponds are located such that they can also collect surface water drainage. Source water for the project would come from an existing well permitted to Matt and Teresa Brown (Brown #1, Permit #P65641W). This well has a reported yield of 12 gpm (WSEO 2010), and is currently used as a water source for the existing pipeline.

Note: The general concept for this pipeline project was discussed with Mr. Brown during a field visit in August 2009.

Elements required for this project:

- Pipeline extensions would be added from: (1) an existing branch line that conveys water to an existing stock pond, and (2) from the main pipeline atop the Lake Creek divide bench. Both of the pipeline extensions would terminate at new stock pond locations.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 6,100 lin. ft.
- Two new stock ponds would be constructed at the termini of the two proposed pipelines.

4.3.2.2 Lake Creek Pipeline Project

The Lake Creek pipeline project would service an area located north of Black Mountain Road, generally following the Pack Saddle Creek drainage. This portion of the watershed lacks upland water sources and only has intermittent (seasonal) water supply from Pack Saddle Creek itself. The pipeline would serve both the Lake Creek and Pack Saddle Creek Allotments. **Figure 4.9** displays the general configuration for this alternative.

Elements required for this project:

- The water source for this pipeline would be an existing well permitted to the BLM (Dick Walker Well #119, Permit #P10269P). This well has a reported yield of 10 gpm (WSEO 2010). A pump would be installed at the existing well, most likely accessing nearby electrical power, to pump water to a storage tank. A pump may also be required to support the eastern branch of the project.

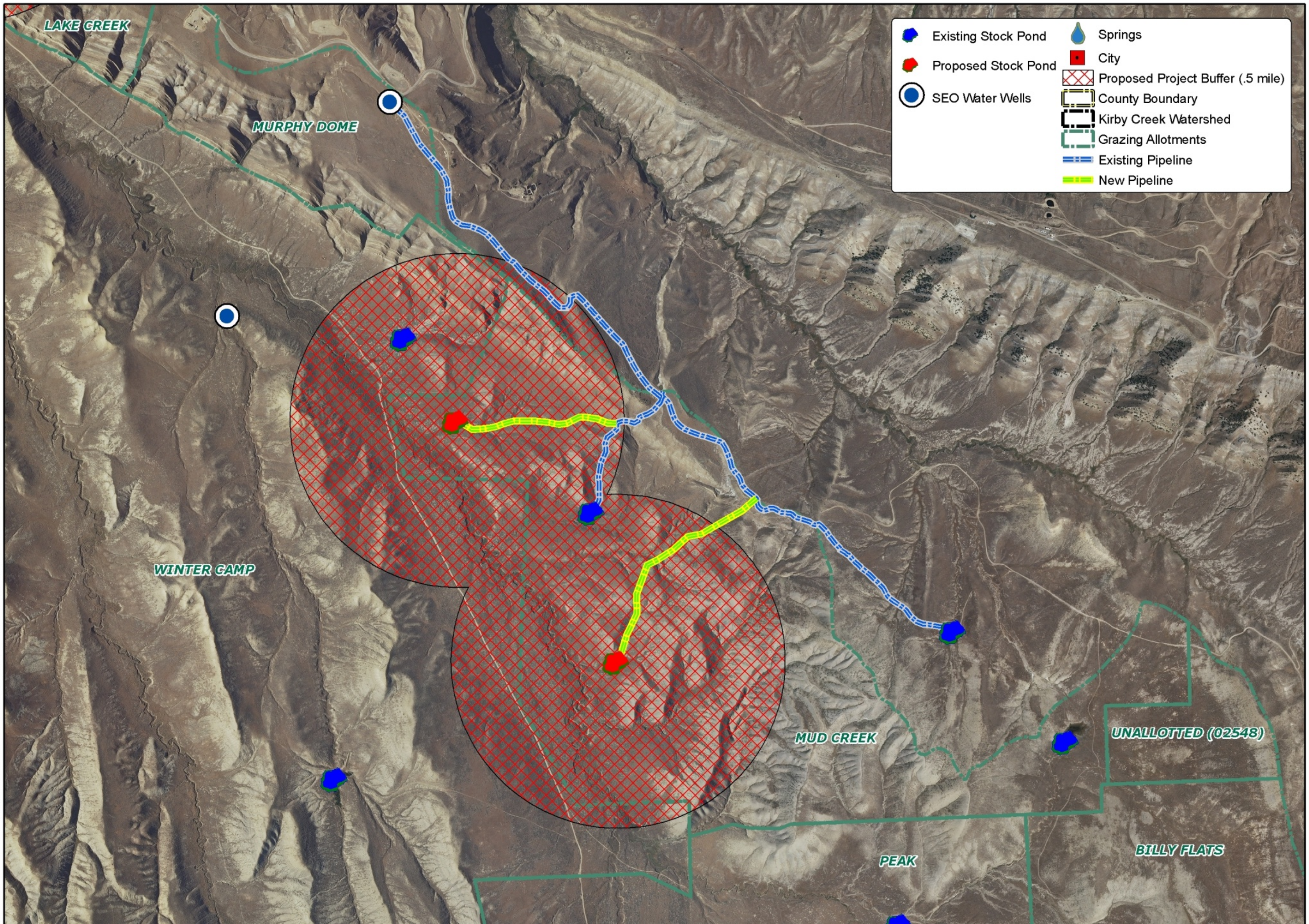


FIGURE 4.8

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE:

UWD-1: Mud Creek Pipeline Extension

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

N

0 0.15 0.3 0.6 Miles

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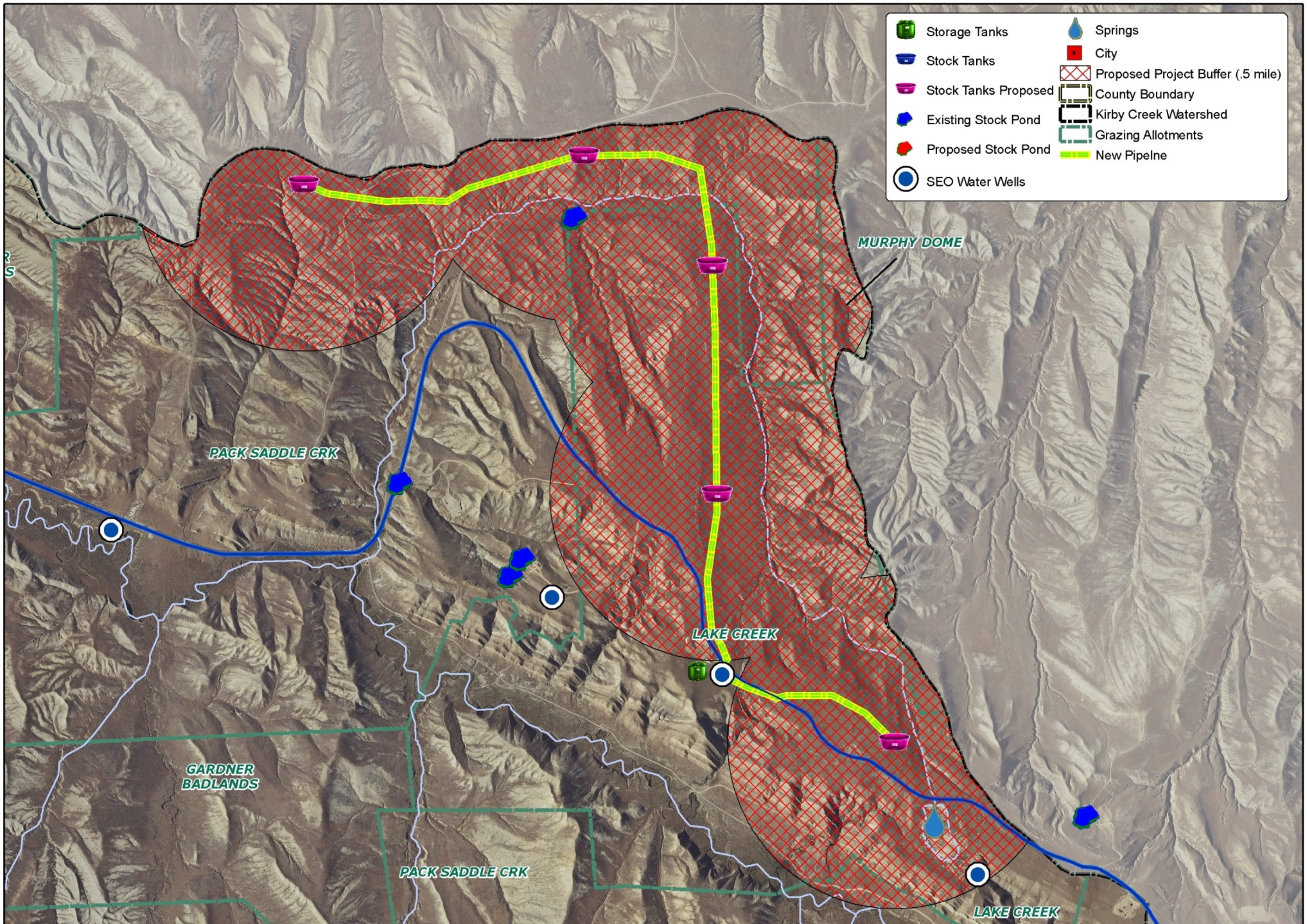

FIGURE 4.9

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: UWD-2: Lake Creek Pipeline Project

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

N

0 0.15 0.3 0.6 Miles

S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\UWD-2: Lake Creek Pipeline Project

- A storage tank (8,000 gallon capacity) would be installed at the well location.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 17,200 linear feet.
- Five (5) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.9**. Stock tank locations would be selected to optimize management of the grazing allotments.

4.3.2.3 Pack Saddle Creek Pipeline Project

This pipeline project would be designed to serve areas in the vicinity of the Lake Creek-Pack Saddle Creek confluence. This includes rangeland in both the Lake Creek and Pack Saddle Creek Allotments. An existing well permitted to BLM (Laurie C-1 Well #121, Permit #P10241P) was targeted as a water supply, however its yield is reported to be zero (WSEO 2010). Therefore, a new well is recommended as a water source, and for cost estimating purposes. The well would likely need to be up to 3,000 feet deep (based on the depth of the Brown #1 well, which is nearby). The estimated well depth may make this project a less attractive alternative, however a decision was made to retain the well in this report. **Figure 4.10** shows the general layout for this project.

Elements required for this project:

- Construction of a new well in the general location of an existing BLM well (Laurie C-1 Well #121). Given that the BLM well has a zero yield, and based upon the depth of the Brown #1 well, it is likely that this well would need to be quite deep (~3,000 feet, min.). For purposes of this report, a depth of 3,000 feet was used for cost estimating purposes.
- The well would access electrical power available nearby
- A storage tank (8,000 gallon capacity) would be installed near the well location.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 11,800 linear feet.
- Four (4) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.10**. Stock tank locations would be selected to optimize management of the grazing allotments.
- One existing stock pond located adjacent to Black Mountain Road could also potentially be used for storage and/or water distribution.

4.3.2.4 V-H Draw North Pipeline Project

This project is located in the V-H Draw Allotment, just to the east of East Kirby Creek. The area is located atop a bench dissected by small, intermittent drainages and lacks a reliable water source. The proposed pipeline would serve the V-H Draw Allotment. **Figure 4.11** shows the proposed layout of this pipeline system. The water source for this project would come from an existing well permitted to Mishurda Mountain Ranches, LP (Slope #1, Permit #P123294W) which yields 15 gpm (WSEO 2010).

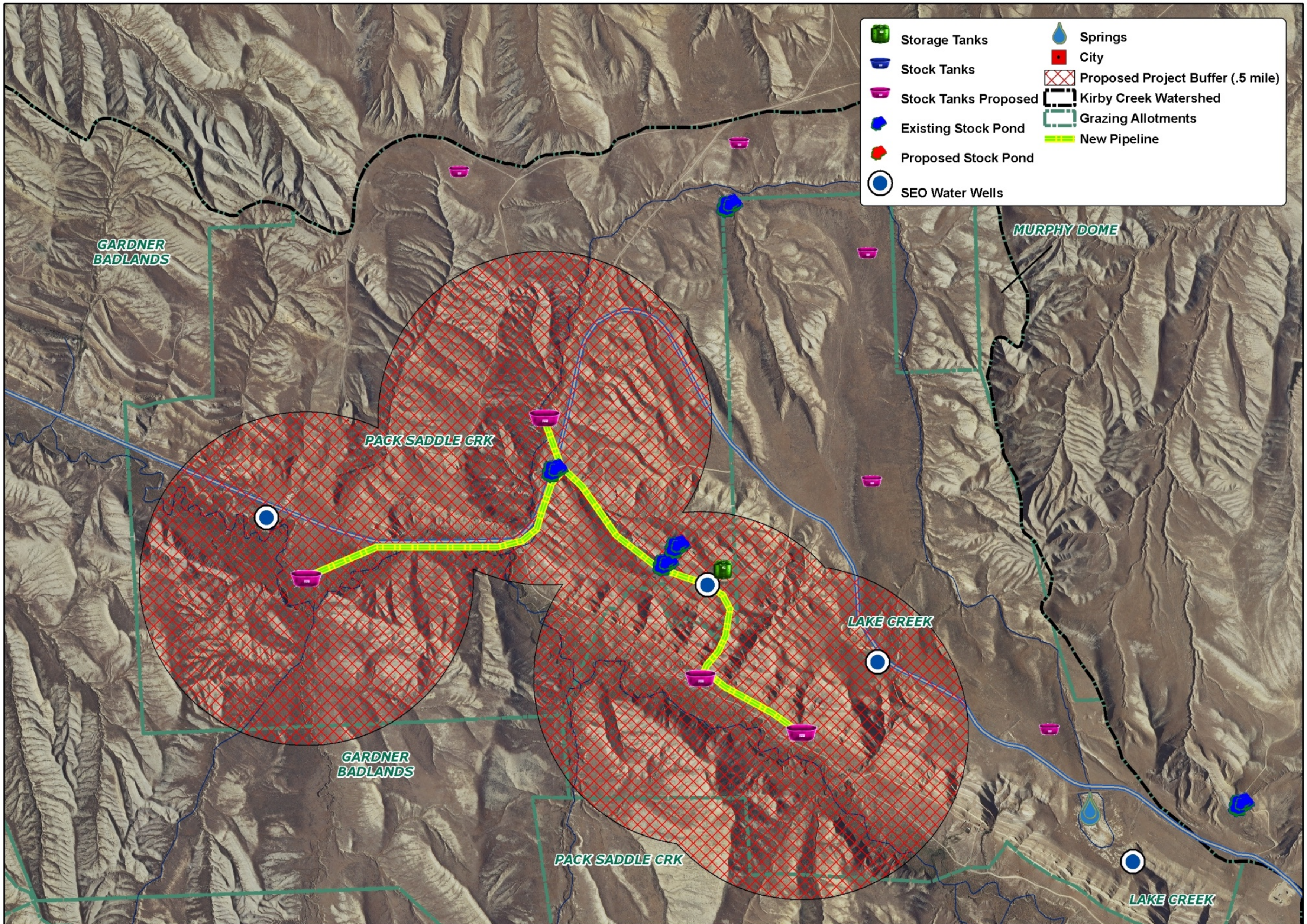

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FIGURE 4.10	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: UWD-3: Pack Saddle Creek Pipeline Project		N; 0 0.15 0.3 0.6 Miles
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

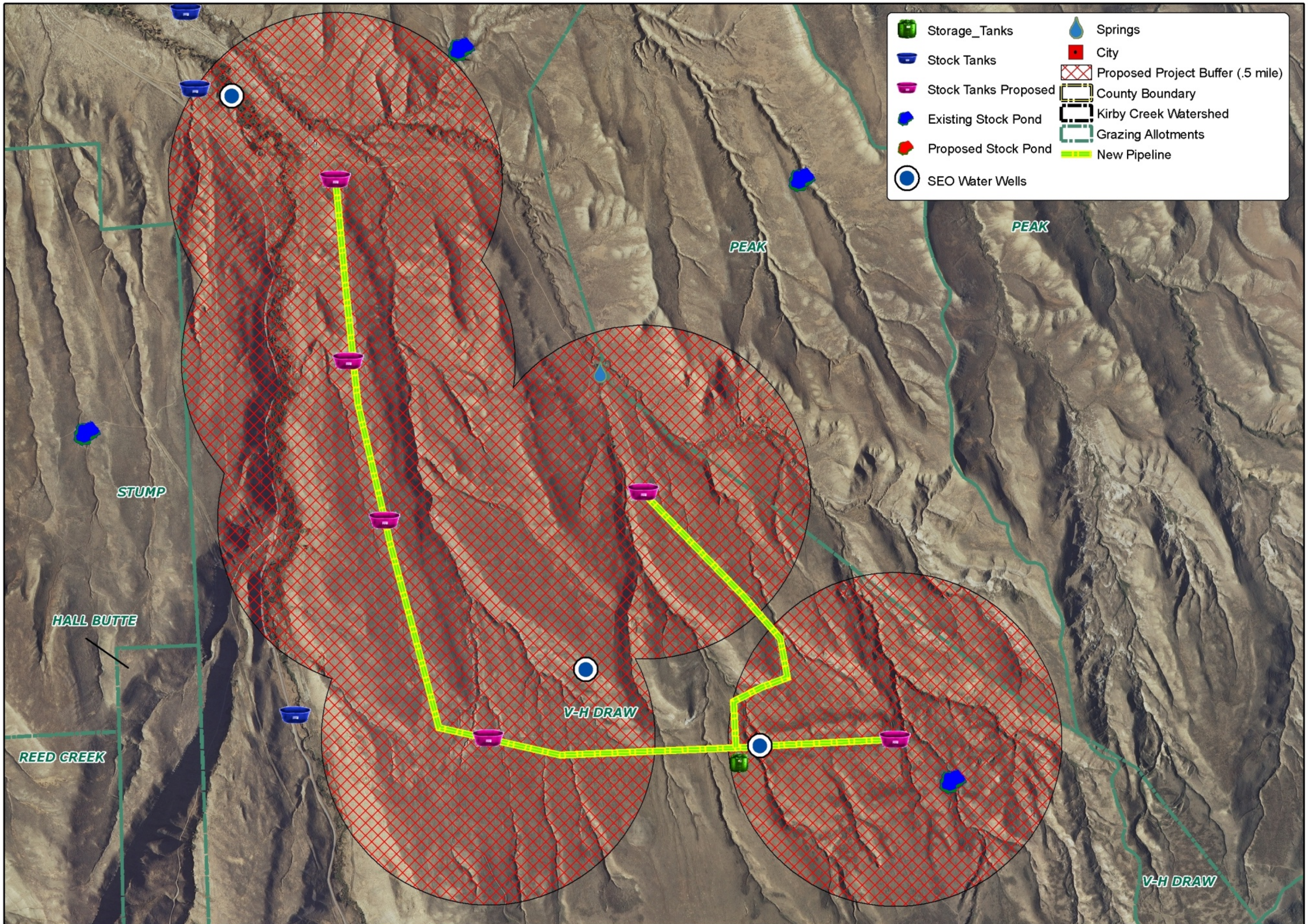

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FIGURE 4.11	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: UWD-4: V-H Draw North Pipeline Project	
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

N
0 0.15 0.3 0.6 Miles

Elements required for this project:

- An existing well would be utilized to supply this pipeline system. The well would be equipped with a pump and solar power source to pump water to a storage tank.
- A storage tank (12,000 gallon capacity) would be installed near the well location.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 21,200 linear feet.
- Six (6) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.11**. Stock tank locations would be selected to optimize management of the grazing allotments.

4.3.2.5 V-H Draw South Pipeline Project

This project is located in the V-H Draw Allotment, just to the west of East Kirby Creek and the Mishurda Mountain Ranches upper E. Kirby Creek cabin/compound. The area lacks a reliable water source. The proposed pipeline would serve the V-H Draw Allotment as well as a small portion of the Out Allotment. **Figure 4.12** shows the proposed layout of this pipeline system. The water source for this project would come from an existing well permitted to Mishurda Mountain Ranches, LP (Mesa #1, Permit #P123291W) which yields 6 gpm (WSEO 2010).

Elements required for this project:

- An existing well would be utilized to supply this pipeline system. The well would be equipped with a pump and solar power source to pump water to a storage tank.
- A storage tank (4,000 gallon capacity) would be installed near the well location.
- The total length of HDPE pipeline (1.5-inch diameter) would be approx. 6,900 linear feet.
- Three (3) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.12**. Stock tank locations would be selected to optimize management of the grazing allotments.

4.3.2.6 Reed Creek Pipeline Project

Located between the West Kirby Creek and Alkali Creek drainages, this project would address a short supply of reliable water in the higher rangeland country. The area that would be served by this pipeline system includes the Out and Reed Creek Allotments. Water supply would be provided from an existing well permitted to the Reed Creek Ltd. Partnership (Justin #1, Permit #40/1/346W). No yield amount from this well is provided in the WYSEO database. Should this well not be capable of producing an adequate water supply, a new well could be constructed in the same general area along West Kirby Creek. **Figure 4.13** shows the proposed layout for this pipeline/stock tank system.

Elements required for this project:

- Use of an existing well if adequate production is available. If this well does not produce adequate water, construction of a new well in the same general area is recommended. For purposes of this report and to facilitate cost estimating, a new well is assumed at a depth of 500 feet.

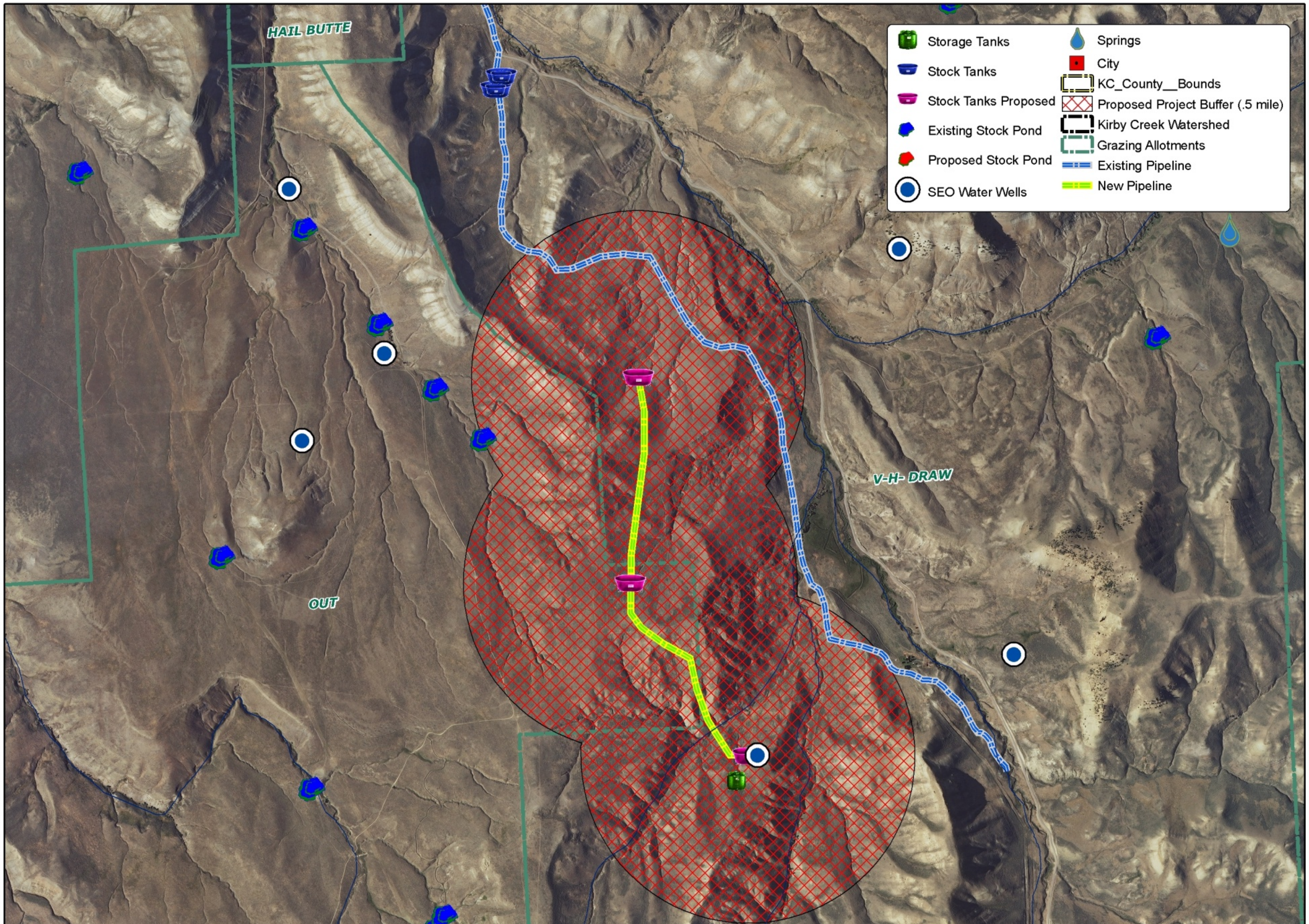

FIGURE 4.12

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: UWD-5: V-H Draw South Pipeline Project

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

N

0 0.15 0.3 0.6 Miles

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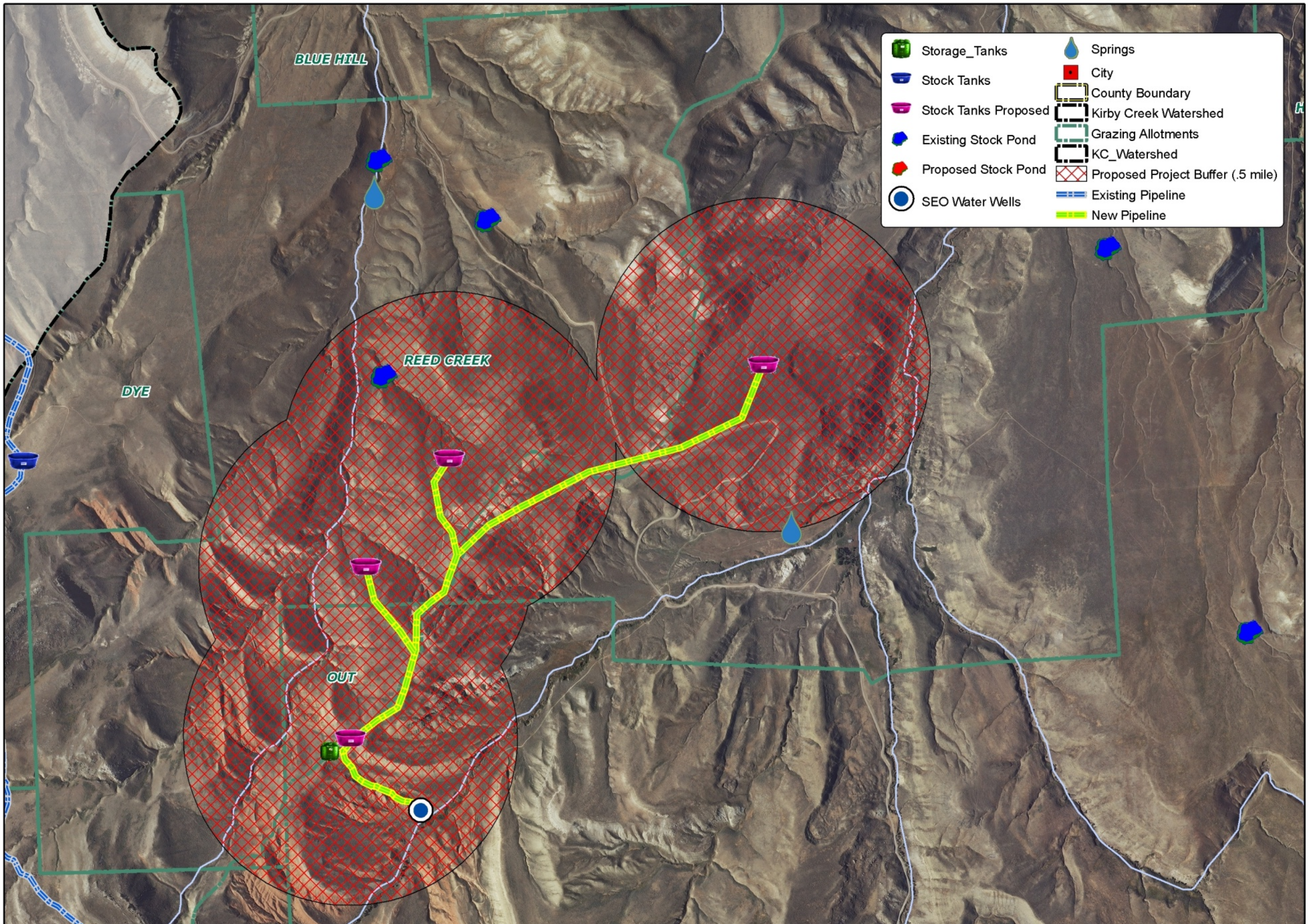

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FIGURE 4.13	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: UWD-6: Reed Creek Pipeline Project	N; 0 0.15 0.3 0.6 Miles
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

- The well would utilize a pump and solar power to pump water up to a storage tank along the ridge.
- A storage tank (12,000 gallon capacity) would be installed at a high point along the divide between West Kirby Creek and Alkali Creek to feed the remainder of the system via gravity flow.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 14,600 linear feet.
- Four (4) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.13**. Stock tank locations would be selected to optimize management of the grazing allotments.

4.3.2.7 Major Basin Pipeline Project

Although portions of the Major Basin Allotment have reliable water sources, the eastern edge of the allotment lacks perennial water. This proposed pipeline would traverse the southeast corner of the Major Basin Allotment, and also serve small areas within the Blue Hill and Swallow Allotments. Significant portions of the Blue Hill/Swallow Allotments are watered with existing pipeline systems; the proposed project would complement these systems by adding water coverage to the north and west. Water supply would come from an existing well permitted to C.H. Gardner (Gardner #1, Permit #P30059P) with a reported yield of 5 gpm (WYSEO 2010). **Figure 4.14** displays the general configuration of this project.

Elements required for this project:

- An existing well would be utilized to supply this pipeline system. The well would be equipped with a pump and solar power source to pump water to a storage tank.
- A storage tank (12,000 gallon capacity) would be installed near the south end of the system (high point) to feed the stock tanks via gravity flow.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 21,300 linear feet.
- Five (5) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.14**. Stock tank locations would be selected to optimize management of the grazing allotments.

4.3.2.8 Blue Springs Pipeline Project – 1

This project would be supplied by the existing water tanks located at the northern end of the Major Basin Allotment. This water supply currently serves most of the stock tanks in the V-Pasture Allotment. A pipeline/stock tank system would be extended from the water source to the northwest, terminating along the Alkali Creek bottom. **Figure 4.15** shows the location of this pipeline extension.

Elements required for this project:

- Existing water tanks would be utilized to supply this pipeline system via gravity flow.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 10,200 linear feet.

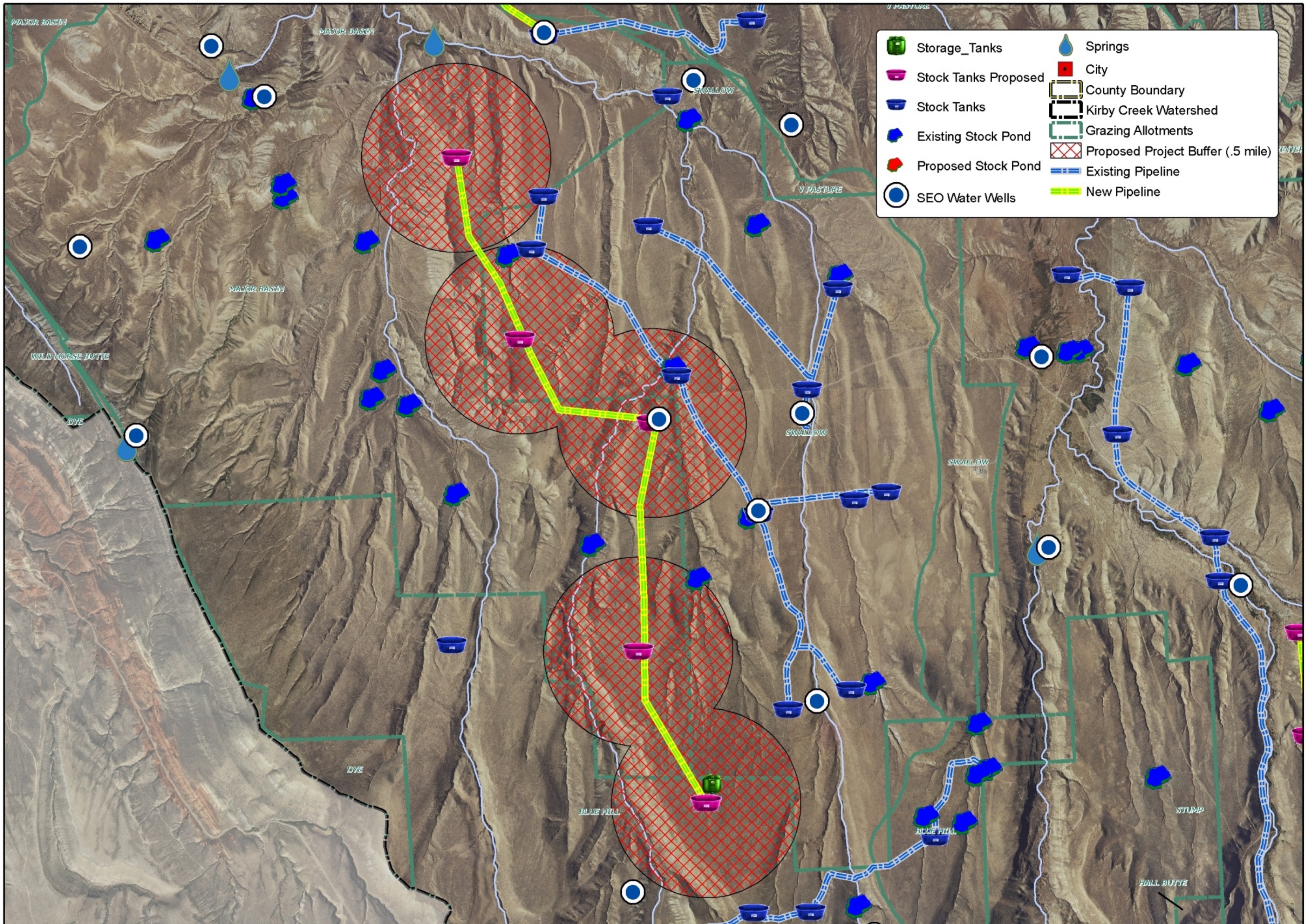

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FIGURE 4.14	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: UWD-7: Major Basin Pipeline Project	N; 0 0.25 0.5 1 Miles
PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

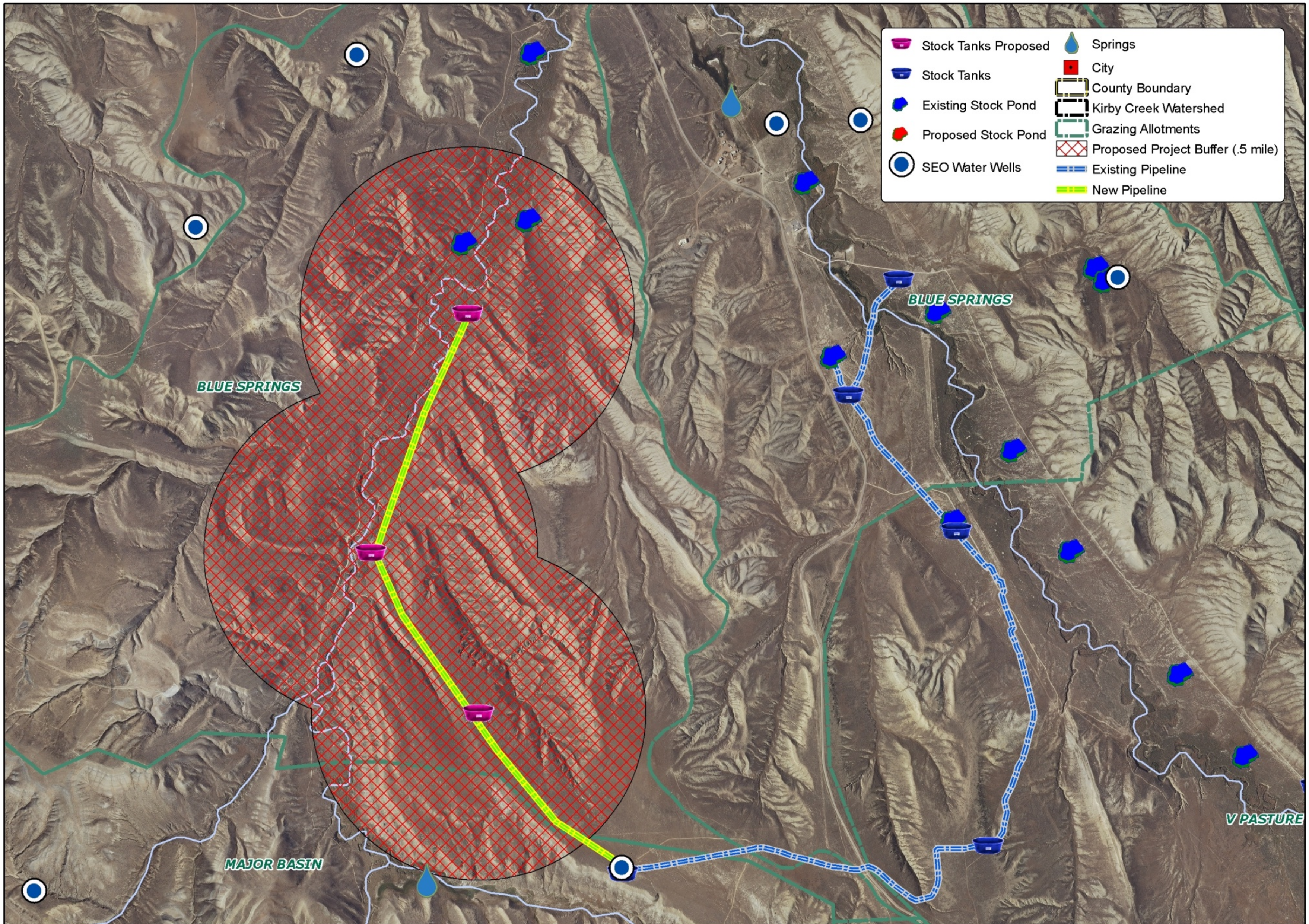

FIGURE 4.15

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: UWD-8: Blue Springs Pipeline Project-1

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

N

0 0.15 0.3 0.6 Miles

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- Three (3) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.15**. Stock tank locations would be selected to optimize management of the grazing allotment.

4.3.2.9 Blue Springs Pipeline Project – 2

This proposed pipeline would cover an area between Alkali Creek and Blue Springs Draw. The area served by this system is entirely within the Blue Springs Allotment. Water supply would come from an existing well permitted to Frank H. Smith (Thomas #1, Permit #P18931P) with a reported yield of 25 gpm (WYSEO 2010). **Figure 4.16** displays the general configuration of this project.

Elements required for this project:

- An existing well would be utilized to supply this pipeline system. The well would be equipped with a pump and solar power source to pump water to a storage tank.
- A storage tank (12,000 gallon capacity) would be installed near the center of the system (high point) to feed the stock tanks via gravity flow.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 12,700 linear feet.
- Five (5) stock tanks (1,200 gallon capacity) would be constructed, roughly placed at the locations shown in **Figure 4.16**. Stock tank locations would be selected to optimize management of the grazing allotments.

4.3.2.10 Blue Springs-Kirby Creek Pipeline Project

This proposed pipeline would address an absence of reliable water in a draw located just west of Blue Springs Draw. The water source for the project would be the Blue Springs, which would need to be developed and/or improved in order to serve as a reliable water source. Water from the spring would be stored in a nearby storage tank, from which it could be pumped over to the adjacent drainage. The area served by this system is located entirely within the Kirby Creek Allotment. F**igure 4.17** displays the general configuration of this project.

Elements required for this project:

- The existing Blue Springs would be utilized to supply this pipeline system. The spring would need to be cleaned and improved. Some of the flow from the springs would be directed to a storage tank equipped with a pump and solar power source to pump water over the drainage divide.
- A storage tank (8,000 gallon capacity) would be installed near the spring.
- The total length of HDPE pipeline (1.5-inch diameter) would be approx. 8,500 linear feet.
- The pipeline would terminate at an existing stock pond located in the adjacent drainage (**Figure 4.18**).

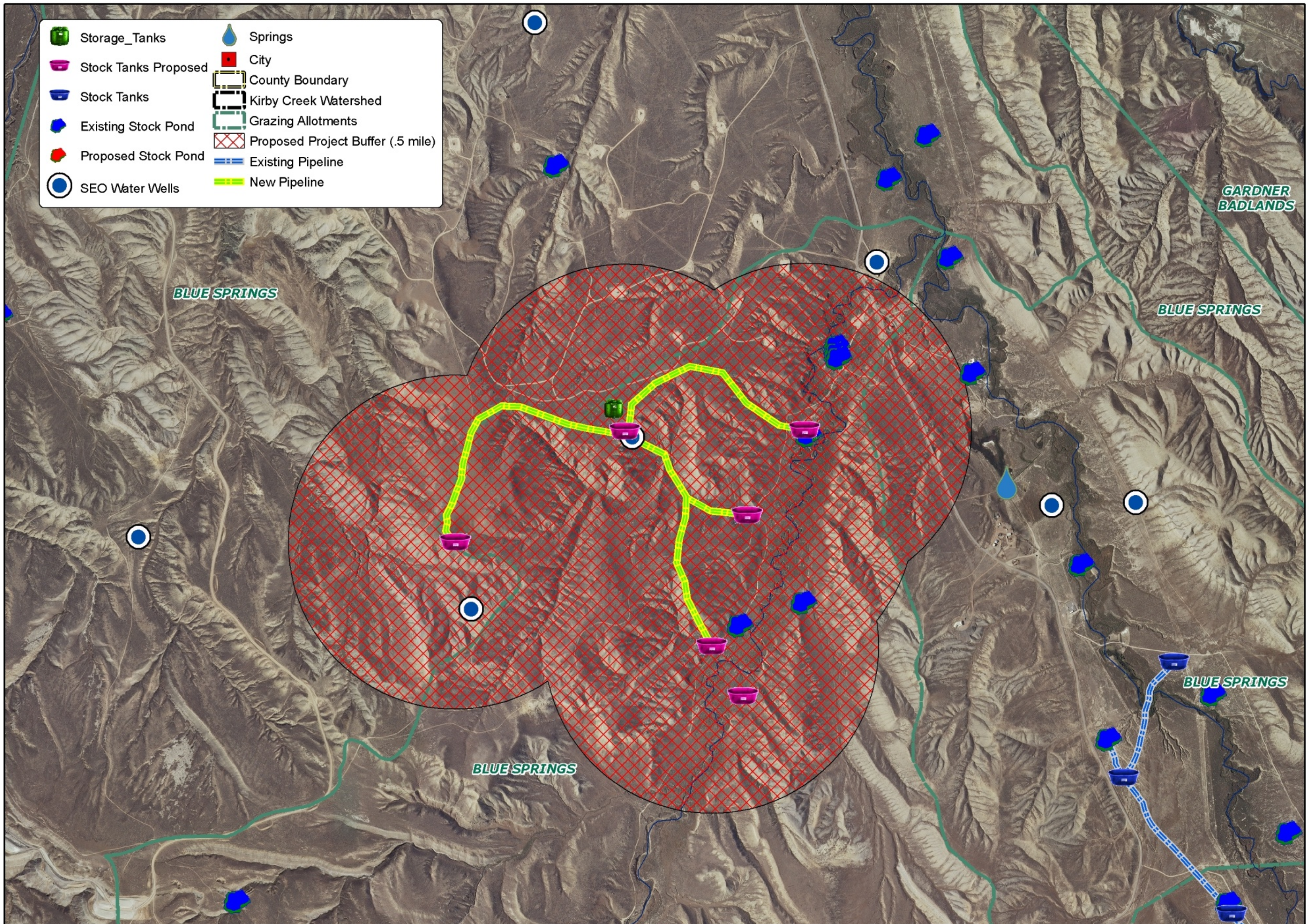

FIGURE 4.16

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: UWD-9: Blue Springs Pipeline Project-2

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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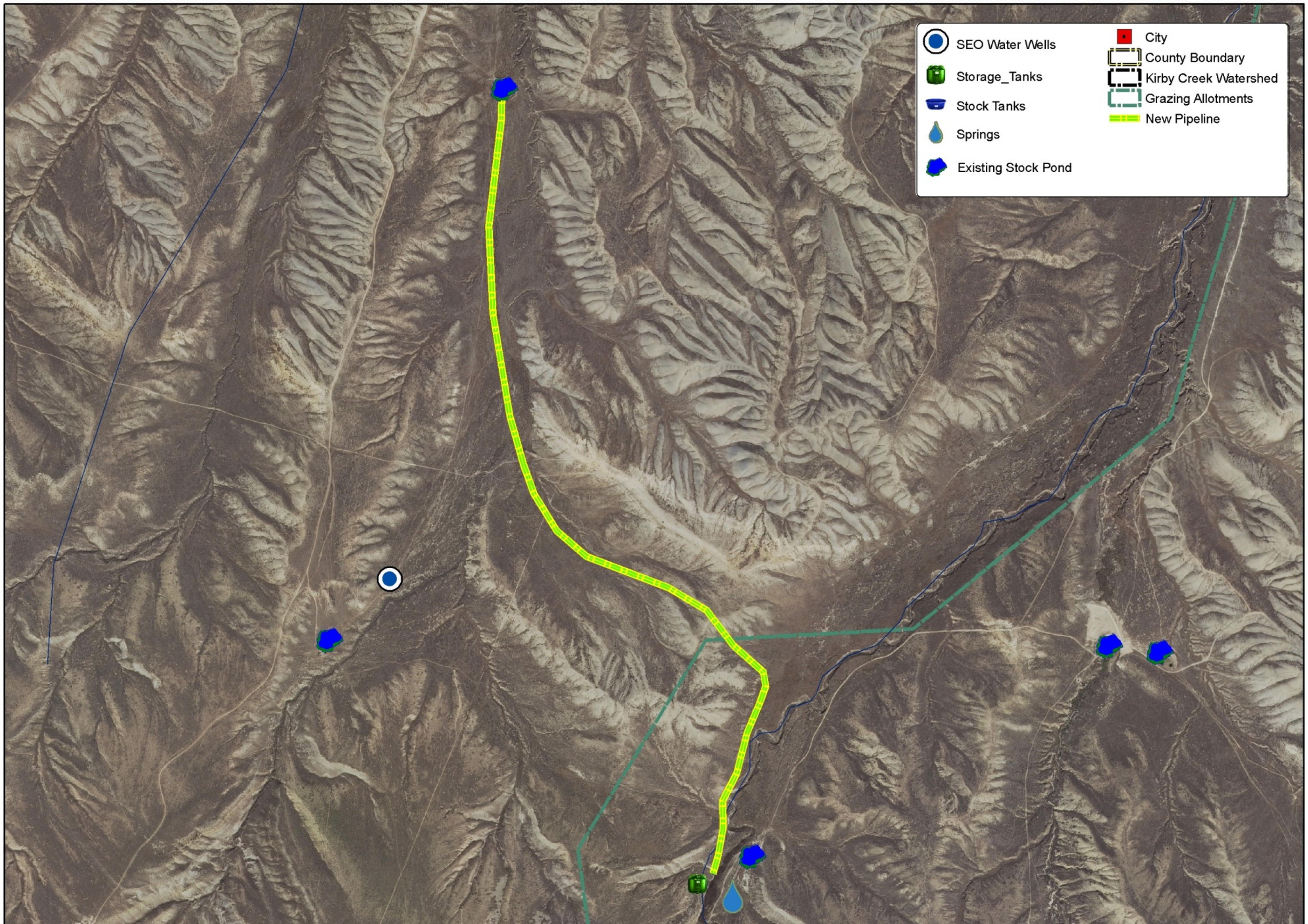

FIGURE 4.17	PROJECT NAME Kirby Creek Watershed Study	FIGURE TITLE: UWD-10: Blue Springs-Kirby Pipeline Project	
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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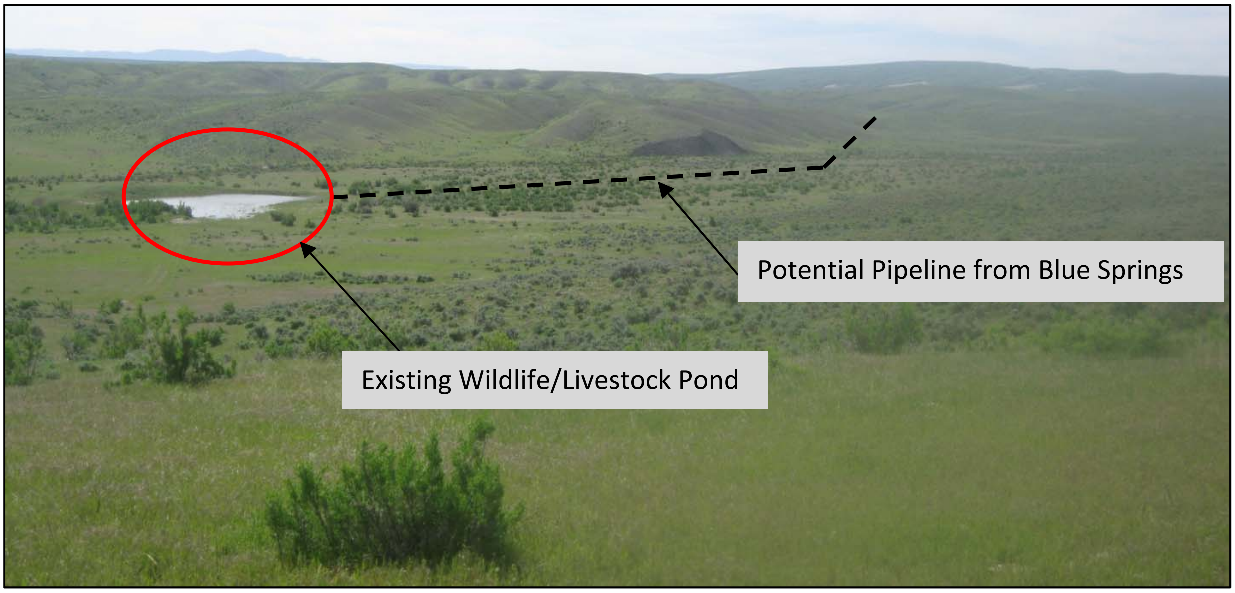

Figure 4.18. Potential route of pipeline entering draw to west of Blue Springs Draw.

4.3.2.11 Red Springs Draw Pipeline Project

This project would tie into an existing pipeline system already in place on the north side of Black Mountain Road in the Red Springs Draw Allotment. An extension of the existing system would run east-west along the northern watershed boundary to provide better distribution of livestock for grazing. **Figure 4.19** shows the addition of this branch pipeline that would convey water to two proposed stock tanks.

Note: The general concept for this pipeline project was discussed with Tom Anderson during a field visit in July 2009.

Elements required for this project:

- A pipeline extension would be added from an existing pipeline that runs north-south. Two stock tanks would be located along the pipeline, one each at the midpoint and at the far end.
- The total length of HDPE pipeline (1.5-inch diameter) would be approx. 7,400 linear feet.

4.3.2.12 South Lucerne Pipeline Project

This project would be used to transport water from BLM land (South Lucerne Group Allotment) north of Black Mountain Road to the southeast corner of the Bunch property. The pipeline would need to pass beneath the highway and cross Kirby Creek. **Figure 4.20** shows the location of this pipeline.

Note: The general concept for this pipeline project was discussed with Chuck Bunch during a field visit in July 2009.

Elements required for this project:

- A pipeline system would be constructed to convey water from BLM ground to private lands.
- The total length of HDPE pipeline (1.5-inch diameter) would be approximately 3,200 linear feet.

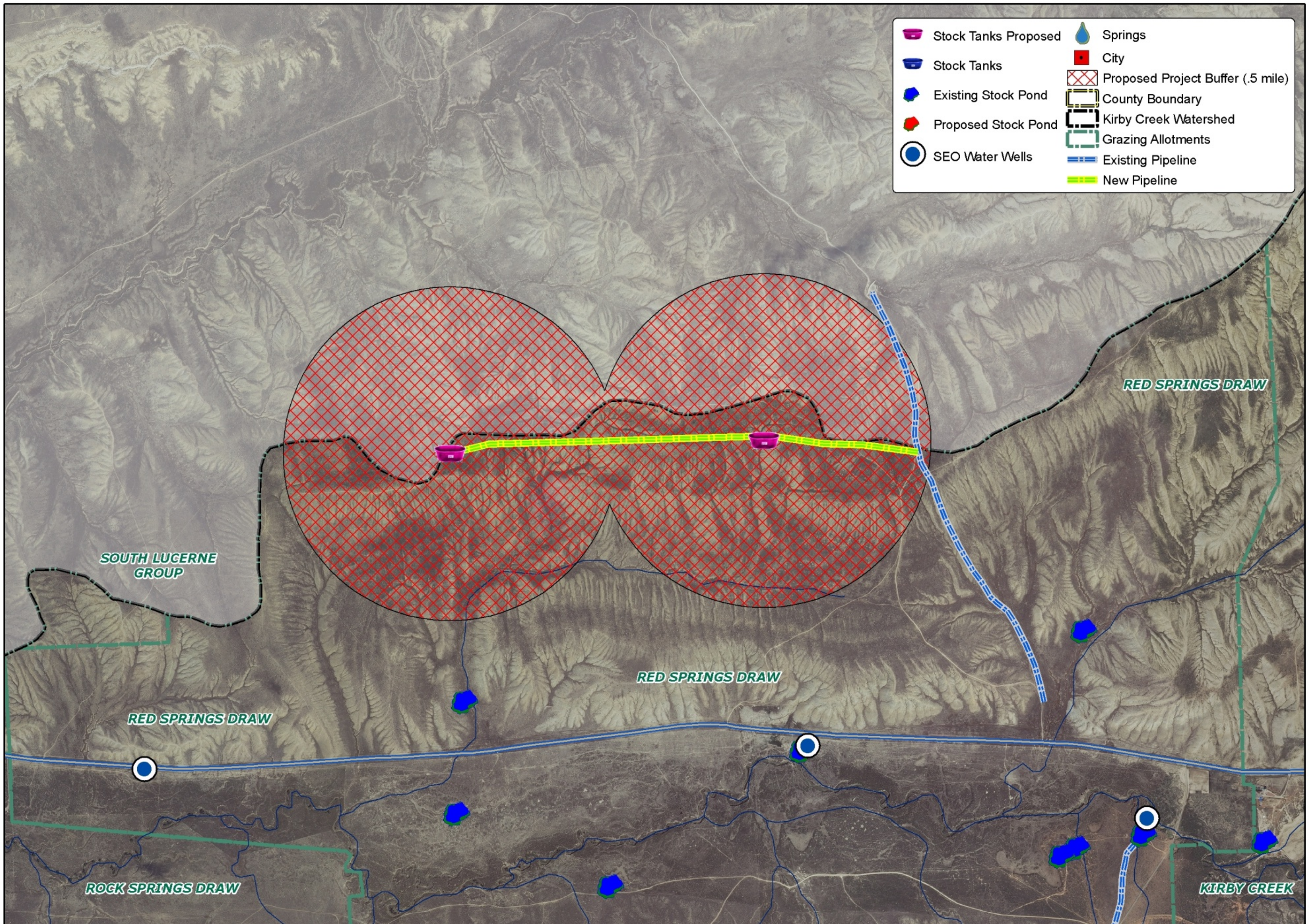

FIGURE 4.19

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: UWD-11: Red Springs Draw Pipeline Project

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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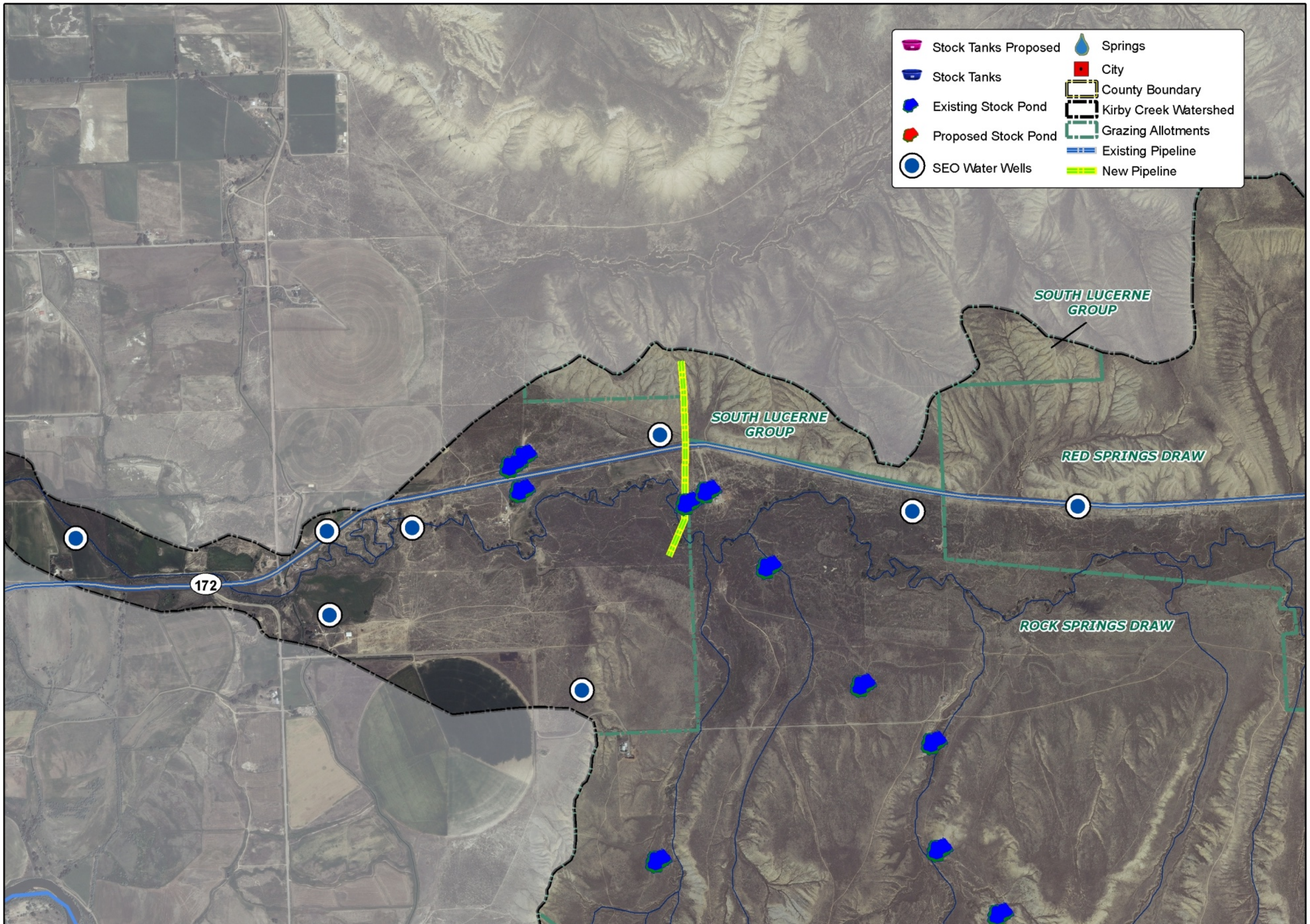

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FIGURE 4.20	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: UWD-12: South Lucerne Pipeline Project		N; 0, 0.15, 0.3, 0.6 Miles
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

4.3.2.13 Blue Springs Development

Blue Springs is a small spring that flows into Blue Springs Draw, which drains a larger watershed area. In the past, Blue Springs has been developed, with a small channel leading down to an impoundment (**Figure 4.21**). There may be some potential to enhance this spring by cleaning out the silt and possibly piping the water for use in a different area. A proposed pipeline project (**Figure 4.17**) would transport flows from Blue Springs into the next draw to the west. **Appendix G** provides example drawings for spring development.

Figure 4.21. Blue Springs.

4.3.2.14 Pat's Pond – Paradise K Ranch

Upland water sources are limited within the higher elevation portions of the Lower Kirby Creek sub-watershed. With few water sources to supply potential pipeline/stock tank projects, the potential for additional stock pond construction was explored. One location appeared suitable for stock pond development. This site is located on private land (Paradise K Ranch); it would also serve a grazing area located in the Rock Springs Draw Allotment. This project would enhance a small depressional area that is seasonally wet. Through construction of an earthen berm, and minor surface excavation/grading, a small stock pond could be created that would have improved water retention characteristics (**Figure 4.22)** provides a generalized plan view of the pond location and pool footprint). Flow into the pond would originate from local surface runoff. An intermittent stream channel also flows into the pond area from the south and would further supplement the water supply.

The earthen berm would likely be no higher than six (6) feet above the surrounding ground surface. Estimated surface area of the stock pond at maximum capacity is 1.5 – 2.5 acres, with a corresponding storage volume of approximately 6 - 8 acre-feet.

Note: The general concept for this stock pond project was discussed with John Baird during a field visit in December 2009.

FIGURE 4.22

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: SP-1: Paradise K Ranch - Pat's Pond

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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4.4 In-Stream Pond Opportunities

The potential to develop in-stream ponds through re-activation of historic meanders and developing historic oxbows was evaluated using color aerial imagery from 2009 and on-the-ground reconnaissance. Areas where a broad floodplain existed and there was evidence of the channel migrating across the floodplain were also included when there appeared to be the potential for water resource development. The goal of this assessment was to identify areas where potential restoration projects similar to the recently completed Lucy Moore project (**Figure 3.46**) and the planned Stan's Folly project (**Figure 4.34**), which are discussed in more detail in **Section 3.6.3** and **Section 4.4.4.1**. In these two projects, historic meander channels were re-activated, and the existing channel was converted into a series of in-stream ponds. This restoration strategy mimics the natural system in which beavers pond water and secondary channels form as water flows around dams. An example of this was observed on East Kirby Creek. These projects increase water storage through surface water impoundment, as well as by subsurface retention in the alluvium, especially during flood events (for more on riparian/wetland functions see **Section 3.2.5.2**).

The historic meander channel assessment was conducted along the mainstem of Kirby Creek and along Lake Creek. Potential sites for in-stream pond development, historic meander re-activation, and historic oxbow development were identified. There appeared to be relatively little potential for these types of projects on East Kirby Creek, West Kirby Creek, or Alkali Creek since these stream channels are generally confined within narrow valleys, though there may be some potential in localized areas. Through this assessment, a total of 42 potential sites were identified, with 38 sites along Kirby Creek and four sites along Lake Creek (**Figure 4.23**). Along Kirby Creek, approximately 9.3 miles of historic meander channels were identified, while along Lake Creek approximately 0.6 miles of historic meander channels were identified (**Table 4.2**). Once identified, the potential for water resource development was ranked as follows:

3 – prime: well defined historic channel, moderately/deeply entrenched existing channel

2 – suitable: moderately defined historic channel, moderately/deeply entrenched existing channel

1 – questionable: broad floodplain lacking evidence of historic channel, minimal/moderate entrenchment along existing channel

The potential for stream restoration and water resource development at each site was ranked by three of the project team members, including a water resources engineer, a wetland ecologist, and a hydrologist, who each provided a unique perspective when evaluating potential sites. Through this process, nine sites were identified as prime sites for historic meander re-activation and three sites were identified for historic oxbow development. Out of the nine sites identified as prime for meander re-activation, two are located within the planned Stan's Folly project, resulting in a total of seven new sites for consideration. Several of these sites were then examined on-the-ground; a brief summary of planned projects is presented in this section, along with discussion of an area where a potential channel avulsion may occur.

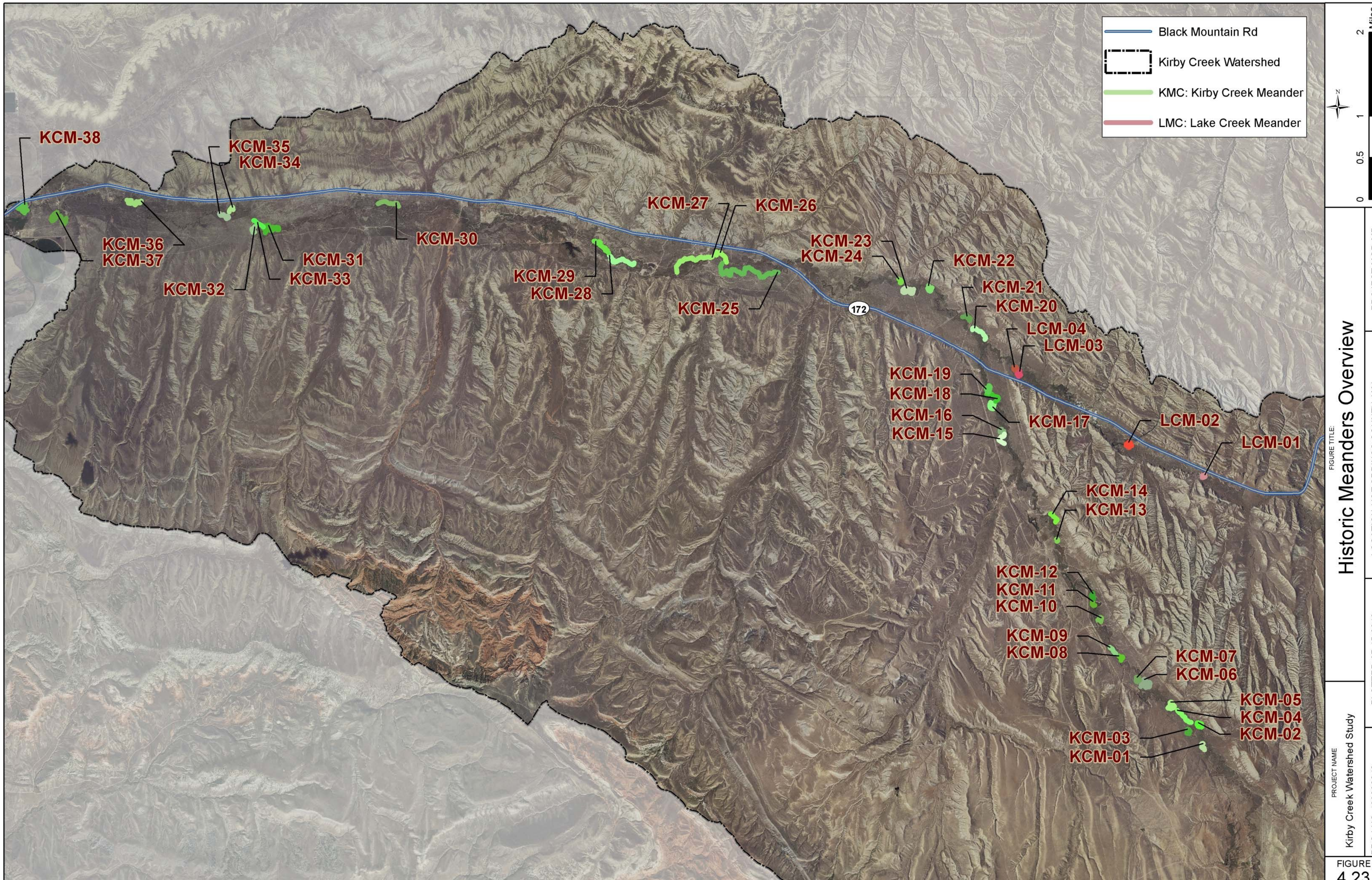

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Table 4.2. Length of Historic Meander Channels along Kirby Creek and Lake Creek.

Stream	Meander ID	Length (ft)	Priority [1]	Comment
Kirby Creek	KCM-01	674	2	
Kirby Creek	**KCM-02**	**959**	**3**	**Historic Oxbow Development Priority Site**
Kirby Creek	**KCM-03**	**661**	**3**	**Historic Oxbow Development Priority Site**
Kirby Creek	KCM-04	1271	3	(ranked as high priority, but determined to be unsuitable in field)
Kirby Creek	**KCM-05**	**1638**	**3**	**Historic Oxbow Development Priority Site**
Kirby Creek	KCM-06	1776	2	
Kirby Creek	KCM-07	700	1	
Kirby Creek	KCM-08	559	2	
Kirby Creek	KCM-09	611	2	
Kirby Creek	KCM-10	599	1	
Kirby Creek	KCM-11	432	2	
Kirby Creek	KCM-12	514	2	
Kirby Creek	KCM-13	227	2	
Kirby Creek	**KCM-14**	**869**	**3**	**In-stream Pond and Historic Channel Re-activation Priority Site**
Kirby Creek	KCM-15	1052	2	
Kirby Creek	KCM-16	572	2	
Kirby Creek	KCM-17	971	1	
Kirby Creek	KCM-18	1152	2	
Kirby Creek	KCM-19	849	1	
Kirby Creek	**KCM-20**	**1397**	**3**	**In-stream Pond and Historic Channel Re-activation Priority Site**
Kirby Creek	KCM-21	820	1	
Kirby Creek	**KCM-22**	**825**	**3**	**Stan's Folly Restoration Project**
Kirby Creek	**KCM-23**	**1872**	**3**	**Stan's Folly Restoration Project**
Kirby Creek	KCM-24	402	1	
Kirby Creek	KCM-25	5839	1	
Kirby Creek	KCM-26	1341	2	
Kirby Creek	KCM-27	3224	2	
Kirby Creek	KCM-28	2451	3	(likely too deeply entrenched for effective meander re-activation)
Kirby Creek	KCM-29	1627	2	
Kirby Creek	KCM-30	1519	2	
Kirby Creek	KCM-31	2581	3	(likely too deeply entrenched for effective meander re-activation)
Kirby Creek	KCM-32	624	2	
Kirby Creek	KCM-33	770	3	(likely too deeply entrenched for effective meander re-activation)
Kirby Creek	KCM-34	585	2	
Kirby Creek	KCM-35	1056	1	
Kirby Creek	KCM-36	1883	2	
Kirby Creek	KCM-37	2395	1	
Kirby Creek	KCM-38	1905	2	
Lake Creek	LCM-01	570	1	
Lake Creek	LCM-02	1007	2	
Lake Creek	**LCM-03**	**773**	**3**	**In-stream Pond and Historic Channel Re-activation Priority Site**
Lake Creek	LCM-04	674	2	

4.4.1 In-stream Pond Development and Historic Channel Re-activation

A total of nine sites were identified for in-stream pond development and historic channel re-activation, with seven new sites identified, and two sites in which the Stan's Folly project (KCM-22 and KCM-23) is already planned. Six of the sites are on Kirby Creek and one site is on Lake Creek. Out of these seven sites, four were evaluated on the ground, including:

- KCM-04
- KCM-14
- KCM-20
- LCM-03

The remaining three sites (KCM-28, KCM-31, and KCM-33), which are located in lower Kirby Creek, were not evaluated on-the-ground, though a general reconnaissance of this portion of Kirby Creek and discussions with local landowners indicated that the channel may be too deeply entrenched for effective historic channel re-activation. Alternative restoration strategies for lower Kirby Creek are presented in **Section 4.5**.

Of the four assessed historic meanders, KCM-14, KCM-20, and LCM-03 appeared to be suitable candidates for potential water resource development projects, while KCM-04 was determined to be unsuitable due to a large drop in elevation at the outlet of the historic channel. KCM-14 is located on Kirby Creek upstream of the confluence with Alkali Creek (**Figures 4.24** and **4.25**). KCM-14 carried streamflow during the rain event prior to the 5/26/10 site visit. There was an estimated 5 - 7 foot difference between the bottom of the existing channel and the historic channel bed at the inlet, though the height was difficult to accurately assess since there was a high streamflow in Kirby Creek at the time of the site visit. KCM-20 is located on Kirby Creek just downstream of the confluence with Lake Creek (**Figures 4.26** and **4.27**). KCM-20 carried streamflow during the rain event prior to the 5/26/10 site visit. There was pink flagging along this historic channel suggesting that it has been identified as a potential restoration site by watershed stakeholders. Incision within the existing channel was estimated to be similar to that at the Stan's Folly site, which is located downstream. Note is made that the proposed meander restoration at KCM-20 could potentially result in a reduction in channel length from the existing channel. However, overall function of the channel and its surrounding floodplain would be improved over the existing conditions because the elevation of the stream would be raised by several feet and access of high streamflows to the floodplain would be facilitated.

On Lake Creek, LCM-03 was observed from the road since access had not been obtained to the property at the time of the site visit. The historic channel is situated to the south of the existing channel. On the aerial photo, there is a clear historic meander channel and this site warrants further investigation (**Figure 4.28**). A second well defined historic channel (LCM-04) is visible just downstream of this site, though it forms a loop off of a relatively short section of stream, which may make it more difficult to incorporate into a water resources development project.

Figure 4.24. Historic Channel KCM-14 at Inlet (Left) and Outlet (Right).

Figure 4.26. Historic Channel KCM-20.

FIGURE 4.25	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Historic Meander Overview - KCM-14		N 0 100 200 400 Feet
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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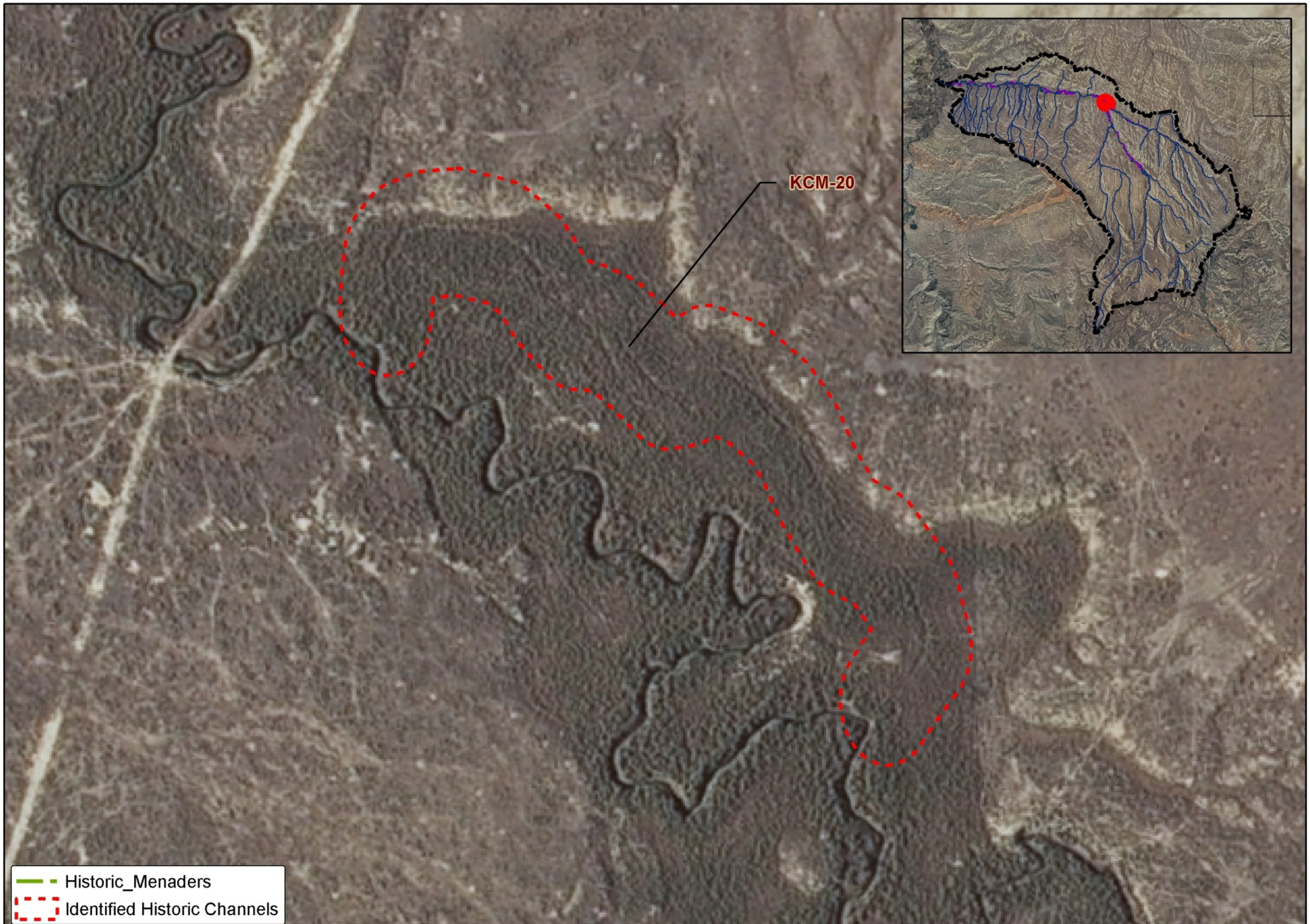

FIGURE 4.27

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE:

Historic Meander Overview - KCM-20

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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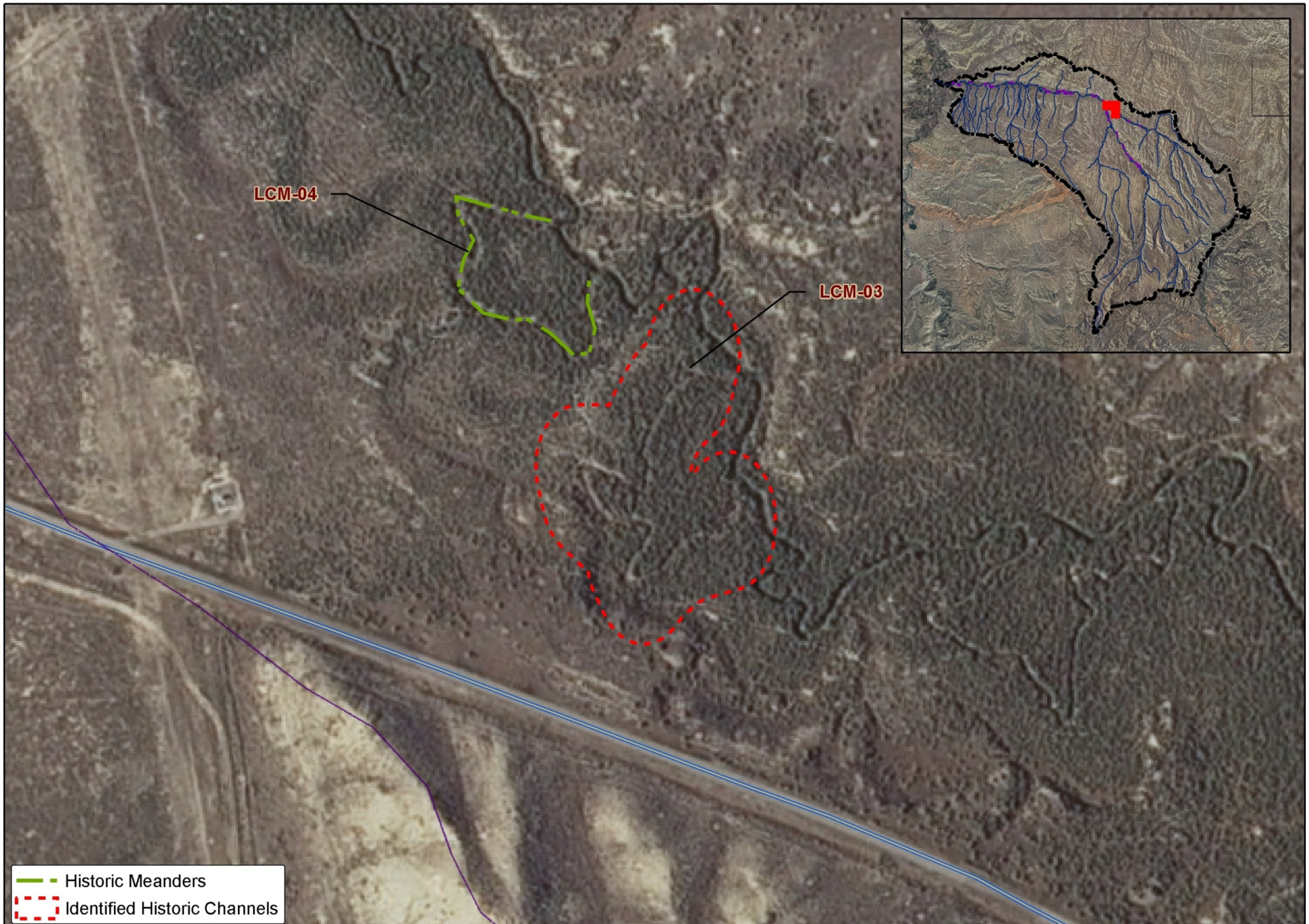

FIGURE 4.28	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: Historic Meander Overview - LCM-03	N; 0 100 200 400 Feet
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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4.4.2 Historic Oxbow Development

A total of three sites were identified for historic oxbow development, all of which are located along a relatively short reach of Kirby Creek approximately 2.5 miles downstream from the confluence of East Kirby Creek and West Kirby Creek. Historic oxbows identified as potential water resource development sites include KCM-02, KCM-03 and KCM-05 (**Figure 4.29**). All three potential historic oxbow development sites were assessed on-the-ground. KCM-02 was determined to be feasible, but would likely yield relatively little benefit and was thus discarded from further analysis. KCM-03 was noted to have the potential for wetland creation (**Figure 4.30**). This site contained standing water during the site visit on 5/25/10 following a significant rain event. KCM-05 also has potential, perhaps for an in-stream impoundment that ponds water back up into the historic oxbow (**Figure 4.31**). There is a large eroding bank on Kirby Creek upstream of this site and a "peninsula" deflecting water toward the historic oxbow that appears to be about to erode. This site warrants further investigation since streambank erosion along Kirby Creek upstream of the historic oxbow is a concern.

Figure 4.30. Historic Oxbow KCM-03.

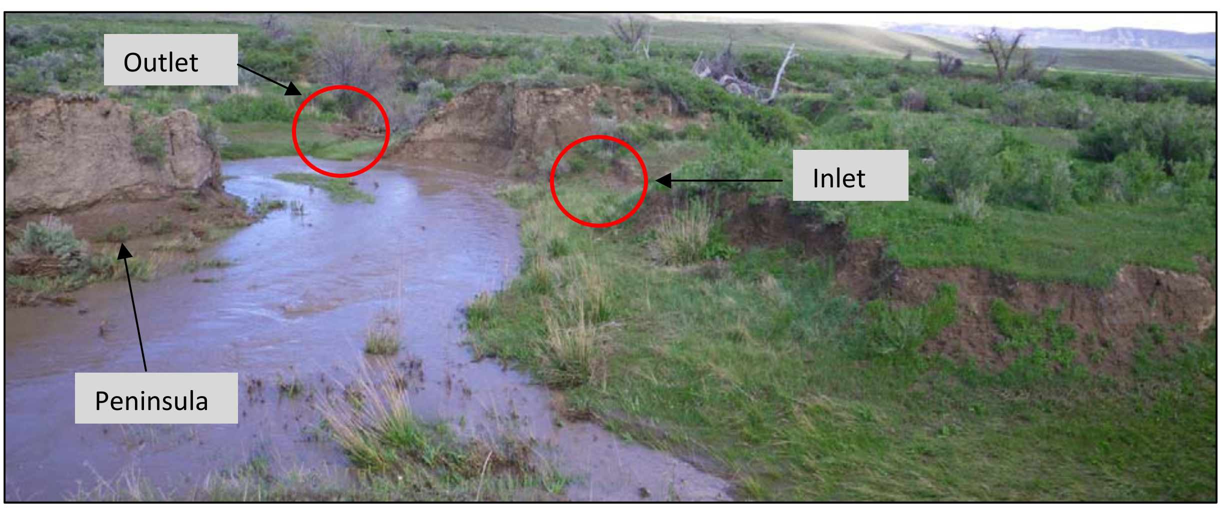
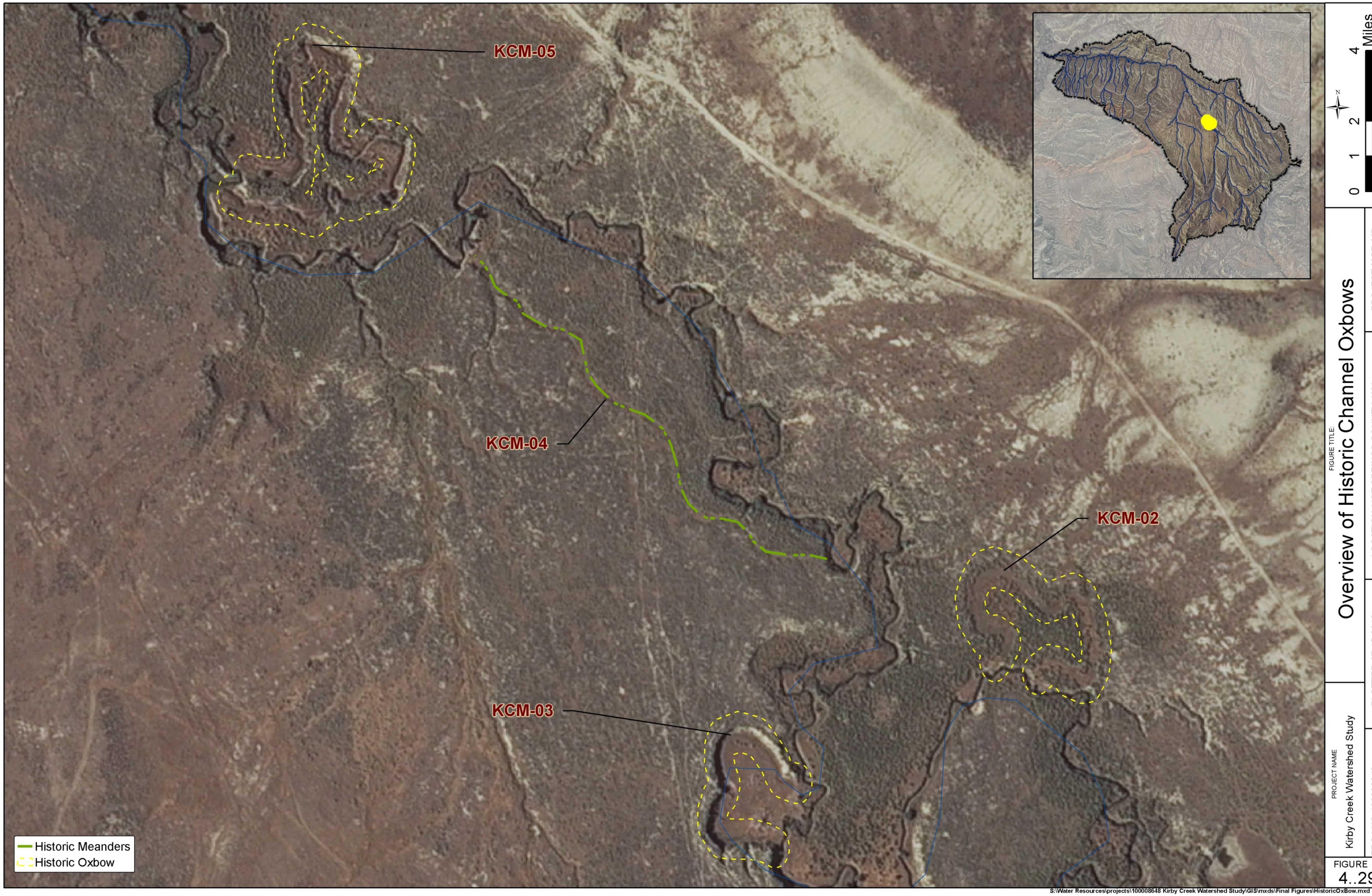


Figure 4.31. Historic Oxbow KCM-05.



KCM-05
KCM-04
KCM-02
KCM-03
Historic Meanders
Historic Oxbow
0
1
2
4
Miles
FIGURE TITLE:
Overview of Historic Channel Oxbows
PROJECT NAME
Kirby Creek Watershed Study
PROJECT MGR:MR
LOCATION:HOT SPRINGS COUNTY, WY
PLOTTED:07-15-2010
PROJ NO:100008648
FIGURE
4..29
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4.4.3 Existing Meander Preservation

During on-the-ground reconnaissance, one site where a channel avulsion is about to occur was observed along Kirby Creek approximately 0.7 miles downstream of the recently completed Twin Tubes project and upstream of the proposed historic meander re-activation at KCM-14 (**Figures 4.32** and **4.33**). It is recommended that action be taken to prevent this from happening since an existing meander bend totaling approximately 500 feet of channel will be lost and upstream headcutting may be initiated.

Figure 4.32. Headcutting and Potential Channel Avulsion along Kirby Creek**.**

4.4.4 Planned Restoration Projects

During this assessment, two sites were visited with watershed stakeholders where restoration projects are currently planned. These sites include the Stan's Folly Project on Kirby Creek and the West Mishurda Diversion Project on West Kirby Creek. Both projects are expected to be completed in 2010.

4.4.4.1 Stan's Folly In-stream Pond Development and Channel Restoration Project

The Stan's Folly project is located on Kirby Creek downstream of the Lake Creek confluence (**Figure 4.34**). This project involves the addition of four dikes within the existing channel and the re-establishment of the historic channel at two meander bends (KCM-22 and KCM-23), which are located along the river left side of the channel. The current channel is deeply entrenched, with an estimated stream type of G6c, indicating a low width-to-depth ratio, low slope, fine substrate, and a lack of floodplain access. Once this project is completed, water storage will be increased through ponding behind the dikes. In addition, with the primary flow re-directed into the historic channel, improved floodplain access will increase subsurface water storage and expand the riparian area.

FIGURE 4.33

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: Potential Channel Avulsion Along Kirby Creek

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

N

0 45 90 180 Feet

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Figure 4.34. Stan's Folly Project Existing Channel and Historic Channel.

4.4.4.2 West Mishurda Diversion Project

On West Kirby Creek, there is a planned project to construct one dike across the main channel. The channel is entrenched downstream of the project site and the entrenchment is migrating upstream into a high quality wetland area (**Figure 4.35**). There is active headcutting within the entrenched area and the streambanks were observed to be falling into the channel. The purpose of the project is to arrest the upstream migration of the headcut and to maintain the point of diversion for the West Mishurda Diversion. Upstream of the existing headcut, there is an E type channel meandering through a wetland area. It may be advantageous to salvage the wetland vegetation from the construction site for use along the new channel and the sides of the impoundment.

Figure 4.35. Entrenched Channel Downstream of Proposed Project Area and Existing Channel within Proposed Project Area.

4.4.5 Additional In-Stream Pond Opportunities

4.4.5.1 Lower Kirby Creek In-stream Pond

This proposed in-stream pond is located in the Lower Kirby Creek sub-watershed (**Figure 4.36**). The pond would be created by constructing an impoundment structure across the Kirby Creek channel coupled with minor grading of an existing depressional area located immediately south of the channel. Creek flow would inundate the graded area and form a pond/small reservoir. The impoundment structure would consist of an earthen berm about 8 – 10 feet in height, and include a properly designed and sized emergency spillway. A rough estimate of potential surface area for this pond at maximum capacity is 6 – 8 acres. The corresponding estimated storage volume is 25 - 40 acre-feet. **Appendix G** provides some basic design and construction guidelines that apply to stock pond implementation.

Note: The general concept for this in-stream pond was discussed with John Baird during a field visit in December 2009.

4.4.5.2 Alkali Creek In-stream Pond

This proposed in-stream pond is located along Alkali Creek (**Figure 4.37**). The pond would be created by constructing an impoundment structure across a narrow point in the Alkali Creek valley. Creek flow would inundate the area immediately upstream and form a stock pond/small reservoir. The impoundment structure would consist of an earthen berm about 5 – 6 feet in height, and include a properly designed and sized emergency spillway. A rough estimate of potential surface area for this pond at maximum capacity is 2 – 3 acres. The corresponding estimated storage volume is 8 – 12 acre-feet.

It is anticipated this stock pond would be a seasonal source of water due to the fact that Alkali Creek only flows intermittently at this point in the sub-watershed.

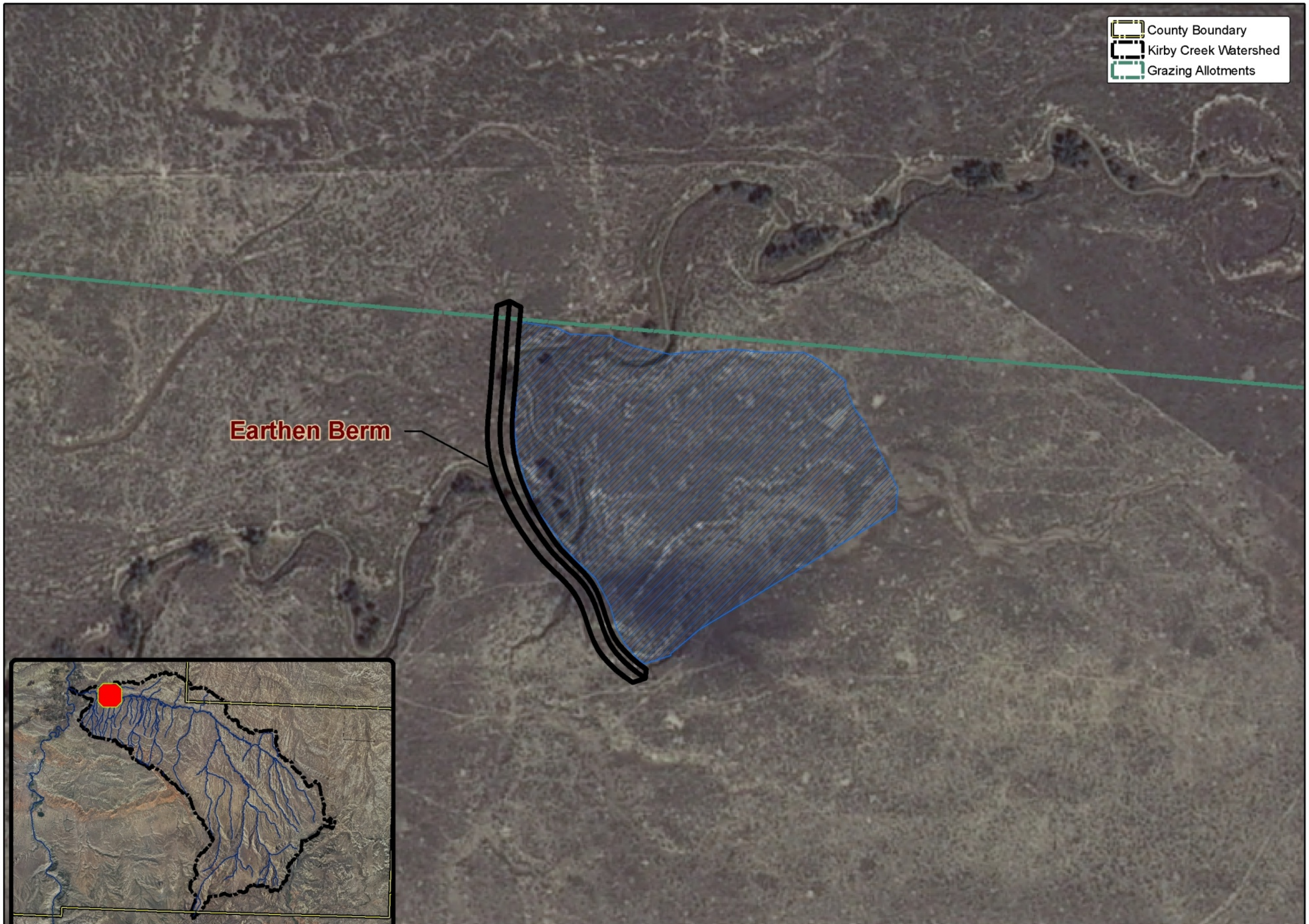

FIGURE 4.36

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: ISP-1: Kirby Creek-Rock Springs Draw

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

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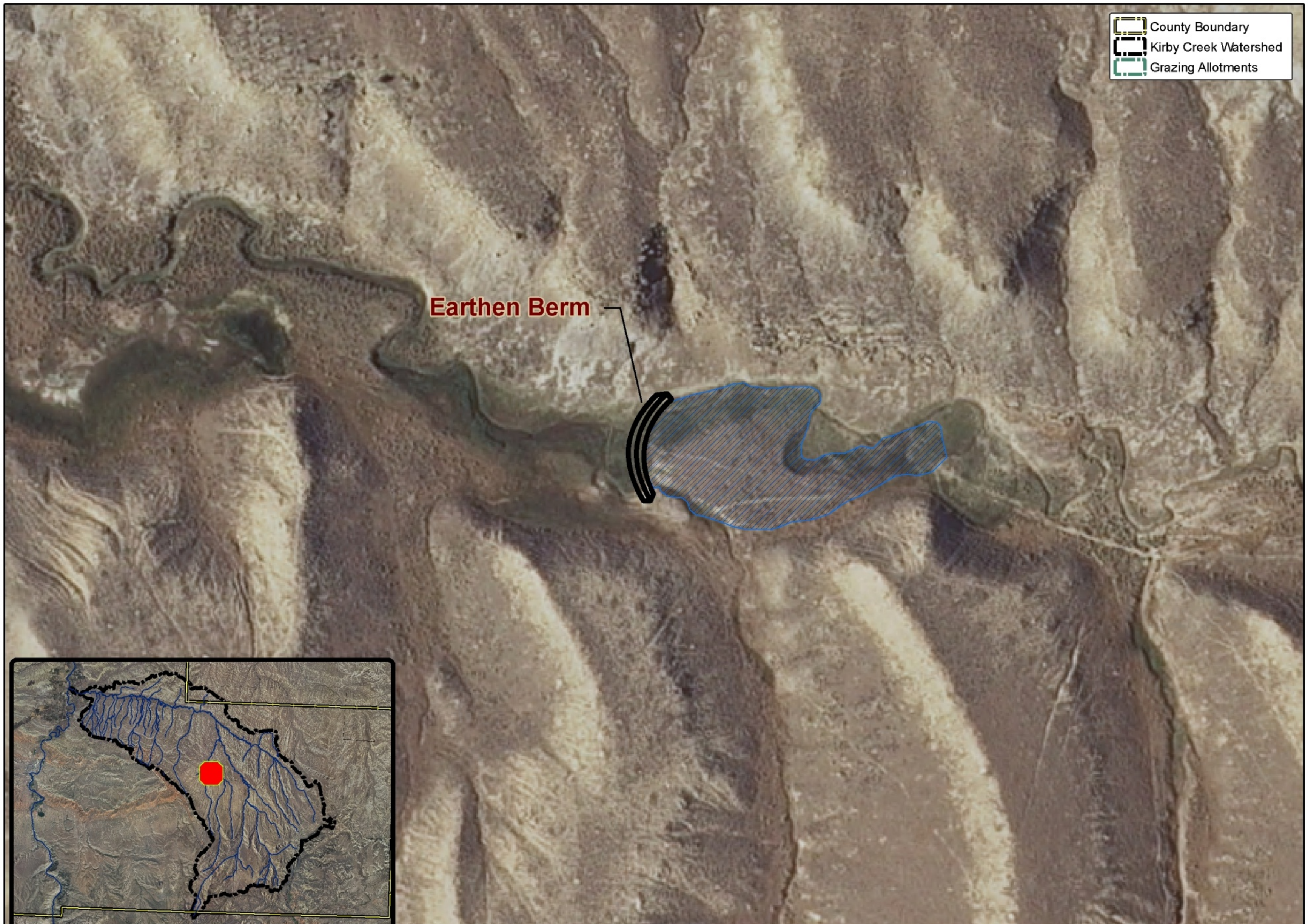

FIGURE 4.37	PROJECT NAME: Kirby Creek Watershed Study	FIGURE TITLE: ISP-2: Alkali Creek Pond		0 100 200 400 Feet
	PROJ NO: *100008648*	PLOTTED: *07-15-2010*	LOCATION: *HOT SPRINGS COUNTY, WY*	PROJECT MGR: *MR*

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4.5 STREAM CHANNEL RESTORATION OPPORTUNITIES

In addition to the stream meander preservation/re-activation, historic oxbow development, and in-stream pond development projects discussed in the previous sections, other opportunities exist for restoring entrenched sections of stream and stabilizing headcuts.

4.5.1 Restoring Entrenched Sections of Stream

As discussed in **Section 3.6.2.1**, Kirby Creek consists of several stream types describing a typical channel evolution process as a stream becomes incised and establishes a new base elevation. The process of incision generally progresses from an E to Gc to F to E stream type as a stream downcuts, then erodes away its banks, and finally develops a new floodplain at a lower elevation from the original floodplain (Rosgen 1996). Each of these stages is apparent along different portions of Kirby Creek. In situations where Gc and F stream types exist, it may be appropriate to try and accelerate the floodplain development process. For Gc channels, this would involve creation of a new floodplain, while for F channels, this would involve actively narrowing the channel and developing a new floodplain. For the segments of lower Kirby Creek that are severely entrenched, there is the potential to develop a new floodplain at the new base elevation. This has occurred naturally in some areas as depicted in **Figure 4.38**. Entrenched reaches lacking floodplain access are candidates for this type of restoration. Restoring these entrenched reaches has many benefits, including reducing sediment loads from streambank erosion, increasing floodplain surface/subsurface water storage, dissipating flood energy which could help reduce additional downcutting in downstream reaches, expanding riparian habitat, increasing forage production in these areas, improving livestock access to water in the stream, along with improving the overall habitat quality and aesthetic characteristics of the valley through which Kirby Creek flows.

Figure 4.38. Example of Potential Future Condition for Kirby Creek.

Most of the channel restoration projects constructed in the watershed during the last decade have restored incised reaches of channel to varying degrees. The extent to which a restoration project in an incised channel environment is carried out will typically be a function of: 1) the point in the channel evolution process of the incised project reach (i.e., has an inset floodplain begun to develop or is the incised channel still narrowly confined by steep banks?), 2) whether the goal of the project is to re-connect the channel with its historic floodplain or not, and 3) the costs associated with complete re-connection of the channel to its historic floodplain (Rotar and Boyd, 1999).

Reconnection of a channel to its historic floodplain requires re-establishing a channel grade that is at or near the grade that existed before the incision process began. This is typically accomplished through construction of grade controls (e.g., check dams) which are used to promote channel infilling, or to raise water elevations to a level where historic meanders are accessed. In cases where a significant degree of incision has occurred, channel/floodplain re-connection may involve raising the channel bed in combination with some excavation of the historic floodplain surface to tie-in with the partially raised channel bed. Often, the most cost-effective approach to incised channel restoration is to support the natural channel evolution process by facilitating development of a new floodplain surface next to the incised channel for flood energy dissipation and riparian corridor establishment.

Numerous channel restoration and stabilization techniques can be applied as part of entrenched channel restoration projects. These include traditional “hard” engineering solutions as well as more ecologically sensitive “soft” approaches, which are often collectively categorized as ***bioengineering***. Identification of specific entrenched channel restoration projects is beyond the scope of this Level I study; these projects, however, should be based on an assessment of channel stability and function.

4.5.1.1 Stream Restoration Techniques

In order to identify and select appropriate channel restoration and stabilization techniques, it is necessary to develop a series of design criteria that quantify the general project objectives. These criteria, which take into consideration risk and cost according to relative priority, are intended to outline the objectives of the project and provide the foundation for making design decisions about the specific sizes and components of channel protection techniques (Washington 2003). **Table 4.3** provides a list of channel restoration techniques which could be applied in the Kirby Creek watershed.

Table 4.3. Channel Restoration Techniques Organized by Functional Group.

No Action	Flow-Redirection Techniques	Structural Techniques	Biotechnical Techniques	Internal Bank-Drainage Techniques	Avulsion-Prevention Techniques	Other Techniques
Allow bank erosion to continue Move structures at risk	Groins Buried groins Barbs Engineered log jams Drop structures Porous weirs	Anchor points Roughness trees Riprap Log toes Rock toes Log cribwalls Manufactured retention systems	Woody plantings Herbaceous cover Soil reinforcement Coir logs Bank reshaping	Subsurface drainage systems	Floodplain roughness Floodplain grade control Floodplain flow spreader	Channel modifications Riparian-buffer management Spawning-habitat restoration Off-channel spawning and rearing habitat

Source: Washington State – Integrated Streambank Protection Guidelines (2003).

4.5.2 Headcut Stabilization

Channel incision due to headcutting is one of the primary geomorphic processes at work within the Kirby Creek watershed. Arresting headcut migration up stream channels will prevent channel incision and thereby promote overbank flooding onto the floodplains where the stream still has access to them. As mentioned previously (see **Section 3.2.5.2**), floodplain access during flood events reduces flood energies and promotes surface and subsurface water storage in the floodplain.

As part of this assessment, major headcuts were identified and prioritized. Headcuts were assessed through a review of 2009 color aerial imagery and on-the-ground investigations. Headcuts were mapped on the primary named streams and tributaries that appear on the 1:100,000 NHD stream layer. In a few cases, headcuts in tributary draws not on the 1:100,000 NHD layer were also mapped, typically when they were within an area of interest for potential restoration or water development projects. Many of the small dry gulches located throughout the Kirby Creek watershed were also observed to contain headcuts, but these were not mapped.

Headcuts were prioritized for restoration using the following criteria:

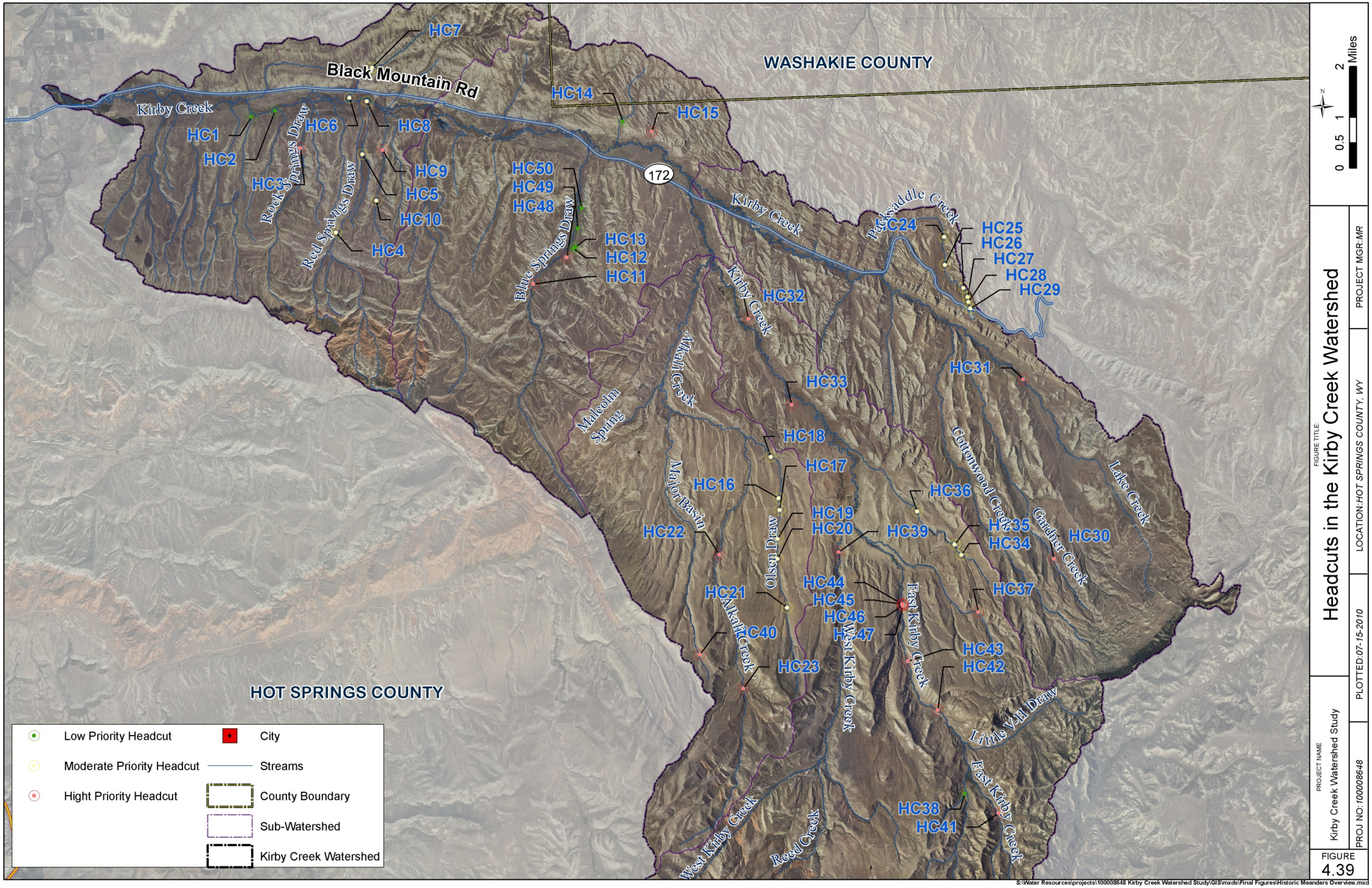
3 – **high priority** – headcut on a primary named stream channel, including Kirby Creek, East Kirby Creek, West Kirby Creek, Lake Creek, Alkali Creek, and Blue Springs Draw; headcut with the potential to deliver a large amount of sediment to a primary named stream channel; headcut threatening a wetland; and/or a headcut that may be negatively influencing a upland wildlife/livestock pond or restoration project

2 – **moderate priority** – headcut on a tributary stream identified on the 1:100,000 NHD layer with more than one identified headcut, including Packsaddle Creek, Red Springs Draw and Olsen Draw

1 – **low priority** – headcut on a tributary stream identified on the 1:100,000 NHD layer with only one identified headcut; headcut on gulch not identified on 1:100,000 NHD layer

Through this process, a total of 50 headcuts were identified for stabilization in the Kirby Creek watershed, including 21 high priority headcuts, 21 moderate priority headcuts, and 8 low priority headcuts (**Figure 4.39** and **Table 4.4**). Note that all of the headcuts identified in this assessment are considered relatively high priority compared to the numerous unmapped headcuts located in ephemeral draws and gulches that are tributaries to the primary stream channels within the Kirby Creek watershed. These unmapped headcuts have the potential to erode large amounts of sediment, which may fill upland wildlife/livestock ponds and stream channels downstream, while also leading to a potential loss of wetland and riparian habitat upstream. Thus, although of lesser priority, these headcuts should also be addressed as time and resources become available.

When headcuts are present within a perennial stream or a channel with the potential to carry a significant streamflow, the placement of drop structures is likely the best restoration option for headcut stabilization as was done in the two recently completed projects on West Kirby Creek (see **Section 3.6.3**). When headcuts occur in dry gulches that only see periodic flows, the use of large cobble to stabilize the headcut may be appropriate (**Figure 4.40**).


WASHAKIE COUNTY
HOT SPRINGS COUNTY
Black Mountain Rd
172
Kirby Creek
Rock Springs Draw
Red Springs Draw
Blue Springs Draw
Packsaddle Creek
Alkali Creek
Malcolm Spring
Major Basin
Olsen Draw
West Kirby Creek
East Kirby Creek
Cottonwood Creek
Gardner Creek
Lake Creek
Little VH Draw
Reed Creek
HC1
HC2
HC3
HC4
HC5
HC6
HC7
HC8
HC9
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HC42
HC43
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HC45
HC46
HC47
HC48
HC49
HC50
Low Priority Headcut
Moderate Priority Headcut
Hight Priority Headcut
City
Streams
County Boundary
Sub-Watershed
Kirby Creek Watershed
0 0.5 1 2 Miles
FIGURE TITLE:
Headcuts in the Kirby Creek Watershed
PROJECT MGR: MR
LOCATION: HOT SPRINGS COUNTY, WY
PLOTTED: 07-15-2010
PROJECT NAME
Kirby Creek Watershed Study
PROJ NO: 100008648
FIGURE
4.39
S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\Historic Meanders Overview.mxd

Table 4.4. Headcut Priority Rankings.

Stream	Tributary To	Priority	HeadcutID
Alkali Creek	Kirby Creek	3	HC22
Alkali Creek	Kirby Creek	3	HC23
Major Basin Draw	Alkali Creek	3	HC40
Olsen Draw	Alkali Creek	2	HC16
Olsen Draw	Alkali Creek	2	HC17
Olsen Draw	Alkali Creek	2	HC18
Olsen Draw	Alkali Creek	2	HC19
Olsen Draw	Alkali Creek	2	HC20
Olsen Draw	Alkali Creek	2	HC21
Blue Springs Draw	Kirby Creek	3	HC11
tributary	Blue Springs Draw	3	HC48
tributary	Blue Springs Draw	1	HC49
tributary	Blue Springs Draw	1	HC50
tributary	Blue Springs Draw	1	HC12
tributary	Blue Springs Draw	1	HC13
East Kirby Creek	Kirby Creek	3	HC42
East Kirby Creek	Kirby Creek	3	HC43
East Kirby Creek	Kirby Creek	3	HC44
East Kirby Creek	Kirby Creek	3	HC45
East Kirby Creek	Kirby Creek	3	HC46
East Kirby Creek	Kirby Creek	3	HC47
tributary	East Kirby Creek	3	HC37
tributary	East Kirby Creek	3	HC41
tributary	East Kirby Creek	1	HC38
Lake Creek	Kirby Creek	3	HC31
Gardner Creek	Lake Creek	3	HC30
Packsaddle Creek	Lake Creek	2	HC24
Packsaddle Creek	Lake Creek	2	HC25
Packsaddle Creek	Lake Creek	2	HC26
Packsaddle Creek	Lake Creek	2	HC27
Packsaddle Creek	Lake Creek	2	HC28
Packsaddle Creek	Lake Creek	2	HC29
Red Springs Draw	Kirby Creek	2	HC4
Red Springs Draw	Kirby Creek	2	HC5
Red Springs Draw	Kirby Creek	2	HC8
Rock Springs Draw	Kirby Creek	3	HC3
tributary	Kirby Creek	3	HC9
tributary	Kirby Creek	3	HC15
tributary	Kirby Creek	3	HC32
tributary	Kirby Creek	3	HC33
tributary	Kirby Creek	2	HC6
tributary	Kirby Creek	2	HC7
tributary	Kirby Creek	2	HC10
tributary	Kirby Creek	2	HC34
tributary	Kirby Creek	2	HC35
tributary	Kirby Creek	2	HC36
tributary	Kirby Creek	1	HC1
tributary	Kirby Creek	1	HC2
tributary	Kirby Creek	1	HC14
West Kirby Creek	Kirby Creek	3	HC39

Figure 4.40. Headcut Stabilization with Large Cobbles in a Tributary to Kirby Creek.

4.5.2.1 East Kirby Creek

Two primary headcuts were identified on East Kirby Creek (HC42 and HC43). Both of these headcuts are located upstream of an in-stream pond that was constructed on East Kirby Creek. The upper headcut (HC42) is located just downstream of a tributary that enters from the northeast. This headcut is 3-4 feet tall and is cutting through a clay lens (**Figure 4.41**). The lower headcut (HC43) is approximately 3 feet tall and may be partially stabilized by a fallen tree (**Figure 4.42**). In addition to these two headcuts, several smaller headcuts were observed downstream of an abandoned beaver dam (HC44-HC47). One headcut (HC41) was identified on a tributary of East Kirby Creek in an area where recent road construction on the Kirby Creek Road has occurred (**Figure 4.43**). It appears that this headcut is moving upstream toward the culvert through loose fill. It may be appropriate to try and stabilize this small tributary downstream of the headcut before it migrates further upstream and reaches the toe of the fill slope. Headcutting was also observed in other tributaries to East Kirby Creek, including a headcut (HC37) which appears to be associated with a breached dam and is threatening a wetland area upstream.

Figure 4.41. Upper Headcut on East Kirby Creek (HC42).

Figure 4.42. Lower Headcut on East Kirby Creek (HC43).

Figure 4.43. Headcut on East Kirby Creek Tributary (HC41) Downstream of Kirby Creek Road Crossing.

4.5.2.2 West Kirby Creek

Only one headcut (HC39) was identified on West Kirby Creek. The West Mishurda Diversion Project is planned upstream of this headcut, which should arrest its upstream migration (see **Section 4.4.4.2**).

4.5.2.3 Alkali Creek

Relatively few headcuts were observed along the mainstem of Alkali Creek, though it does appear to be slightly entrenched in the lower reaches. One headcut (HC23) was observed upstream of the Buffalo Creek Road crossing near the headwaters (**Figure 4.44**). This headcut is approximately four feet tall and is actively migrating upstream and has extended approximately 200 feet upstream from the road crossing. The channel is not entrenched downstream of the road crossing nor upstream of the headcut. This headcut is threatening a wetland area upstream. A second headcut (HC22) was observed upstream of an upland wildlife/livestock pond (SP-P-21). In the headwaters of Major Basin Draw, which is a tributary to Alkali Creek, one headcut (HC40) was observed in the overflow channel of an upland wildlife/livestock pond (SP-P-212). Several headcuts (HC16-HC21) were observed on Olsen Draw, which is a tributary to Alkali Creek. Headcuts were also observed in many of the un-named draws leading into Alkali Creek.

Figure 4.44. Headcut (HC23) on Alkali Creek Upstream of the Buffalo Creek Road Crossing.

4.5.2.4 Blue Springs Draw

Blue Springs Draw is highly incised, with entrenched conditions extending from Kirby Creek upstream almost to the Blue Spring. Just downstream of the Blue Spring, there is a headcut (HC11) which threatens the extensive wetland complex associated with the existing channel upstream (**Figure 4.45**). Placement of large cobble riprap within this headcut may arrest its upstream migration. In addition, there are several large headcuts (HC12, HC13, HC48-HC50) in tributaries to the east of Blue Springs Draw that were also identified. One headcut (HC48) was identified in a draw leading up to a recently constructed upland wildlife/livestock pond (SP-P-90) on a tributary to Blue Springs Draw (**Figure 4.46**). This headcut could pose a problem to the outfall of the reservoir and is a high priority for stabilization, though runoff captured in this reservoir may effectively slow the advancement of the headcut. It would be relatively simple to add some large cobble to this headcut as a stabilization measure. Since Blue Springs Draw has become incised, headcutting is advancing up many of the tributaries (**Figure 4.47**). An example of this process being initiated is depicted in **Figure 4.48**. Upstream of the Blue Spring, Blue Springs Draw is not incised and no additional headcuts were observed.

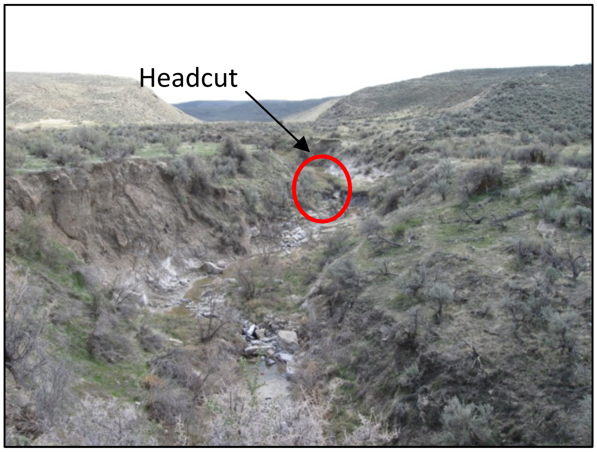

Figure 4.45. Headcutting in Blue Springs Draw (HC11).

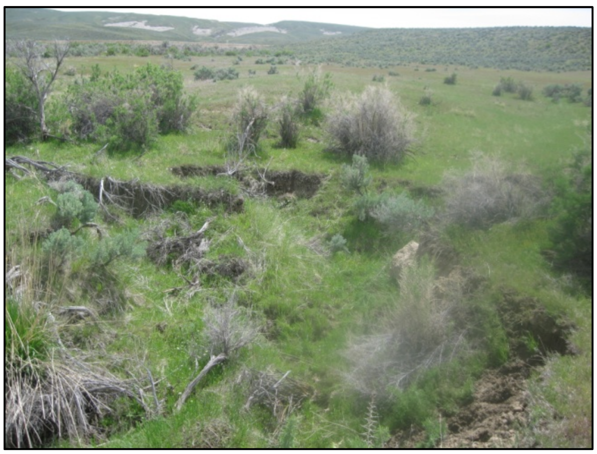


Figure 4.46. Headcut (HC48) Downstream of Recently Completed Upland Livestock/Wildlife Pond, Looking Toward Pond (Left) and Looking Downstream from Headcut (Right).


Figure 4.47. Examples of Headcuts in Tributaries to Blue Springs Draw.

Figure 4.48. Headcut Initiation on Tributary to Blue Springs Draw.

4.5.2.5 Lake Creek

One headcut (HC31) was identified near the upper end of Lake Creek and one headcut (HC30) was identified in the headwaters of Gardner Creek, which is a tributary of Lake Creek that enters from the south. The headcut in Gardner Creek appears to be threatening a large wetland area. In addition, several headcuts were identified in Packsaddle Creek, which enters Lake Creek from the north.

4.5.2.6 Kirby Creek

Kirby Creek has become incised along much of its length as discussed in **Section 4.5.1**. As a result, tributaries streams entering Kirby Creek are also becoming incised. Dry gulches entering Kirby Creek are headcutting in several areas, including HC33 which was visited in the field (**Figure 4.49**). One of these types of headcuts was stabilized by the pipeline company, providing an example of a potential restoration strategy (**Figure 4.40** in **Section 4.5.2**).

Figure 4.49. Headcut in a Tributary to Kirby Creek (HC33).

4.6 GRAZING MANAGEMENT STRATEGIES AND OPPORTUNITIES

4.6.1 Ecological Site Description (ESD) – State and Transition Models

The concept of an Ecological Site Description (ESD) was introduced in Chapter 3 (**Section 3.3.4.4**). An ESD classifies a land area based on distinctive characteristics including soils, precipitation and vegetation cover. Each unique ESD includes a State and Transition model.

State and Transition (S/T) models are a way of documenting our understanding of how processes create patterns we observe in an ecosystem. They define the different discrete types of vegetation – called "states" – that occur as a result of an area's characteristics like climate, soils, history, or disturbances. States vary in their ability to resist change and one state can "transition" to another as a result of natural processes - like succession or wildfire - or management practices – like grazing or juniper removal. S/T models are useful because they quantify what is known about the vegetation states of a rangeland ecosystem and what events may lead to changes in the states and how likely those events are to occur. This kind of information, gleaned from the model documentation, can be useful when considering management regimes to maintain or improve rangeland condition or developing restoration activities.

S/T models are one tool that can assist land managers in identifying where they are today, where they can go based on goals and objectives, and how to get there. **Figures 4.50** and **4.51** are the S/T models for the two dominant ESDs in the watershed. **Appendix E** includes the S/T models for each of the upland range sites inventoried in this study.

4.6.2 Historic Climax Plant Community (HCPC)

For the two dominant ESDs in the Kirby Creek watershed (**Loamy** [soils], **10" – 14" East** [precipitation]; *and* **Loamy** [soils], **15" – 19" Foothills & Mountain East** [precipitation]), a Historic Climax Plant Community (HCPC) is defined. The HCPC is the *potential* plant community of a site that existed at the time of European immigration and settlement in North America. Theoretically, the HCPC was in dynamic equilibrium with its environment. It is the plant community that was able to avoid displacement by the suite of disturbances and disturbance patterns that naturally occurred within the area it occupied.

The following are descriptions of the two HCPC's for the dominant ESDs in the watershed:

- **Loamy, 10" – 14" East:** Bluebunch Wheatgrass / Rhizomatous Wheatgrass
- **Loamy, 15" – 19" Foothills & Mtn. East:** Columbia Needlegrass / Spikefescue

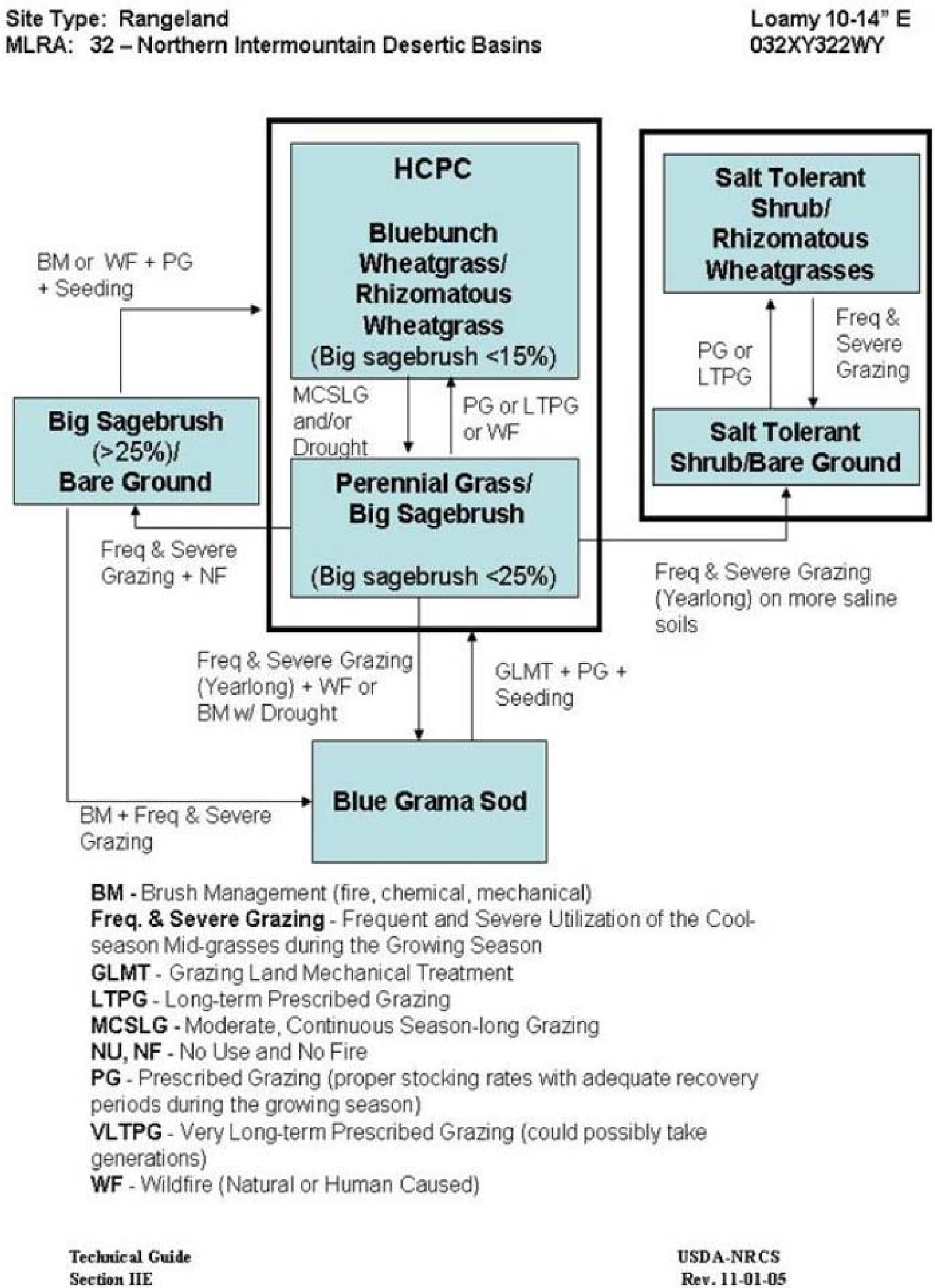

Figure 4.50. State and Transition Model for Loamy, 10" – 14" East, ESD

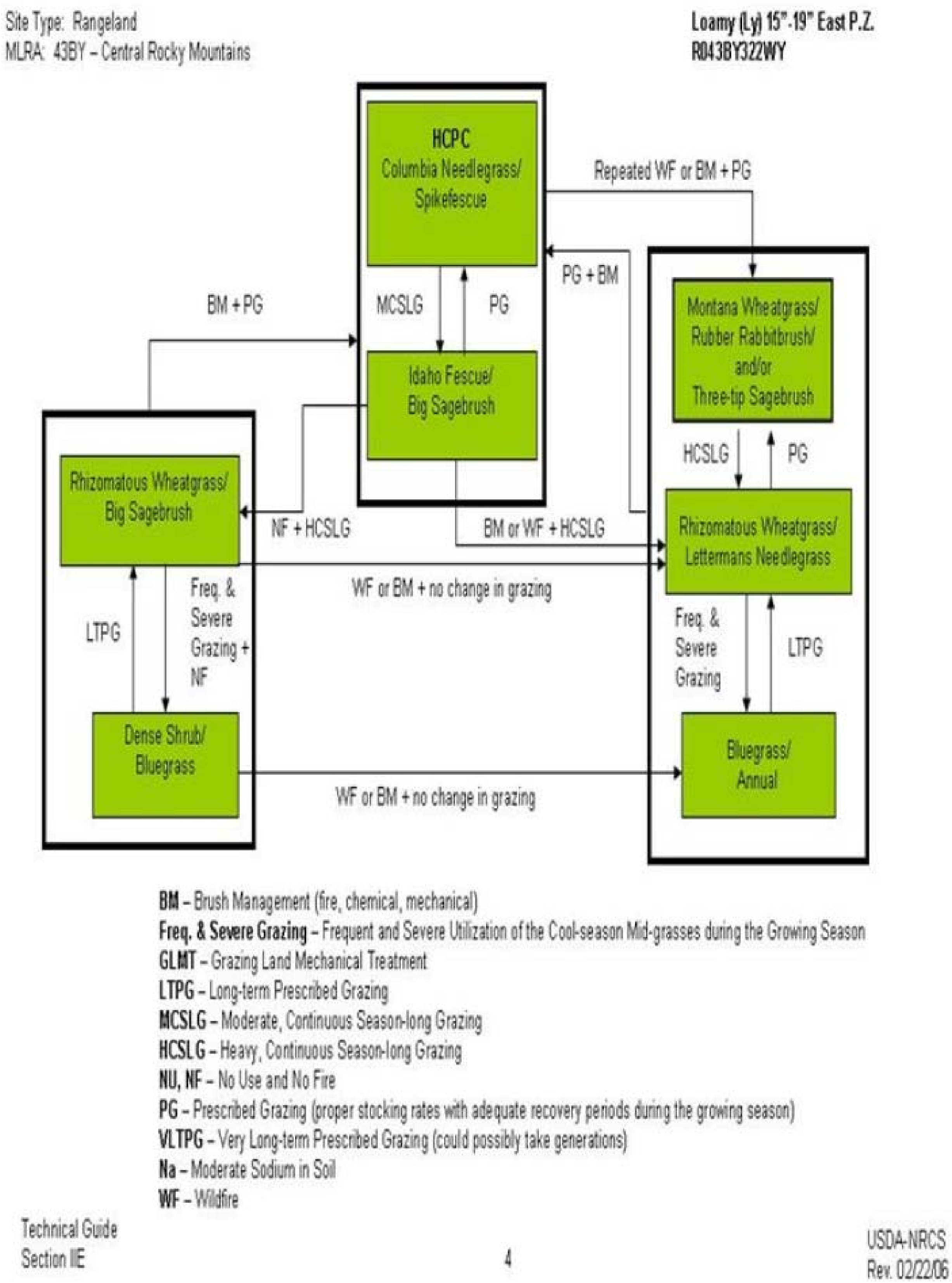

Figure 4.51. State and Transition Model for Loamy, 15" – 19" Foothills & Mountain East, ESD

4.6.3 Range and Grazing Management Practices

Using a site's ESD coupled with the S/T model, land managers can target certain grazing practices towards achieving improvements in rangeland health. Other management practices that can be used to improve overall range conditions and watershed function include:

1) Upland water development to facilitate more balanced grazing distribution across the landscape. Movement of livestock away from riparian areas, to the extent practicable, can result in improved riparian area health.
2) Fencing of riparian areas to reduce impacts on stream channels and banks. This practice can be implemented informally, or in a more formal manner via programs such as the Continuous Conservation Reserve Program (CCRP) through the USDA-Farm Services Agency (FSA).
3) Inclusion of wildlife-compatible components in range management practices. These can include: smooth wire fencing, and installation of wildlife escape ramps in water development projects.
4) Utilization of Integrated Pest Management (IPM) strategies to control weeds and pest animals and insects.
5) Seeps and springs should be protected from livestock trampling to prevent damage to the spring, maintain water quality and enhance the growth of food forbs for sage grouse and other wildlife.
6) Prescribed fire can be used as a tool to promote range health. Time-of-year is a major burn prescription component for obtaining desired results. Burns should be conducted when preferred plants are dormant. Warm season grasses, like buffalograss and blue grama, benefit from a spring burn. Cool season grasses, like bluebunch wheatgrass, Idaho fescue, and western wheatgrass benefit from a fall burn following their growing season. Forbs typically benefit from fall burns (especially forbs that grow from rootstocks) and are negatively impacted by spring burns. Small burns conducted in a mosaic pattern to enhance forbs and create a diversity of age classes of mountain big sagebrush may provide benefits. Use caution when conducting prescribed burning in Wyoming big sagebrush--there may be potential for invasion of cheatgrass and shrub recovery on these dry sites can be extremely slow. Be careful with fire, as removals of large expanses of sagebrush are detrimental to sage grouse and other sagebrush dependent wildlife.

Additional Best Management Practices (BMPs) for rangeland that are compatible with wildlife can be found on the WYGF's website at:
http://gf.state.wy.us/wildlife/nongame/LIP/BestMgmtPractices/index.asp

Specific grazing management recommendations for each of the upland sites inventoried in the field are provided at the bottom of the range site and condition guide (**Appendix E**).

4.7 OTHER UPLAND MANAGEMENT OPPORTUNITIES

Other upland and range management practices can and should be applied in addition to those geared towards livestock grazing and upland water development. The following subsections briefly address noxious weed management and the use of prescriptive burning to control and manage undesirable vegetation.

4.7.1 Weed and Pest Management

The Hot Springs County Weed and Pest District administers the treatment and control of noxious weeds within the watershed. Within Hot Springs County, three (3) plant species, and one (1) insect species are included on the declared weed and pest list (WDA 2010). These include:

- Puncturevine (*Tribulus terrestris* L.)
- Russian olive (*Elaeagnus angustifolia* L.)
- Wild oat (*Avena fatua* L.)
- Mosquito (*Culicidae* spp.)

The district is active with implementation of a variety of control programs across the county. Weed and Pest District activities of particular interest in the watershed during this study (June 2009 – August 2010) have included a control program for Whitetop/Hoary cress (*Cardaria draba* L.), and an action plan for control and management of an anticipated grasshopper outbreak. The BLM also initiated a strategy to treat federal lands under their control for grasshoppers via insecticide spraying.

Continued effective management of noxious weeds and pests will include participation between willing landowners, and local, state, and federal land management agencies. Continued support of the Weed and Pest District in acquiring grant funding, as well as volunteering with in-kind efforts during planning sessions and workshops will be important.

4.7.2 Prescriptive Fire

Historically within the Kirby Creek watershed, prescribed fire has been used in an attempt to control sagebrush and enhance forage production for livestock. The following discussion and information was obtained from a ***White Paper*** prepared by the Sage and Columbian Sharp-tailed Grouse Technical Committee for the Western Association of Fish and Wildlife Agencies:

> *In many cases, invading exotic species such as cheatgrass are often spread as a result of fire, leading to vegetation type conversion, particularly where understory herbaceous vegetation is already depleted. Managers considering treatments aimed at a reduction in sagebrush cover should be aware of the negative impact this type of treatment could have, potentially for an extended period of time. Prescribed fire and other treatments can result in furthering habitat conversion or fragmentation. The risk of invasion by annuals and associated factors affecting invasibility should be considered when assessing treatment appropriateness and technique. When prescribed fire is used to control pinyon pine and juniper woodland expansion, sagebrush stands should be protected to conserve sagebrush habitat and allow sagebrush recruitment into burned areas.*

In some circumstances where sagebrush occurs but severely lacks herbaceous understory, chemical or mechanical treatments that reduce sagebrush cover and allow for mechanical seeding of native grasses and forbs may be necessary for accelerating sagebrush grassland habitat restoration. These sites would be characterized by: an absence of typical dominant native species and depleted seed bank; bare soils dominate–even under sagebrush; and long-term attempts to restore habitat through herbivore rest, deferment, and proper stocking have failed. Treatments are most appropriate where loss of topsoil is an imminent risk. Treatments should not be implemented without a high likelihood of success. From an ecological standpoint, treatments should always emphasize use of native species adapted to treatment areas to avoid eventual dominance by competitive exotic species and resultant loss of habitat function. Mechanical or chemical treatments that conserve sagebrush and enable re-establishment of native herbs are preferred. By comparison, fire treatments are less selective, tend to burn the best remaining habitats, and are at risk of invasion by cheatgrass or other invasive species in areas where they occur. The likelihood of habitat restoration success using aggressive vegetation treatments in areas lacking topsoil is very low. In these settings any remnant native cover should instead be protected.

Given the large losses of xeric sagebrush habitats that have occurred to date, we encourage managers to first consider protecting and improving vegetative integrity and habitat function in place of stand replacing treatments that further fragment degraded sagebrush habitats and face other risks. Realizing these habitats deteriorated over long periods of time and over large expanses, a long-term approach to large-scale restoration appears more feasible. A combination of fire suppression and conservative management techniques such as proper grazing strategies should be considered first. For most circumstances, this approach conserves sagebrush, allows herbaceous vegetation to recover – directly benefiting sage-grouse. This involves the least amount of risk and cost, both financially and ecologically. We question vegetation models that do not recognize sagebrush grasslands as an ecological endpoint or sustainable climax community. Instead we recommend such models be based on principles of plant ecology and iterative refinement involving scientific testing, observation, and adaptation. For those habitats in a healthy intact status, actively conserving these areas pays ecological dividends and avoids the future prospect of intensive treatments with uncertain outcomes.

4.8 KIRBY CREEK WATERSHED MANAGEMENT PLAN

Components of the watershed management plan were developed to address identified resource concerns or management issues within the following categories:

- Irrigation Infrastructure Improvements
- Upland Wildlife/Livestock Watering Opportunities
- In-stream Pond Opportunities
- Stream Channel Restoration Opportunities
- Grazing Management Strategies and Opportunities
- Other Upland Management Opportunities

The recommended projects and improvements comprise an action plan; the implementation of which is designed to improve overall watershed function and health. **Table 4.5** provides a summary of the Kirby Creek Watershed Plan in tabular format. Priority rankings are assigned to projects within some of the watershed plan categories. Within other categories, priority rankings are not defined due to factors such as landowner interest/need, permitting requirements, etc., which would require further assessment prior to ranking individual projects. For the recommended headcut stabilization projects, **Table 4.4** (page 4.51) provides a priority ranking of identified headcut locations.

Table 4.5. Kirby Creek Watershed Plan.

Watershed Plan Category: Irrigation Infrastructure Improvements (refer to Section 4.2 for project descriptions and maps)		
Priority [A]	**Project Name**	**Project Components**
3	**Richardson #1 Ditch Re-activation**	
		Installation of 3 check structures in adjacent channel Ditch Re-conditioning Installation of measuring device
2	**Kirby Creek Ditch Re-activation**	
		Installation of 3 check structures in adjacent channel Ditch Re-conditioning Installation of measuring device Install one culvert at road crossing Install one stream crossing
1	**Idared Ditch Re-activation**	
		Installation of 3 check structures in adjacent channel Ditch Re-conditioning Installation of measuring device Install one culvert at road crossing Install one stream crossing

[A] Priority of 3 = highest, 1 = lowest; project prioritization is relative only between each of the ditch re-activation projects

Table 4.5 (continued). Kirby Creek Watershed Plan.

Watershed Plan Category: Upland Wildlife/Livestock Water Development Projects (refer to Section 4.3 for project descriptions and maps)							
Priority [B]	**Project Name**	**Allotments Served**	**water source**	**pipe length (feet**	**stock tank (each)**	**storage tank (each)**	**stock pond (each)**
	UWD-1: Mud Creek Pipeline Extension Project	Mud Creek	well (existing)	6,100	0	0	2
	UWD-2: Lake Creek Pipeline Project	Lake Creek, Pack Saddle Creek	well (existing)	17,200	5	1	0
	UWD-3: Pack Saddle Creek Pipeline Project	Lake Creek, Pack Saddle Creek	well (new)	11,800	4	1	0
	UWD-4: V-H Draw North Pipeline Project	V-H Draw	well (existing)	21,200	6	1	0
	UWD-5: V-H Draw South Pipeline Project	V-H Draw, Out	well (existing)	6,900	3	1	0
	UWD-6: Reed Creek Pipeline Project	Out, Reed Creek	well (new)	14,600	4	1	0
	UWD-7: Major Basin Pipeline Project	Major Basin, Blue Hill, Swallow	well (existing)	21,300	5	1	0
	UWD-8: Blue Springs Pipeline Project - 1	Blue Springs, Major Basin	well (existing)	10,200	3	0	0
	UWD-9: Blue Springs Pipeline Project - 2	Blue Springs	well (existing)	12,700	5	1	0
	UWD-10: Blue Springs-Kirby Ck. Pipeline Project	Kirby Creek	spring development	8,500	0	1	1
	UWD-11: Red Springs Draw Pipeline Project	Red Springs Draw	well (existing)	7,400	2	0	0
	UWD-12: South Lucerne Pipeline Project	South Lucerne Group	unknown	3,200	0	0	0
	UWD-13: Blue Springs Development	N/A	spring development	0	0	0	1
	UWD-14: Pat's Pond - Paradise K Ranch	N/A	N/A	0	0	0	1

[B] Due to several factors (e.g., landowner interest/need, permit requirements) upland water development projects were not prioritized for implementation.

Watershed Plan Category: In-stream Pond Opportunities (refer to Section 4.4 for project descriptions and maps)		
Priority [C]	**Project Name**	
3	**KCM-03:** Kirby Creek - Historic Oxbow Development	
2	**KCM-05:** Kirby Creek - Historic Oxbow Development	
3	**KCM-14:** Kirby Creek - Historic Channel Re-activation	
1	**KCM-20:** Kirby Creek - Historic Channel Re-activation	
N/A	**KCM-22/23:** Stan's Folly Project [D]	
2	**LCM-03:** Lake Creek - Historic Channel Re-activation	
3	**Kirby Creek:** Potential Channel Avulsion	
1	**Kirby Creek:** In-stream Pond	
2	**Alkali Creek:** In-stream Pond	

[C] Priority of 3 = highest, 1 = lowest; refer to Table 4.2 for listing of more potential projects. [D] As of September 2010, the Stan's Folly project has been completed.

Watershed Plan Category: Stream Channel Restoration Opportunities (refer to Section 4.5 for project descriptions and locations).		
Priority [E]	**Project Name**	
	Entrenched/Incised Channel Restoration	
	Headcut Stabilization [E] (HC-1 through HC-50, refer to Table 4.4)	

[E] Specific channel restoration and headcut stabilization projects are not prioritized here; however Table 4.4 does prioritize headcut stabilization projects.

Table 4.5 (continued). Kirby Creek Watershed Plan.

Watershed Plan Category: Grazing Management Opportunities (refer to Section 4.6)	
	Management Activity Description
	Improved grazing distribution via upland water development
	Riparian area fencing
	Inclusion of wildlife-compatible components in range management
	Protection and maintenance of natural water sources (i.e., seeps and springs)
Watershed Plan Category: Other Upland Management Opportunities (refer to Section 4.7)	
	Management Activity Description
	Use of prescribed fire to promote range health
	Utilization of Integrated Pest Management (IPM) strategies

5.0 PERMITS

Projects proposed in the watershed management and rehabilitation plan include upland water development (wells/pipelines/stock tanks, stock ponds), stream channel restoration and mitigation of ongoing channel processes (historic meander reactivation, in-stream pond creation, headcut stabilization), and irrigation infrastructure improvements. Each of these project types will require that a specific set of permitting obligations are satisfied before the project implementation. This section of the report provides an outline of the anticipated permitting processes, including a summary of the necessary permits, requirements for environmental analysis and documentation, resource agency coordination, and estimated timelines. Numerous federal and state regulations may apply to the proposed projects, and relate to the following areas of concern: fish and wildlife; wetlands; state waters; cultural; water rights, water storage and conveyance; rights-of-ways; stormwater elimination; and other miscellaneous issues such as noise and air quality.

The watershed area is comprised of federal Bureau of Land Management (BLM) lands, State of Wyoming lands, and private property. Projects that are located on, or cross, BLM-managed land are subject to the National Environmental Policy Act (NEPA) and other federal environmental regulations. The Environmental Protection Agency (EPA), Army Corps of Engineers (ACOE), and the U.S. Fish and Wildlife Service (USFWS) all administer additional federal regulations that may be relevant to proposed projects. State agencies that may have jurisdiction for certain projects include the Wyoming Game and Fish Department (WGFD), the Department of Environmental Quality (WDEQ), State Engineer's Office (WSEO), State Historic Preservation Office (SHPO), and the Board of Land Commissioners through the State Lands and Investments Board (SLIB).

5.1 NEPA PROCESS

Any proposed project located on federal lands or, in some cases, where federal funding is involved must be in compliance with NEPA. The intent of NEPA is to insure that projects in the federal domain (including lands and/or funding) adhere to guidelines that seek to avoid, minimize and mitigate adverse environmental impacts. NEPA requires that the potential adverse and beneficial effects of a proposed project be evaluated and documented, and that an alternatives analysis be performed. The BLM would likely be the lead agency for NEPA compliance and documentation on projects that affect lands under their management. For projects that occur within jurisdictional wetlands and/or Waters of the U.S., the ACOE may take control of the NEPA process as the lead agency.

5.1.1 Small Water Projects

Many of the projects recommended in the watershed rehabilitation and management plan can be classified as small water development projects. For these types of projects, NEPA applicability is determined on a case-by-case basis. Proposed new pipeline and stock tank systems that traverse and/or serve federal or state managed rangeland typically fall under NEPA purview. For most small projects that have limited impact on the environment, and Environmental Assessment (EA) is usually acceptable rather than a more comprehensive Environmental Impact Statement (EIS).

NEPA compliance and authorization will be guided in large part by the Washakie Resource Management Plan - RMP (BLM, 1988) and any subsequent new or additional guidance and/or updates. The RMP and a Record of Decision (ROD) were developed on the basis of a NEPA-compliant Environmental Impact Statement (EIS) (BLM, 1987). The BLM is currently in the process of completing a Bighorn Basin Resource Management Plan Revision and associated EIS. The project is a combined effort revising RMPs for both the Cody and Worland Field Offices of BLM. Public lands within the field offices are currently managed according to three RMPs: the Washakie RMP and Grass Creek RMP (1998) for the Worland Field Office; and the Cody RMP (1990). BLM intends to produce a single RMP and EIS encompassing both field offices that will be called the Bighorn Basin RMP Project. Each field office will issue its own ROD for its jurisdictional area.

5.2 PERMITS, CLEARANCES, AND APPROVALS

Required permits and clearances for specific projects will require evaluation on a case-by-case basis. Specific permitting requirements for a given project should be identified as early in the planning process as possible to insure that the project is compliant with applicable laws and regulations. Timeframes to complete various permitting processes and obtain authorization to implement a project can be lengthy, which further supports getting as early a start as possible. Table 5.1 provides a list of the relevant resource agencies, the permits or approvals under their jurisdiction, and a non-comprehensive list of activities that typically fall under the specified permit or approval.

Table 5.1. List of Permits and/or Approvals That May Be Required for Projects

Resource Agency	Permit or Approval	Subject Activities
U.S. Environmental Protection Agency (EPA)	EPA has oversight responsibility for the federal Clean Water Act (CWA); the Wyoming DEQ's Water Quality Division (WQD) administers certifications and permits such as 401 Certification and National Pollution Discharge Elimination System (NPDES) permits.	The EPA oversees State Water Quality (NPDES) and aids in the resolution of interstate conflicts where upstream waters may affect water quality downstream.
Bureau of Land Management (BLM) – the likely Federal Lead Agency	National Environmental Policy Act (NEPA), Endangered Species Act (ESA)	NEPA: In the event a project will affect federal lands, the beneficial and adverse effects of proposed actions and alternatives will require analysis and documentation. The results of the NEPA process will determine whether an EA or an EIS is required. ESA: A biological assessment is required to determine potential effects on threatened, endangered and candidate species.

Table 5.1. List of Permits and/or Approvals That May Be Required for Projects

Resource Agency	Permit or Approval	Subject Activities
U.S. Army Corps of Engineers (ACOE)	Clean Water Act (CWA) Section 404 Permit	Analyze potential wetland and Water of the U.S. impacts.
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act, Section 7 Consultation; Fish and Wildlife Coordination Act	ESA: The USFWS issues an opinion on the results of the biological assessment and the potential effects on wildlife, habitat/vegetation, threatened and endangered species. The Fish and Wildlife Coordination Act requires that federal agencies proposing to alter natural streams or water bodies to protect fish and wildlife by consulting with federal and state agencies to prevent, mitigate, compensate, and enhance those resources.
Wyoming State Historic Preservation Office (SHPO)	Section 106 Consultation: National Historic Preservation Act (NHPA), 1966; NEPA, 1969; Archaeological Resources Protection Act (ARPA), 1979; National Register of Historic Places (NR) under the National Park Service (NP); Advisory Council on Historic Preservation's Procedures for the Protection of Cultural Properties; Treatment of Archaeological Properties of 1980: Determination of Eligibility for Inclusion in the NR; Secretary of Interior's Standards and Guidelines for Archaeological Historical Preservation, 1983; Reservoir Salvage Act of 1960; 1974 Amendment to the Reservoir Salvage Act of 1960; American Indian Religious Freedom Act (AIRFA), 1978 (AIRPA 1996) and Section 4 of ARPA, 1979; and the State of Wyoming Historic Preservation Office (SHPO).	The NEPA process requires Section 106 Consultation, an analysis of proposed impacts and alternatives on cultural resources.

Table 5.1. List of Permits and/or Approvals That May Be Required for Projects

Resource Agency	Permit or Approval	Subject Activities
Wyoming Board of Land Commissioners, State Lands and Investments Board (SLIB)	Regulation of all state land activities and Rights-of-Way (ROW)	ROW for any facility, utility, road, reservoir or ditch is regulated by the SLIB.
State Engineer's Office (SEO)	Surface Water Storage Permit; Water Rights appropriations; Permit to Construct/Dam Safety Review; Dam Safety Act; Ditch Enlargement Permit	Permits are required for storage and diversion of state waters. Storage of greater than (>) 50 acre feet of water, a dam > 20 feet high, or conveyance of >50 cubic feet per second requires a state permit. A ditch enlargement permit would be required if a ditch is enlarged or it is used to convey water to a new reservoir.
Wyoming Department of Environmental Quality (DEQ), Water Quality Board (WQB)	National Pollution Discharge Elimination System (NPDES) permit; Section 401 Certification	The 401 certification is required when a Section 404 permit is authorized, and provides protection to state water quality. The WQB administers the NPDES permitting. Temporary water discharges require a general NPDES permit.
Wyoming Game and Fish Department (WGFD)	NEPA	WGFD will comment on wildlife concerns for EIS or EA documentation.
State of Wyoming	Mining Permit	No necessary if materials are used on site.
State/County/Federal	Rights-of-Way, Easements, Special Use Permits	County, State and Federal permits may be required to access any portions of the proposed project site or for installation of temporary or permanent access roads or pipes, fences, etc. Permits will vary depending on activity and land ownership, and gaining ROW will require research, public contact, permitting, and other efforts.

Table 5.1. List of Permits and/or Approvals That May Be Required for Projects

Resource Agency	Permit or Approval	Subject Activities
Contractor(s)	Other Permits concerning but not limited to: Air Quality, Burning, Permit, Noise, Traffic Volumes, Vehicular Weights, etc.	Final project design plans and timing of construction will be examined closely and analyzed regarding permitting requirements.

5.3 ENVIRONMENTAL CONSIDERATIONS

5.3.1 Threatened and Endangered Species

The following threatened or endangered species have the potential to occur within the watershed area (Wyoming natural Diversity Database-WYNDD, 2010):

- **Endangered:** Black-footed Ferret (*Mustela nigripes*)
- **Threatened:** Gray Wolf (*Canis lupus*)

The Greater Sage Grouse (*Centrocercus urophasianus*) is a native species to the area and is almost totally dependent on open sagebrush plain. Males gather in the early spring at lek (breeding ground) locations to start their elaborate courtship rituals (strutting). They are considered omnivores, eating insects, sagebrush and seeds; but are most reliant upon sagebrush for both cover from predators and for food.

On March 5, 2010, the U.S. Fish and Wildlife Service (USFWS) issued a statement that while the sage grouse merits protection under the Endangered Species Act (ESA), that protection is precluded at the present time by the need to take action on other species facing more immediate and severe extinction threats. The sage grouse is listed as a sensitive species by the BLM, and a species of concern by the Wyoming Game and Fish Department (WGFD).

The BLM definition of a sensitive species is as follows: species that could easily become endangered or extinct in the state, including: (a) species under status review by the USFWS/National Marine and Fisheries Service; (b) species whose numbers are declining so rapidly that Federal listing may become necessary; (c) species with typically small or fragmented populations; and (d) species inhabiting specialized refugia or other unique habitats. WGFD lists the greater sage grouse as: species that are widely distributed, with population status or trends unknown but suspected to be stable; habitat restricted or vulnerable but no recent or on-going significant loss; species likely sensitive to human disturbance. The sage grouse are not listed as a Threatened or Endangered species and does not receive any protections from the Endangered Species Act; however, BLM and WGFD have developed restrictions/recommendations to help protect the sage grouse. BLM has recommended that there be no surface occupancy within 0.25-mile radius of any known lek location or a 2-mile radius during the breeding season, on BLM land or lands adjacent to BLM lands. Recent studies have shown that the 2-mile radius is not sufficient, showing declines in the number of males returning to the leks with activities occurring beyond the 2-mile radius. Thus, the current recommendations may change over time. It is recommended that coordination with BLM and WGFD occur regarding any proposed or alternative project that has the potential to impact sage grouse habitat. Note that providing water to areas where water is limited may create a beneficial impact for sage grouse and should be considered when evaluating the net potential impacts to this species.

5.4 MITIGATION

Mitigation plans would potentially need to be submitted for projects that impact sensitive areas such as wetlands, streambed and banks, cultural resources, fish and game resources, and threatened or endangered species. Alternatives that avoid and/or minimize impacts are preferred, as are projects that incorporate a design that provides "self-mitigation". A portion of the potential impacts to streambeds, riparian vegetation and the limited acreage of wetlands within the Kirby Creek drainage would be self-mitigated by the restoration of dewatered stream reaches. Impacts that occur as a result of stock pond construction would be mitigated by the creation of wetland and riparian habitat along the perimeter of the impoundment.

If possible, construction activities would be conducted before or after the wildlife nesting and denning season. Known sage grouse lekking grounds would be avoided at all times of the year. Avoidance or minimization to threatened or endangered species that may be discovered within the project site through environmental studies would be conducted according to USFWS and WYGFD suggestions. Mitigation efforts would be designed according to further agency suggestions or through avoidance measures.

Field surveys and literature searches for cultural resources would be conducted according to the Wyoming SHPO, other agencies and federal regulations (Table 5.1). A cultural resources mitigation plan would be developed and result in a Memorandum of Agreement (MOA) between the Wyoming SHPO and the lead federal agency and project sponsor(s). The Advisory Council on Historic Preservation would need to approve this agreement.

5.5 LAND OWNERSHIP AND PROPERTY OWNERS

Where applicable, permission should be negotiated for easement/right-of-access for all construction activities associated with potential projects.

> *It is important to note that the WWDC has stated that lands will NOT be 'taken' or condemned in order to construct projects recommended within the watershed management plan. Representatives of the WWDO have stated that the State is not interested in condemning lands for the purpose of constructing a project built with the objective of benefitting those who's lands would be used. Participation must be voluntary.*

6.0 COST ESTIMATES

Estimated costs are provided at a conceptual-level for each of the recommended project types presented in the Watershed Management and Rehabilitation Plan (**Section 4.0**). The basis and source for costs used in the estimates are presented in the following subsections provided for each type of project. In general, cost data was obtained from the NRCS cost database for Wyoming (NRCS 2009). The latest cost information available in this database is from FY 2009. For purposes of this study, the 2009 unit cost data was assumed to still be generally valid in 2010.

6.1 IRRIGATION INFRASTRUCTURE

Three ditches in the Kirby Creek watershed were identified as inactive with the potential to be re-activated, including the Richardson #1 Ditch, the Kirby Creek Ditch and the Idared Ditch (**Section 4.2.1**). The Richardson #1 Ditch and Idared Ditch are on West Kirby Creek, while the Kirby Creek Ditch is on East Kirby Creek. The identified ditches are all currently inactive, and would require significant channel work (one or more check structures) to enable water to be diverted. Also, each ditch would require some level of cleaning (i.e., vegetation clearing, obstruction removal) and potential re-grading to adequately convey water. Based on these general rehabilitation items, **Table 6.1** provides conceptual cost estimates to reactivate these ditch systems.

Table 6.1. Irrigation Infrastructure Cost Estimates.

Ditch Name	Length of Ditch to Rehabilitate (lin. ft.)	Installation of check structure(s) at POD [1]		Ditch Re-conditioning ($5/lin. ft.)	Install measuring device [2]	Culverts for road crossings		Pipe for stream crossings		Total Estimated Cost
		Qty.	Total Cost			Qty.	Cost	Qty.	Cost	
Richardson #1 Ditch	2150	3	$25,000	$10,750	$3,000	0	0	0	0	**$39,000**
Kirby Creek Ditch	3650	3	$25,000	$18,250	$3,000	1	$4,000	1	$3,000	**$53,000**
Idared Ditch	3700	3	$25,000	$18,500	$3,000	1	$2,000	1	$1,800	**$50,000**

[1] POD = Point of Diversion

[2] assumes 24" Parshall flume

6.2 UPLAND WILDLIFE/LIVESTOCK WATER DEVELOPMENT

Several potential upland water development projects were identified in **Section 4.3.2**. These included pipeline/stock tank projects (including additions to existing pipeline systems and completely new pipeline systems), a spring development project at Blue Springs, and a new stock pond on the Paradise K Ranch. Conceptual-level costs associated with these projects are provided in **Table 6.2**. Unit costs for various project components shown in this table were obtained from FY 2009 NRCS-EQIP project rates for the State of Wyoming (NRCS 2009). Estimated project costs were also compared against reported costs for previously completed projects in the Kirby Creek watershed through September 2009 obtained from the Hot Springs Conservation District (HSCD 2009). Additional information regarding various upland water development project components can be found in **Appendix G**.

Table 6.2. Conceptual-Level Cost Estimates for Upland Wildlife/Livestock Water Development Projects.

		Project Name	Mud Creek Pipeline Extension Project	Lake Creek Pipeline Project	Pack Saddle Creek Pipeline Project	V-H Draw North Pipeline Project	V-H Draw South Pipeline Project	Reed Creek Pipeline Project	Major Basin Pipeline Project	Blue Springs Pipeline Project - 1	Blue Springs Pipeline Project -2	Blue Spgs.- Kirby Ck. Pipeline Project	Red Springs Draw Pipeline Project	South Lucerne Pipeline Project	Blue Springs Development	Pat's Pond Paradise K Ranch
		Project Identifier	**UWD-1**	**UWD-2**	**UWD-3**	**UWD-4**	**UWD-5**	**UWD-6**	**UWD-7**	**UWD-8**	**UWD-9**	**UWD-10**	**UWD-11**	**UWD-12**	**UWD-13**	**UWD-14**
Project Element	**Water Source**															
	Well Construction or Improvement / Spring Development	Well / Spring	Existing Well	Existing Well	New Well	Existing Well	Existing Well	New Well	Existing Well	Existing Well / Storage Tanks	Existing Well	Spg. Development	Existing Well	Unknown	Spg. Development	N/A
		Quantity (each)			1			1				1			1	
		Well Depth (ft)	N/A	N/A	3,000	N/A	N/A	500	N/A		N/A	N/A	N/A	N/A	N/A	
		Unit cost ($/LF or $/ea)			$32.50			$26		N/A		$3,000			$3,000	
		Well Screen ($2500/ea)			$2,500			$2,500				N/A			N/A	
		Subtotal	$0	$0	$100,000	$0	$0	$15,500	$0	$0	$0	$3,000	$0	$0	$3,000	$0
	Water Distribution															
	Pump	Quantity (each)	N/A	1	1	1	1	1	1	N/A	1	1	N/A	Unknown	N/A	N/A
		Type		Electric	Electric	Solar	Solar	Solar	Solar		Solar	Solar		N/A		
		Unit Cost (each)		$5,000	$5,000	$7,500	$7,500	$7,500	$7,500		$7,500	$7,500				
	Pipeline	Quantity (lin.ft.)	6,100	17,200	11,800	21,200	6,900	14,600	21,300	10,200	12,700	8,500	7,400	3,200	N/A	N/A
		Unit Cost ($/lin. ft.)	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50		
	Storage Tank	Quantity (each)		1	1	1	1	1	1		1	1				
		Size (gal.)	N/A	8,000	8,000	12,000	4,000	12,000	12,000	N/A	12,000	8,000	N/A	N/A	N/A	N/A
		Unit Cost ($/gal.)		$0.75	$0.75	$0.75	$0.75	$0.75	$0.75		$0.75	$0.75				
		Subtotal	$9,150	$36,800	$28,700	$48,300	$20,850	$38,400	$48,450		$35,550	$26,250	$11,100	$4,800	$0	$0
	Water Supply															
	Stock Tanks	Quantity (each)		5	4	6	3	4	5	3	5		2			
		Size (gal.)	N/A	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	N/A	1,200	N/A	N/A	N/A
		Unit Cost (each)		$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500		$2,500			
	Stock Ponds	Quantity (each)	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	1	1
		Unit Cost (each)	$5,000									Existing			Existing	$10,000
		Subtotal	$10,000	$12,500	$10,000	$15,000	$7,500	$10,000	$12,500	$7,500	$12,500	2,000	5,000	0	2,000	$10,000
		Construction Subtotal	$19,150	$49,300	$138,700	$63,300	$28,350	$63,900	$60,950	$7,500	$48,050	$31,250	$16,100	$4,800	$5,000	$10,000
		Project Design and Engineering (10%)	$1,915	$4,930	$13,870	$6,330	$2,835	$6,390	$6,095	$750	$4,805	$3,125	$1,610	$480	$500	$1,000
		Design, Engineering & Construction Subtotal	$21,065	$54,230	$152,570	$69,630	$31,185	$70,290	$67,045	$8,250	$52,855	$34,375	$17,710	$5,280	$5,500	$11,000
		Contingency (15%)	$3,160	$8,135	$22,886	$10,445	$4,678	$10,544	$10,057	$1,238	$7,928	$5,156	$2,657	$792	$825	$1,650
		Environmental, Permitting, Legal (5%)	$1,053	$2,712	$7,629	$3,482	$1,559	$3,515	$3,352	$413	$2,643	$1,719	$886	$264	$275	$550
		TOTAL ESTIMATED PROJECT COST	**$25,278**	**$65,077**	**$183,085**	**$83,557**	**$37,422**	**$84,349**	**$80,454**	**$9,901**	**$63,426**	**$41,250**	**$21,253**	**$6,336**	**$6,600**	**$13,200**

Applicable unit costs obtained from the NRCS cost data for common project elements contained in the upland water development projects include:

- **Wells**: $26/ft. (drilled/cased: 100' to 700' deep);

  $32.50/ft. (drilled/cased: greater than 700' deep).

  (NRCS Practice Code 642)

  Well screens were also included in the cost estimates for new wells. Screen costs were estimated to be $50/lin. ft., with a minimum of 50 feet of screening required (total of $2,500 per new well).

- **Spring Development:** $1,463 each

  (NRCS Practice Code 574)

  Spring development projects funded with assistance from the NRCS-EQIP program must include fencing around the spring. Therefore, for purposes of this study, a unit cost of $3,000 for each spring development was used.

- **Electric Pumps:** $5,000 each

  A unit cost of $5,000 for a standard electric pump was utilized. This cost assumes that power is available in close proximity to the pump site.

- **Solar Pumps:** $7,500 each

  (NRCS Practice Code 533)

  Reported costs for solar pumps ranged from $3,715 to $7,044 each, depending upon the total dynamic head (TDH) requirements. A unit price of $7,500 was selected for this study.

- **Water Pipeline (1.5" diameter HDPE pipe):** $1.50/lin. ft.

  (NRCS Practice Code 516)

- **Storage Tanks:** $0.75/gal. of capacity

  (NRCS Practice Code 614)

- **Stock Tanks (1,200 gal.):** $2,500 each

  (NRCS Practice Code 614)

  Unit price estimates for stock tanks ranged from approximately $1,200 to $2,800 each, depending upon size and installation. A unit cost of $2,500 each was selected for this study.

- **Stock Ponds:** Costs for stock pond construction were calculated based on the estimated quantity of embankment construction. A unit price of $3.00/cubic yard was used to calculate earthwork costs. For purposes of this study, no liner material was included in pond construction costs.

  (NRCS Practice Code 378)

6.3 IN-STREAM POND OPPORTUNITIES

A number of in-stream pond opportunities were outlined as potential projects in **Section 4.4**. A majority of these projects include in-stream pond creation as an ancillary benefit to re-activation of historic channel meanders and oxbows. For prioritization purposes, projects were identified and preliminary investigations conducted to assess overall feasibility. Although recommendations for specific projects are presented, designs were not completed to a level sufficient to provide meaningful cost comparisons. However, **Table 6.3** provides unit costs for a few of the common elements that are typically included in historic channel re-activation projects.

Table 6.3. Range of Estimated Costs for Typical Meander Re-activation Project Components.

Project Component	Typical Range of Quantities [2]	Unit Cost [3]	Range of Est. Costs
Earthen Diversion Dam(s) [1]	50 – 500 cubic yards (each)	$7.00/cu. yd.	$350 - $3,500
Rock Diversion/Drop Structure(s) [1]	50 – 500 cubic yards (each)	$80/cu. yd.	$4,000 - $40,000
Channel Earthwork/Grading	0 – 1,000 cubic yards	$5.00/cu. yd.	0 - $5,000
Channel Revegetation	0 – 1,000 feet	$5.00/lin. ft.	0 - $5,000

[1] The number of diversion/drop structures required is dependent on project size, channel gradient, and degree of channel incision.

[2] Range of quantities shown represents the size of projects identified in the watershed plan.

[3] Unit costs are from NRCS-EQIP project cost data (2009).

Total costs for instream pond / meander re-activation projects will be dependent on the scale of the project (i.e., restored channel length, channel dimensions (width & depth) at the project location, number of diversion/drop structures, etc.). Based on the unit costs shown in **Table 6.3**, total project costs (including design/engineering and contingency) can be expected to vary widely depending on project scale, with an approximate range of $25,000 to greater than $200,000.

Two of the proposed instream pond projects do include enough detail to submit very preliminary opinions of cost. **Tables 6.4** and **6.5** provide conceptual-level costs for the Lower Kirby Creek (**Section 4.4.5.1**) and Alkali Creek (**Section 4.4.5.2**) in-stream ponds.

Table 6.4. Conceptual Cost Estimate for Lower Kirby Creek Pond.

Cost Item	Estimated Quantity	Unit Cost	Estimated Cost
Mobilization	1	$10,000	$10,000
Embankment	8,000 cubic yards	$8.00/cubic yard	$64,000
Outlet Structure	1	$20,000	$20,000
Emergency Spillway	1	$50,000	$50,000
		Construction Costs	$144,000
		Design and Engineering (10% of const. costs)	$14,400
		Subtotal	$158,400
		Contingency (15% of Subtotal)	$23,760
		Construction Cost Total	$182,160
		Environmental, Permitting, and Legal Fees (5% of Construction Cost Total)	$9,110
		TOTAL PROJECT COST	**$191,270**

Table 6.5. Conceptual Cost Estimate for Alkali Creek Pond.

Cost Item	Estimated Quantity	Unit Cost	Estimated Cost
Mobilization	1	$5,000	$5,000
Embankment	2,500 cubic yards	$8.00/cubic yard	$20,000
Outlet Structure	1	$10,000	$10,000
Emergency Spillway	1	$30,000	$30,000
		Construction Costs	$65,000
		Design and Engineering (10% of const. costs)	$5,500
		Subtotal	$71,500
		Contingency (15% of Subtotal)	$10,725
		Construction Cost Total	$82,225
		Environmental, Permitting, and Legal Fees (5% of Construction Cost Total)	$4,115
		TOTAL PROJECT COST	**$86,340**

6.4 STREAM CHANNEL RESTORATION OPPORTUNITIES

Section 4.5 presented other concepts and opportunities for stream channel restoration, and provided detailed descriptions for two specific restoration strategies including re-establishing a channel/floodplain connection in entrenched channel sections and stabilization of active channel headcuts.

Entrenched/incised channel restoration, resulting in re-connection of the channel to either its historic floodplain or a "new" floodplain surface that is close to the incised channel grade, can be accomplished through implementation of projects having a wide range of complexity. Significant manipulation of channel grade can be achieved by constructing grade control structures (e.g., check dams or weirs) that stabilize the channel and prevent further incision, as well as resulting in channel aggradation or an increase in bed elevation. Conversely, new floodplain surfaces can be excavated adjacent to the incised channel grade to provide a channel/floodplain connection. Given the wide variation in scope of entrenched channel restoration projects, and the fact that preliminary design of such projects was outside the scope of this study (beyond those already included in the list of in-stream pond projects, all of which will also provide some level of entrenched channel restoration), it is difficult to provide accurate cost estimates. **Table 6.6** provides unit costs for a few of the common elements that are typically included in historic channel re-activation projects.

Table 6.6. Estimated Unit Costs for Typical Entrenched Channel Restoration Project Components.

Project Component	Unit Cost [3]
Earthen Grade Control Structure [1]	$7.00/cu. yd.
Rock Grade Control Structure [2]	$54 - $103/cu. yd.
Floodplain Excavation (Earthwork)	$5.00/cu. yd.
Bioengineering (Vegetation Only)	$2.80/lin. ft.
Bioengineering with Rock Toe	$9.40/lin. ft.
Channel Revegetation (Willow Planting)	$0.50/lin. ft.
Channel Revegetation (Wetland Planting)	$9.30/lin. ft.

[1] The number of diversion/drop structures required is dependent on project size, channel gradient, and degree of channel incision.

[2] Range in unit cost is based on the height of the rock structure ($54/cu. yd. for heights up to 36", $103/cu. yd. for heights greater than 36")

[3] Unit costs are from NRCS-EQIP project cost data (2009).

Stabilization of active headcuts was identified as a critical element in the watershed management plan (**Section 4.5.2**). Locations of 50 major headcuts were identified and prioritized as part of the analysis. Similar to some of the other stream restoration strategies described in this study, it is difficult to provide cost estimates for stabilization of the identified headcuts due to the absence of preliminary design information. Under the supposition that many of the headcuts could be stabilized using rock drops and/or chutes, with several examples already in-place within the watershed, the following unit costs and estimated ranges of material quantities are provided in **Table 6.7**.

Table 6.7. Estimated Unit Costs and Ranges of Quantities for Headcut Stabilization Project Elements.

Project Component	Typical Range of Quantities [2]	Unit Cost [3]	Range of Est. Costs
Rock Riprap (rock chute application)	10 - 200	$38/cu. yd.	$380 - $7,600
Rock Drop Structure(s) [1]	10 – 50 cubic yards (each)	$80/cu. yd.	$800 - $4,000
Channel Earthwork/Grading	0 – 100 cubic yards	$5.00/cu. yd.	0 - $500

[1] The number of diversion/drop structures required is dependent on project size, channel gradient, and depth of headcut.

[2] Range of quantities shown represents the size of priority projects identified in the watershed plan.

[3] Unit costs are from NRCS-EQIP project cost data (2009).

Based on the unit costs shown in **Table 6.7**, total costs (including design/engineering and contingency) for a headcut stabilization project can be expected to vary significantly, depending on the magnitude of the headcut, with an approximate range of $1,500 for a small headcut to $15,000, or greater, for deep headcuts in larger channels. As described in **Section 4.5.2**, the method used for headcut stabilization will be dependent on whether the channel has perennial flow or is located in a dry gulch that typically sees flow only during large precipitation events. One or more drop structures are recommended for channels with perennial flow, whereas rock chutes may be more applicable and cost effective for stabilization of headcuts in dry or ephemeral channels.

6.5 OTHER WATERSHED MANAGEMENT STRATEGIES

Other management strategies identified in Chapter 4 include:

- Grazing management practices;
- Prescriptive fire; and
- Weed and pest management.

Costs associated with these types of projects are very site-specific. Local staff of the various resource management agencies (BLM, NRCS, Hot Springs County Weed & Pest District) can provide information regarding design, estimated costs, and potential funding opportunities for these projects.

7.0 ECONOMIC ANALYSIS AND PROJECT FINANCING

7.1 OVERVIEW

This section provides information on cost-share programs and grants available through a number of different agencies and organizations associated with the implementation of watershed improvement projects. Many of these programs provide technical and/or financial assistance to agricultural producers, private landowners, various land management agencies, and other organizations for implementation of activities that benefit future watershed improvements. Types of projects that may be pursued include storage reservoirs, irrigation infrastructure improvements, wildlife/stock watering, stream/riparian corridor rehabilitation, and other water-resource related projects.

Alternative sources of funding for watershed projects are discussed in the following pages. Potential funding sources include local, state, federal and private entities. Much of the information contained in this report was obtained through three main sources which provided information on grant, loan, and in-kind support for watershed related projects:

- ***Water Management & Conservation Assistance Programs Directory***, Fourth Edition (WWDC, May 2009). There are approximately 19 participating local, state and federal agencies and organizations that provide educational, technical, financial, planning and policy assistance to water users and the public in pursuing voluntary water management and conservation implementation. Access this directory through the following website: http://wwdc.state.wy.us/wconsprog/consdir/ConservationDirectoryFinal.pdfg

- ***The Catalog of Federal Funding Sources for Watershed Protection*** developed and maintained by the Environmental Protection Agency (EPA). This website is a searchable database of financial assistance sources (grants, loans, cost-sharing programs, etc.) available to fund a variety of watershed protection projects. Criteria searches include the type of organization (e.g., non-profit groups, private landowner, state, business), type of assistance sought (grants or loans), and keywords (e.g., watershed management). The document is available at the following website: http://cfpub.epa.gov/fedfund/

- ***Habitat Extension Bulletin No. 50 – Fisheries and Wildlife Habitat Cost-Share Programs and Grants*** published by the Wyoming Game and Fish Department (WGFD). This extension bulletin provides information on cost-share programs and grants available through a number of different agencies and organizations for fisheries and wildlife habitat projects. The document is available at the following website: http://gf.state.wy.us/habitat/ExtBulletinsCont/index.asp

Additional information of potential funding sources was extracted from previous watershed investigations completed on behalf of the Wyoming Water Development Commission. This information included the Nowood River Storage/Watershed Study (ACE 2009) and the Cottonwood Creek/Grass Creek Watershed Investigation (SEH 2007).

Other useful resources include the Wyoming Grants Information:

- **Catalog of Wyoming State Grants Compiled by the Wyoming State Library.** The Catalog of Wyoming State Grant Programs is a starting point for potential grant applicants and provides basic information on representative programs.
- **Cooperating Foundation Center Libraries** (http://fdncenter.org/collections/index.html). The Foundation Center sponsors cooperating collections in libraries all over the country, including Wyoming. These facilities own all materials published by the Center. They also have full text financial reports filed with the IRS (990-PF) for foundations located in their state.
- **Wyoming Foundations Directory** (http://www.wycf.org/search.aspx). The Wyoming Community Foundation is now providing the *Wyoming Foundations Directory* in an updated and revised on-line format.
- **Wyoming Foundations Directory 2001**. This is a print "guide to public and private foundations with interest in the State of Wyoming... its main purpose is to match grant seekers with grant makers within Wyoming."

Additional information is available at the following website: http://will.state.wy.us/sis/grants/.

It is important to understand that the potential sources identified within this section are not necessarily an exhaustive list of all the resources that may be available. Existing programs change, sometimes are removed or cancelled and new programs arrive, funding levels vary year to year, and competition for many of the programs is significant. Also, contact information for various programs and key people can also change. Key local contacts for current information on funding sources relevant to watershed protection, restoration and conservation, wildlife/stock watering, and irrigation infrastructure improvements include, but are not limited to the following:

- Hot Springs Conservation District (307-864-3488)
- Natural Resources Conservation Service Thermopolis Office (307-864-3488)
- Bureau of Land Management/Hot Springs District Office (307-332-8400)

Additional information, including the contact person(s), about the primary funding programs identified are discussed in the following sections and summarized in a matrix format (**Table 7.1** - Reference Guide to Potential Funding Sources) at the end of this chapter.

7.2 Local Agencies

7.2.1 Worland Grazing District/Taylor Grazing Act Funds

Hot Springs County receives money from the federal Taylor Grazing Act grazing fees on behalf of the Worland Grazing District (District). Hot Springs County receives 12.5 percent of the fees allocated to the Worland Grazing District. These fees are credited to a special Range Improvement Fund (Fund) for the District. This District is administered by the Wyoming State Grazing Board of the Worland District (Board) which is comprised of permittees who hold Taylor Act permits and graze livestock on public lands within the District. Meetings may be held by the Board at any time to conduct the business of the Board, but must be held at least twice each year.

Disbursements by the County treasurers from the Fund may be made at the request of the Board for the construction of range improvements or any other purpose beneficial to the District. Projects involving construction and maintenance of range improvements on public lands may only be undertaken by cooperative agreements between the Board and the applicable federal officials (BLM or USFS). Similarly, other projects not involving construction or maintenance but located on public lands also must be implemented under a cooperative agreement with the applicable governmental entity. The relevant state statues for the District are available at:
http://legisweb.state.wy.us/statutes/titles/Title9?t9CH4AR4.htm.

7.2.2 Hot Springs Conservation District

The Hot Springs Conservation District (HSCD) serves as the local entity to assist landowners and resource users with conservation practices and provide leadership in natural resource management issues and efforts. The conservation district plays a key role in federal land management planning process and federal and state legislative and administrative initiatives affecting local conservation and land use activities. Conservation Districts can also provide funding assistance for:

- In-kind technical assistance within local resources, capacity and expertise.
- Assistance in the development of leveraged, partnership and projects.
- Administration of grants, projects and programs on behalf of recipients of state and federal natural resources program funding.

The HSCD would implement the grant program being developed by the Wyoming Association of Conservation Districts (WACD) to address locally driven watershed efforts.

7.2.3 Hot Springs County Weed and Pest District

Wyoming Weed and Pest Districts provide in-kind support to landowners and other agencies/entities including, but not necessarily limited to:

- Assistance in the identification of noxious weeds and other undesirable plants;
- Organization and/or participation in local meetings, seminars and field trips to educate local landowners and agencies on the problems and potential solutions for weed and other undesirable plant control;
- Facilitating work days attended by a broad base of stakeholders (e.g. Russian olive tree cuttings); and
- Assistance in preparation of grant applications.

7.3 STATE AGENCIES

7.3.1 Wyoming Department of Environmental Quality

The Wyoming Department of Environmental Quality (WDEQ) is a primary source of funding for implementation of best management practices (BMP's) to address non-point sources of pollution under **Section 319 of the Clean Water Act**. Section 319 grant funding requires a non-federal (i.e., local) match of 40 percent from the applicant. Matching funds may be provided by landowners, a conservation district, or other governmental type entities (e.g., watershed improvement district, irrigation district), and/or non-profit organizations (e.g., Trout Unlimited and Ducks Unlimited). Applications (proposals) need to follow a specific format. The proposal identifies the key issues to be addressed as well as the proposed methods/BMP's to be implemented. The proposal describes all the other information required to evaluate the proposed project and matching funds. Generally proposals are due in August or September of each year. The following link provides useful information on how to format and submit the final report required on all 319 projects including information on content and format, scheduling, and a sample report.
http://deq.state.wy.us/wqd/watershed/Downloads/319/Final%20Report%20Guidance.pdf

The Bureau of Land Management (BLM) in Wyoming is partnering in the implementation of several section 319 watershed plans statewide as part of their Watershed and Water Quality Improvement efforts. Given the distribution of private, state and federal (primarily BLM) lands within the Kirby Creek watershed, this type of partnering may be applicable to future BLM projects that might be best implemented across land ownerships.

7.3.2 Wyoming Game and Fish Department

The WGFD offers a funding program to help landowners, conservation groups, institutions, land managers, government agencies, industry and non-profit organizations develop and/or maintain water sources for fish and wildlife. This program also provides funding for the improvement and/or protection of riparian/wetlands for fish and wildlife resources in Wyoming. Applications for projects are accepted any time with approval on January 1 and August 1 of each year. (Water Management & Conservation Assistance Program Directory (WWDC, May 2009).

- **Riparian Habitat Improvement Grant**. The purpose of this program is to improve or maintain riparian and wetland resources. Fencing, herding, stock water development, streambank stabilization, small damming projects and beaver transplanting are a few examples of efforts that qualify under this program. Permits, NEPA compliance, construction, maintenance, access and management planning are all grantee responsibilities. There is $10,000/project maximum available with 50% cash or in-kind required from grantee.

- **Water Development/Maintenance Habitat Project Grant.** The purpose of this program is to develop or maintain water for fish and wildlife. Spring development, windmills, guzzlers, water protection and pumping payments are examples of the extent of this program. Permits, NEPA compliance, maintenance, access and water righting are responsibilities of the grantee. There is a maximum of $7500/project and 50% cash or in-kind contribution required from the grantee.

- **Upland Development Grant.** The purpose of this program is to develop upland wildlife habitat. Examples of projects in this program are shrub management, grazing systems, prescribed burning, wildlife food plots such as oat, millet or corn plantings, range pitting and range seeding. Permits, NEPA compliance, maintenance, access and management planning are responsibilities of the grantee. There is a maximum of $10,000/project and 50% cash or in-kind contribution required from the grantee.

- **Fish Wyoming.** The purpose of this program is to develop public fishing opportunities. Examples of projects within this effort are boat ramps and fishing access. This program provides a 50% match of funding which is channeled through a private organization or municipality.

- **Wyoming Sage Grouse Conservation Fund**. WGFD also administers the Wyoming Sage-Grouse Conservation Fund (WSGCF); http://gf.state.wy.us. The WSGCF is a special fund established by the Wyoming State Legislature to support the efforts of Local Sage-Grouse Working Groups (LWGs). The WSGCF funding is intended to promote conservation of sage grouse populations and habitat (sagebrush ecosystems), including socio-economic and human use of the habitat. The BHLWG has completed the Sage-grouse Conservation Plan for the Big Horn Basin (BHLWG, 2007) to identify and guide implementation of these objectives.

  Requests for WSGCF funding must be made on a Project Proposal Form available at: http://gd.state.wy.us/wildlife/wildlife_management/sagegrouse/BigHornBasin/BHB%20SgConservPlanFinal.pdf. Funding is normally considered for projects ranging between $5,000 and $50,000 with priority given to those with matching funds, established partnerships, multi-species benefits, management relevance and consistency with the local sage-grouse conservation plan, highest wildlife impact, appropriate budgets, landscape scale, and a lasting legacy of benefits.

  Evaluation criteria include: consistency with the local plan, likelihood of project success, project readiness, availability of matching funds, multiple species benefits, significance at local/state/regional level, duration of benefits, and adequacy of funding. Applications may be made at any time, but should be made by February 1 to receive first round consideration. Funds awarded must be expended between July 1 of the year received and September 30 of the second year after award. The funds are normally distributed as reimbursable grants (i.e. payments are made for expenses incurred and not "up-front"). Request for funding of habitat improvement projects, including water development, must include a livestock grazing management plan.

- **Landowner Incentive Program**. The Landowner Incentive Program (LIP) provides flexible opportunities for the Wyoming Game and Fish Department to partner with private landowners willing to implement habitat improvements and manage their lands to benefit at-risk species. At-risk species are any plant or animal species that are federally listed as endangered, threatened, or candidate; species listed by NatureServe as critically imperiled (G1), imperiled (G2), or vulnerable (G3); or species designated as such by the State of Wyoming. By partnering with the department, private landowners will receive technical and financial assistance to implement management practices to benefit both fish and wildlife habitat and the agricultural productivity of their land. LIP projects will focus on select species inhabiting the three main ecosystems where most of Wyoming's at-risk species occur: grasslands; sagebrush; and prairie streams/watersheds.

7.3.3 Wyoming Office of State Lands and Investments

As the administrative advisory arm of the Board of Land Commissioners and State Loan and Investments Board, the Office of State Lands and Investments (OSLI) administers Regular Farm Loans and Small Water Development Project Loans that may be applicable to potential projects identified in Chapter 4.

- **Regular Farm Loans**. These loans are made for a wide range of agricultural purposes which may be include purchasing, constructing or installing equipment and/or improvements necessary to maintain or improve the earning capacity of the farming operations. Eligible applicants include individuals whose primary residence is in Wyoming and legal entities with a majority of the ownership meetings the individual residency requirements. Single loans or combinations of loans cannot exceed an outstanding principal balance of $600,000. Loan rates are 8 percent for loans up to 50% of the appraised value of the security land and improvements and 9 percent for loans between 50 to 60 percent of the security. The term of a given loan is limited to 30 years.

- **Small Water Development Project Loans**. These loans are authorized for projects for development and use of water on agricultural lands for agricultural purposes. Projects may convert dry land into irrigated land or which may lead to more efficient use of water and/or increased crop or forage production. Eligible recipients may include court approved water districts, agencies of state and local government, individuals, corporations, associations, and other legal entities recognized under state law. Individual loans up to $150,000 may be obtained. Interest is currently set at 6 percent (2010) and the maximum term of the loan is 40 years.

7.3.4 Wyoming Water Development Commission

The Wyoming Water Development Commission provides grant and loan funding for water supply reconnaissance and feasibility studies and construction projects. Funding for studies and construction projects comes from mineral taxes. All planning studies and construction projects must be approved for funding by the Wyoming Legislature. Applicants must be public entities such as municipalities, irrigation districts, service and improvement districts, or joint power boards. Projects must address water supply, transmission and storage. Key aspects of the Wyoming Water Development Program WWDP) and the Small Water Project Program (SWPP) administered by WWDC are described in the following subsections.

7.3.4.1 Wyoming Water Development Program

Key aspects of the Wyoming Water Development Program encompass: new development, dams and reservoirs, rehabilitation, water resources planning, master planning and groundwater inventories. Most important to the Kirby Creek watershed with respect to implementing alternative projects are the New Development Program, Rehabilitation Program, and Water Resource Planning. This information was extracted from the Operating Criteria of the Wyoming Water Development Program available at: http://wwdc.state.wy.us/opcrit/final_opcrit.pdf and from a form titled Information for New Applicants available at the following website:
http://wwdc.state.wy.us/projappl/New_Ap_Info.pdf.

Review of information available at the two websites listed in the previous paragraph and contact with the staff of the WWDC (307-777-7626) is recommended prior to beginning the application process. It is important that the most current information on funding is reviewed prior to making an application on WWDC's policies and procedures which do and can change over time in response to legislative direction and/or Commission action.

New Development Program – develops presently unused and/or unappropriated waters of Wyoming.

Rehabilitation Program – provides funding assistance for the improvement of water projects completed and in use for at least 15 years.

Dam and Reservoir Program – proposes new dams with the storage capacity of 2,000 acre feet or more and proposes expansion of existing dams of 1,000 acre feet or more.

Water Resource Planning – the Water Development Commission serves as the water development planning agency for the State of Wyoming. In this capacity, the WWDC can provide the following assistance to project sponsors.

- Basin Wide Plans – this program serves to develop basin wide plans for each of the state's major drainage basins.
- Master Plans – this program provides a service to municipalities, districts and other entities to assist in the preparation of planning documents which serve as master plans for future water supply systems and improvements. The plans serve as a framework for the entities to establish project priorities and to perform the financial planning necessary to meet those priorities. These plans can assist entities in preparing the reports necessary to achieve federal funding assistance for water development and other water related projects.

Groundwater Grant Programs – the primary purpose of this program is to inventory the available groundwater resources in the state. The program also serves to assist communities in developing efficient water supplies. Municipalities and special districts that convey drinking water are eligible to receive up to $400,000 in grant funds if 25% of the total project costs will be paid by local matching funds.

New Development Program:

This program provides technical assistance and funding to develop waters of the state that are presently unused and/or unappropriated. It deals with a wide range of projects, including several that relate to proposed projects in the watershed rehabilitation and management plan for Kirby Creek, including:

- Multiple Purpose (including agriculture, recreation, environmental and erosion control);
- New Storage (dams and reservoirs less than 2,000 acre-feet);
- New Supply (e.g., deep wells, alluvial wells, diversion dams);
- Watershed Improvement (where primary function or benefit is water development): and
- Recreation

These projects types are listed above in the order of preference assigned by WWDC when determining what projects to pursue among all of the applications received for funding.

Rehabilitation Program:

This program addresses the improvement of water projects completed and in use for at least 15 years in order to assist in keeping existing water supplies effective and viable for the future. With respect to the Kirby Creek watershed, the Rehabilitation Program can improve existing cattle storage facilities, improve pipeline systems to insure safety, decrease operation and maintenance costs, increase the efficiency of conveying water and agricultural water use. The types of projects supported relevant to this watershed are basically the same as listed for the New Development Program.

Note: On farm improvements (e.g., gated pipe, side rolls, center pivots and related facilities and/or equipment such as pumps, power lines) are excluded from WWDC funding under both the New Development and Rehabilitation Programs.

Dam and Reservoir Program:

Dam and Reservoir Program proposes new dams with a storage capacity of 2,000 acre feet or more and proposed expansions of existing dams of 1,000 acre feet or more qualify. The source for revenue for the program is Water Development Account No. III [W.S. 41-2-124(a)(iii)], which has received Water Development Account No. l appropriations and budget reserve account appropriations on occasion, as approved by the legislature; the interest earnings that have accrued to the Water Development Account No. lll; and a percent (0.5%) of the revenues which accrue to the state's severance tax distribution account. Legislative approval must be granted prior to allocating funds to a particular purpose or project.

Dams and reservoirs typically provide opportunities for many potential uses. While water supply should be emphasized in the development of reservoir operating plans, recreation, environmental enhancement, flood control, erosion control and hydropower uses should be explored as secondary purposes.

Key Criteria and Procedures:
An application for funding under either the New Development and/or the Rehabilitation Programs must meet the following key criteria as applicable to potential projects identified within the Kirby Creek watershed.

- "*The project sponsor shall be a public entity that can legally receive state funds, incur debt, generate revenues to repay a state loan, hold title and grant a minimum of a parity position mortgage on the existing water system and improvements or provide other adequate security for the anticipated state construction."*
- "*The proposed project must serve…2,000 or more acres of irrigated cropland, or must rehabilitate watershed infrastructure, which will develop or preserve the estimated minimum useful life span of 25 years and demonstrate that sufficient public benefits will accrue to justify construction of the anticipated improvements.*

Important procedures, deadlines and requirements for applications to the New Development and Rehabilitation Programs include but are not necessarily limited to the following:

- A fee of $1,000 must be submitted with initial project applications; the fee does not apply to projects advanced to the next level of study or to construction.
- A certified resolution passed by the governing body of the sponsoring entity must accompany an application for a Level II study or a Level III construction. This requirement may be deferred if the applicant is in the process of forming a public entity.
- A public entity must be in a place before a Level II study or Level III construction can commence, with certain exceptions discussed in the following paragraphs.
- The due date for new project applications is August 15 or each year; the due date for applications for advancing to the next study level or construction funding is October 1 of each year.

Two important criteria that apply specifically to dam and reservoir projects are:

- *"For projects that enlarge existing storage projects by 1,000 acre-feet or greater or far proposed new dam and reservoirs with a capacity of 2,000 acre-feet or greater, expenses associated with final engineering design and required National Environmental Policy Act review, including but not limited to environmental assessments and environmental impact statements, are eligible components of a Water Development Program Level III, Phase III Study Project."*
- *"For dams and reservoirs projects, the Commission may waive sponsor eligibility requirements through Level II, Phase II. However, the eligible entity requirements shall be met prior to initiation of Level II, Phase III activities described herein."*

Financial Plan:
The current terms of the Wyoming Water Development Program financial plan are summarized as follows:

- Sixty-seven (67) percent grant to 33 percent loan mix.
- Minimum of 4 percent loan interest rate (current rate is 4 percent, but legislature may increase rate).
- Maximum 50-year term for loans, terms shall not exceed economic life of project.
- Payment of loan interest and principal may be deferred up to 5 years after substantial completion of WWDC's discretion under special circumstances.

In the document titled Information for New Applicants the following additional information is provided regarding financial terms:

- *"The best available project financial terms include a great for Level I and Level II expenses, a grant of 75% of the Level III costs, a loan of 25% of the Level III costs with an interest rate of four percent (4%) and a term equal to the economic life of the project/improvement of fifty (50) years, whichever is less. Principal and interest payments may be deferred for five (5) years after project completion. However, these favorable terms will be granted when a project is essential and the project sponsor has a very limited ability to pay."*
- "*Those sponsors who feel more favorable terms are warranted due to a limited ability to pay must make a formal presentation to the Commission documenting their case. Sponsors electing to pursue this option should be aware that the Commission is reluctant to deviate from this standard and such requests will be denied unless they are clearly documented and justified."*

The Commission will evaluate whether or not a project will be funded for Level III construction following review of the results of Level II studies. If the Commission determines that the project should not advance due to high repayment costs (as determined by an analysis of the sponsor's ability to pay and after other funding sources have been considered), the sponsor has the option of making a formal presentation to WWDC relative to the sponsor's ability and willingness to pay. This presentation must address the need for the project, the direct and indirect benefits of the project, and any other information the sponsor feels is relevant to the Commission's final decision. The project sponsor shall be a public entity that can legally receive state funds, incur deft, generate revenues to repay a state loan, hold title and grant a minimum of a parity position mortgage on the existing water system and improvements appurtenant to the project or provide other adequate security for the anticipated state construction loan.

A complete description of the operating criteria for the Wyoming Water Development Program can be reviewed at the following website: http://wwdc.state.wy.us/opcrit/final_opcrit.pdf.

7.3.4.2 Small Water Projects Program

The Small Water Project Program (SWPP) is intended to be compatible with the Wyoming Water Development Commission conventional program and criteria and to parallel and partner with local, state and federal programs that perform water resource planning and water development. Small water projects are defined as those projects that provide multiple benefits and where estimated construction costs, permit procurement, construction engineering and project land procurement are

$100,000 or less, or where the maximum financial contribution from the commission is 50 percent of project costs or $25,000, whichever is less. SWPP funding is a “one-time” grant so that ongoing operation and maintenance costs are not included. Loans are not available under SWPP.

Projects eligible for SWPP grant funding assistance include:

- the construction or rehabilitation of small reservoirs and stock watering ponds (up to 20 feet high and 20 acre-feet capacity);
- wells, pipelines and conveyance facilities;
- springs, solar platforms;
- irrigation works;
- windmills; and
- wetland developments.

Irrigation works/projects may be eligible if they are already documented in a conservation district’s existing watershed plan or a resource management plan or environmental evaluation prepared by a state or federal agency. These types of projects are only eligible if they cannot be addressed by the Water Development Program. Benefits associated with SWPP projects may include, but are not limited to:

- Improved water quality;
- Habitat and water for fish and wildlife;
- Improved riparian habitat; and
- Increased recreational opportunities.

These projects may address environmental concerns by providing water supplies to support plant and animal species, and serve as instruments to improve range land conditions. Funding can only be provided to eligible public entities including but not limited to conservation districts, watershed improvement districts, water conservation districts and irrigation districts.

Planning for small water projects will be generated by a WWDC watershed study or equivalent as determined by the Wyoming Water Development Office. A watershed study will incorporate, at a minimum, available technical information describing conditions and assessments of the watershed including hydrology, geology, geomorphology, geography, soils, vegetation, water conveyance infrastructure, and stream system data. A plan outlining the site specific activities that may remediate existing impairments or address opportunities beneficial to the watershed may also be included. A watershed study should identify one or more projects that may qualify for SWPP funding. A professional engineer and/or geologist, as appropriate, will certify any analysis submitted unless generated by a federal agency.

Applications should be received by January 1st of each calendar year. Applications meeting criteria requirements will be considered during the regularly scheduled WWDC meetings in March. Applications should include a project application, sponsor project referral, project location map, project cost estimates and any letters of authorization or commitment of participation that may be available from other funding sources. A management and rehabilitation plan outlining site specific projects that may remediate existing watershed impairments or address opportunities beneficial to the watershed is required for access to the SWPP. Activities should improve watershed condition and function and provide benefit for wildlife, livestock and the environment. Projects may provide improved water quality, riparian habitat, habitat for fish and wildlife and address environmental concerns by providing water supplies to support plant and animal species or serve to improve natural resource conditions.

7.3.5 Wyoming Wildlife and Natural Resource Trust

The Wyoming Wildlife and Natural Resource Trust (WWNRT) was created by the Wyoming Legislature in 2005 with the purpose to enhance and conserve wildlife habitat and natural resource values throughout the state. Any project designed to improve wildlife habitat or natural resource values is eligible for funding provided a public benefit such as continued agricultural production is maintained for open space and healthy ecosystems, enhancements to water quality, and maintenance or enhancement of wildlife habitat.

Wildlife and Natural Resource Trust funding is available for a wide variety of projects throughout the state, including natural resource programs of other agencies. Some examples include the following:

- Projects that improve or maintain existing terrestrial habitat necessary to maintain optimum wildlife populations may include grassland restoration, changes in management, **prescribed fire**, or treatment of invasive plants.
- Preservation of **open space** by purchase or acquisition of development rights, contractual obligations, or other means of maintaining open space.
- Improvement and maintenance of **aquatic habitats**, including wetland creation or enhancement, stream restoration, water management or other methods.
- Acquisition of **terrestrial or aquatic habitat** when existing habitat is determined crucial/critical, or is present in minimal amounts, and acquisition presents the necessary factor in attaining or preserving desired wildlife or fish population levels.
- Mitigation of impacts detrimental to **wildlife habitat**, the environment and the multiple use of renewable natural resources, or mitigation of conflicts and reduction of potential for disease transmission between wildlife and domestic livestock.

Allowable projects under this program that are potentially relevant to this watershed management plan study include the following:

1. Improvement and maintenance of existing terrestrial habitat necessary to maintain optimum wildlife populations.
2. Preservation of open space by purchase or acquisition of development rights.
3. Improvement and maintenance of existing aquatic habitat necessary to maintain optimum fish populations.

4. Acquisition of terrestrial or aquatic habitat when existing habitat is determined crucial/critical, or is present in minimal amounts, and acquisition presents the necessary factor in attaining or preserving desired wildlife or fish population levels.

5. Conservation, maintenance, protection and development of wildlife resources, the environment, and Wyoming's natural resource heritage.

6. Participation in water enhancement projects to benefit aquatic habitat for fish populations and allow for other watershed enhancements that benefit wildlife.

Funding is by grant with no matching funds required. Non-profit and governmental organizations (including watershed improvement districts, conservation districts, etc.) are eligible for funding by WWNRT. Projects will be funded in July and January. Applications may be filed any time, but must be filed within 90 days of the next funding cycle to receive consideration in that cycle.

7.4 FEDERAL AGENCIES

7.4.1 U.S. Army Corps of Engineers

The US Army Corps of Engineers (USACE) has civil responsibilities for flood damage reduction, hydroelectric power generation and navigational improvement as well as other water and land resource problems and needs including environmental preservation and enhancement, ecosystem management and comprehensive flood plain management. They are responsible for a worldwide military construction program, an extensive environmental program and a broad national civil works program.

The USACE is authorized to provide technical assistance to local communities, States and federally recognized Indian Tribes in support of their efforts to alleviate flooding impacts, reduce erosion and otherwise plan for the wise and prudent use of the nation’s water and related land resources. They also have authority to construct certain water resources related projects and respond to water resource needs.

- **Planning Assistance to States.** This program provides for assistance in preparation of plans for the development, utilization and conservation of water and related land resources. The Corps provide technical planning assistance in all areas related to water resources development such as bank stabilization, sedimentation, water conservation, ecosystem and watershed planning and water quality. Assistance is limited to $500,000 per state and studies are cost-shared on a 50-50 basis with a non-federal sponsor such as a state, public entity or an Indian Tribe.

- **Flood Plain Management Services.** This program provides technical services and planning guidance for support and promotion of effective flood plain management. Flood and flood plain data are developed and interpreted with assistance and guidance provided in the form of “Special Studies” on all aspects of flood plain management planning. All services are provided free of charge to local, regional, state or non-federal public agencies. Federal agencies and private entities have to cover 100% of costs.

- **Flood Damage Reduction Projects**. This program provides structural and non-structural projects to reduce damages caused by flooding and focuses on solving local flood problems in urban areas, towns and villages. The USACE works with the project sponsor to define the flood problem, evaluate solutions, select a plan, develop the design and construct a project. A feasibility study is conducted to identify potential projects with the first $100,000 of the cost Federal. Any cost above this amount is cost-shared 50-50 with the sponsor in the form of cash and in-kind services. Construction lands, easements, rights-of-way, relocations and disposal and 5% of the projects costs are the sponsor's responsibility. Operation and maintenance and a maximum of 50% of total project cost are the sponsor's responsibility.

- **Project Modification for Improvement of Environment.** The purpose of this program is to modify structures or operation of previously constructed water resources projects to improve environmental quality, especially fish and wildlife values. A study, at federal expense, is initiated followed by a feasibility plan that is cost-shared 25% by the sponsor.

- **Aquatic Ecosystem Restoration.** This effort is for restoration of historic habitat conditions to benefit fish and wildlife resources. This is primarily to provide structural or operational changes to improve the environment such a river channel reconnection, wetland creation or improving water quality. Conditions are similar to the Project Modification program with sponsor cost-share being 35%.

- **Water Resources Projects.** The purpose of this program is to construct larger projects for flood damage reduction and to provide technical assistance in resolving more complex water resource problems. It is used to evaluate projects costing more than $10 million that include purposes of flood control, water supplies, water quality, environmental protection and restoration, sedimentation or recreation. This would include reservoirs, diversions, levees, channels or flood plain parks as examples. The USACE works with a non-federal sponsor to define the flood or water resource related problem or opportunity, evaluate flood control or solutions, select a plan, develop a design and construct a project. This requires special authorization and funding from Congress with a reconnaissance study being federal cost. A feasibility study to establish solutions is cost-shared 50% by the non-federal sponsor with 35 to 50% of construction cost the responsibility of the sponsor.

- **Support for Others Program**. This program provides for environmental protection and restoration or facilities and infrastructure. This includes Environmental Planning and Compliance, Economic and Financial Analyses, Flood Plain Management, Cultural Resources and General Planning. All costs for these programs are provided by the customer agency.

- **Regulatory Authority/Responsibility.** The USACE has regulatory authority under the Clean Water Act and the River and Harbor Act. The purpose of these laws is to restore and maintain the chemical, physical and biological integrity of waters of the United States. Section 404 of the Clean Water Act authorizes the Corps to regulate the discharge of dredged

or fill material into waters. This would include dams and dikes, levees, riprap, bank stabilization and development fill. There are three kinds of permits issued by the Corps and include Individual, Nationwide and Regional General permits.
Web site: http://www.usace.army.mil/Pages/Default.aspx

7.4.2 U.S. Department of Agriculture

7.4.2.1 Farm Service Agency

There are three different programs administered through the Farm Service Agency (FSA) that may be applicable to the Kirby Creek Watershed Project. Technical assistance needed for implementation of these FSA programs is provided through the Natural Resource Conservation Service (NRCS). Each of these programs is briefly discussed below.

- **Conservation Reserve Program (CRP).** This is a voluntary program under which eligible highly erodible cropland is removed from production in return for annual rental payments and cost share assistance by FSA over a 10 to 15 year period. The produced is required to establish long-term conservation practices on the erodible, environmentally sensitive lands taken out of production. This cost share program offers rental rates for the CRP lands based on the average value of the dry land cash rent with an additional financial incentive of up to 20 percent of the soil rental rate for selected practices. Establishing permanent cover merits up to a 50 percent cost share.

- **Continuous Sign-Up for High Priority Conservation Practices.** Under this program farmers and ranchers implement certain high-priority conservation practices on their eligible CRP lands. These practices may include: riparian buffers, filter strips, grass waterways, shelterbelts, field windbreaks, living snow fences, contour grass strips, salt tolerant vegetation, and shallow water areas for wildlife.

  This is a cost share program that offers rental rates based on the average value of dry land cash rent with an additional financial incentive of up to 20 percent of the soil rental rate for field windbreaks, grass waterways, filter strips and riparian buffers. An additional 10 percent may be added if the land is located in an EPA-designated wellhead protection area. There is also a provision for cost share of up to 50% of the cost of establishing permanent cover.

- **Emergency Conservation Program (ECP**). This program provides emergency funding and technical assistance for farmers and ranchers to rehabilitate farmland damaged by natural disasters and for carrying out emergency water conservation measures in periods of severe drought. ECP program participants receive cost-share assistance of up to 75 percent of the cost to implement approved emergency conservation practices, as determined by county FSA committees.

7.4.2.2 Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) administers a number of funding and technical assistance programs applicable to many of the watershed rehabilitation projects outlined in Chapter 4. These programs are briefly described in the following subsections and summarized in **Table 7.1**.

- **Environmental Quality Incentives Program (EQIP).** This program is a voluntary conservation program available to farmers and ranchers that promotes technical assistance, cost-sharing and incentive payments for projects and practices that improve water quality, enhance grazing lands, and/or increase water conservation.

  EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum term of ten years. These contracts provide financial assistance to implement conservation practices. Non-federal land owners (including American Indian tribes) who are engaged in livestock or agricultural production on eligible land may participate in the EQIP program. Eligible lands include cropland, rangeland, pasture, forestland, and other farm and ranch lands. Eligibility also requires that the applicant develop an EQIP plan of operations that becomes the basis of the cost-sharing agreement between NRCS and the participant.

  EQIP provides payments up to 75 percent of the incurred costs and income foregone of certain conservation practices and activities. However certain historically underserved producers (Limited resource farmers/ranchers, beginning farmers/ranchers, socially disadvantaged producers) may be eligible for payments up to 90 percent of the estimated incurred costs and income foregone. Farmers and ranchers may elect to use a certified Technical Service Provider (TSP) for technical assistance needed for certain eligible activities and services. The new Farm Bill established a new payment limitation for individuals or legal entity participants who may not receive, directly or indirectly, payments that, in the aggregate, exceed $300,000 for all program contracts entered during any six year period. Projects determined as having special environmental significance may, with approval of the NRCS Chief, have the payment limitation raised to a maximum of $450,000.

Additional information about the EQIP program is available at the following website:
http://www.nrcs.usda.gov/programs/eqip/

- **Watershed Protection and Flood Prevention Program**. This program is also known as the "Small Watershed Program" or the "PL 566 Program", and offers technical and financial assistance to States, local governments and Tribes (project sponsors) to plan and implement authorized watershed project plans for the purpose of:
  - watershed protection, flood mitigation, water quality improvements,
  - soil erosion reduction, rural, municipal and industrial water supply, irrigation,
  - water management, sediment control, fish and wildlife enhancement, wetlands
  - and wetland function creation and restoration, groundwater recharge,
  - easements, wetland and floodplain conservation easements, hydropower, and
  - watershed dam rehabilitation

  Under the Watershed Program NRCS cooperates with local or state agencies, county, conservation districts or other subunits of state government to carry out works of improvement for soil conservation and for other purposes including flood prevention;

conservation, development, utilization and disposal of water; and conservation and proper utilization of land. Projects are limited to watersheds containing less than 250,000 acres.

Watershed Operations provides technical and financial assistance in authorized watershed projects which have public sponsors who:

- Conduct public meetings to assure local involvement,
- Obtain all land and water rights and permits required for the installation of works of improvement,
- Provide local share of funds to install works of improvement, and
- Operate and maintain works of improvement.

The assistance provided consists of technical assistance and cost sharing (Amount varies) for implementation of NRCS-authorized watershed plans. Technical assistance is provided on watershed surveys and planning. Although projects vary significantly in scope and complexity, projects in Wyoming (Laramie and Goshen County) for the purpose of flood prevention and watershed protection ranged from $515,000 to $780,000.

Eligibility for authorized watershed projects must include the following criteria:

- Public sponsorship
- Watershed projects up to 250,000 acres
- Benefits that are directly related to agriculture, including rural communities that are at least 20 percent of the total benefits of the project.

Other NRCS Programs. Other programs administered through the NRCS that may be relevant to certain of proposed project discussed in Chapter 4 include the following:

- **Wildlife Habitat Incentive Program (WHIP)** – This program provides technical and financial assistance to enhance priority fish and wildlife habitat in areas impacted by agricultural activities. WHIP provides cost-share funds for enhancing priority habitat such as wetlands and riparian habitat on private lands.
- **Wetland Reserve Program (WRP)** – This program provides landowners with financial incentives to restore, create and enhance wetlands. Landowners may establish a conservation easement or enter into a cost-share restoration agreement. Landowners voluntarily limit future use of the land yet retain remains in private ownership. Landowners and the NRCS develop a plan for the restoration and maintenance of the wetland.
- **Grassland Reserve Program (GRP)** – This program provides funds to grassland owners to maintain and improve established grass. The GRP emphasizes support for grazing operations, plant and animal biodiversity, and grassland and land containing shrubs and forbs under the greatest threat of conversion.
- **Emergency Watershed Protection (EWP)** - This program undertakes emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has

caused a sudden impairment of the watershed. Program objective is to assist sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protect destabilized streambanks, establish cover on critically eroding lands, repairing conservation practices, and the purchase of flood plain easements. The program is designed for installation of recovery measures.

- **Farm and Ranch Land Protection Program (FRPP)** – This is a voluntary program that provides funds to farmers and ranchers to preserve their agricultural land. The program provides matching funds to State, Tribal, and local governments and non-governmental organizations, who have farmland protection programs to purchase perpetual conservation easements. USDA will provide up to 50 percent of the fair market easement value of the conservation easement, while the cooperating partners provide at least 25 percent of the acquisition price.
- **Resource Conservation and Development (RC&D)** – Wyoming's RC&D areas develop community based projects to: promote conservation, development, and use of natural resources, improve the general level of economic activity and enhance the environment and standard of living in communities.
- **Small Watershed Rehabilitation Program** - The *Grain Standards and Warehouse Improvement Act of 2000* authorized cost-sharing to rehabilitate aging structural measures that are part of water resources projects (including structures built under the watershed and flood prevention operations program area of the Natural Resources Conservation Service).
- **Sage Grouse Restoration Project (SGRP)**
- **Grazing Lands Conservation Initiation (GLCI) Grants**
- **Cooperative Conservation Partnership Initiative (CCPI)**
- **Conservation Security Program (CSP)**

More information on all NRCS programs is available from the local contact listed in **Table 7.1**.

7.4.3 U.S. Department of Interior

7.4.3.1 Bureau of Land Management (BLM)

- **Riparian Habitat Management Program**. This program offers the opportunity to coordinate with outside interests on riparian improvement projects. The goal of BLM's riparian-wetland management is to maintain, restore, improve, protect, and expand these areas so they are in proper functioning condition for their productivity, biological diversity, and sustainability. The overall objective is to achieve an advanced ecological status, except where resource management objectives, including proper functioning condition, would require an earlier successional stage. The goal includes aggressive riparian-wetland information, inventory, training, and research programs as well as improving the partnerships and cooperative management processes.

  Partnerships have been available for riparian improvement projects and for research into riparian issues. Funding is available on an annual basis subject to budget allocations from Congress. All submitted cooperative projects compete for the funds available in the riparian program. For information on the riparian habitat program within BLM, please contact Mark Gorges (307) 775-6100.

- **Range Improvement Planning and Development**. This program is a cooperative effort not only with the livestock operator but also with other outside interests including the various environmental/conservation groups. Water development, whether it be for better livestock distribution or improved wetland habitats for wildlife, is key to healthy rangelands and biodiversity. Before actual range improvement development occurs, an approved management plan must be in place. These plans outline a management strategy for an area and identify the type of range improvements needed to accommodate that management. Examples of these plans are Coordinated Resource Plans, Allotment Management Plans, and Wildlife Habitat Management Plans.

  All rangeland improvement projects on lands administered by the Bureau of Land Management require the execution of a Permit. Although there are a couple of methods for authorizing range improvements on the public lands, Cooperative Agreement for Range Improvements form 4120-6 is the method most commonly used. This applies equally to range improvement projects involving water such as reservoirs, pits, springs, and wells including any associated pipelines for distribution. The major funding source for the Bureau of Land Management's share comes from our range improvement fund which is generated from the grazing fees collected. There, too, is a limited amount of funding from the general rangeland management appropriations. If the cooperator is a livestock operator, their contributions come generally in the form of labor. There are times they also provide some of the material costs as well. Contributions from the conservation/environmental interests is monetary and often come in the form of grants. They also contribute labor on occasion. For information on the range improvement program within BLM, please contact Jim Cagney (307) 775-6194.

- **Watershed and Water Quality Improvement** efforts are undertaken in a cooperative approach with the State of Wyoming, Conservation Districts, livestock operators and various conservation groups. Wyoming's BLM is partnering in the implementation of several Section 319 watershed plans state-wide.

  It is anticipated that as the Wyoming Department of Environmental Quality (WDEQ) continues the inventory of waters of the State and the identification of Impaired and/or Threatened water bodies, BLM will be partnering with the WDEQ to improve water quality in water bodies on Public Lands. In the course of developing watershed plans or TMDL's for these watersheds, BLM will be routinely involved in watershed health assessments, planning, project implementation and Best Management Practice (BMP) monitoring.

  The goals of cooperative watershed projects will typically be the restoration and maintenance of healthy watershed function. These goals will typically be accomplished through approved BMP's, e.g. prescribe burns, vegetation treatments, instream structures, to enhance vegetation cover, control accelerated soil erosion, increase water infiltration and enhance stream flows and water quality.

Currently, in response to the Clean Water and Watershed Restoration initiative and associated funding increases, BLM is expanding its efforts to address water quality and environmental concerns associated with abandoned mines. This work will also be accomplished, in cooperation with the State Abandoned Mine Lands Division, on a priority watershed basis and will employ appropriate BMP's to address identified acid mine drainage and runoff problems from mine tailings and waste rock piles. For information on the watershed and water quality program within BLM, please contact Rick Schuler at (307) 775-6092.

7.4.3.2 Bureau of Reclamation

Promoting water conservation and efficient water use is a key priority for the Bureau of Reclamation.

WaterSMART. Through the Bureau, four WaterSMART funding opportunities are available to provide funding for projects focused on water conservation and water efficiency: Reclamation promotes water conservation, use of water markets, and improved efficiency are crucial elements of any plan to address water issues. With leveraged water sustainability grants, key step will be taken towards increasing conservation for a more efficient use of water.

1. **System Optimization Review Grants**; projects which assess the potential for water management improvements in a river basin, system, or district and identify specific improvements to increase efficiency, including a plan of action for implementing the recommendations..
2. **Water and Energy Efficiency Grants**; provides 50/50 cost share funding to irrigation and water districts, Tribes, States and other entities with water or power delivery authority. Projects should seek to conserve and use water more efficiently, increase the use of renewable energy, protect endangered species, or facilitate water markets. Projects are selected through a competitive process and the focus is on projects that can be completed within 24 months that will help sustainable water supplies in the western United States.
3. **Advanced Water Treatment Pilot and Demonstration Project Grants**; projects address the technical, economic, and environmental viability of treating and using brackish groundwater, seawater, impaired waters, or otherwise creating new water supplies within a specific locale.
4. **Research Grants**; projects for universities, non-profits and other organizations with water or power delivery authority will be invited to leverage their money and resources by cost sharing with Reclamation on research activities designed to enhance the management of water resources, including developing tools to assess the impacts of climate change on water resources, and research that will increase the use of renewable energy in the management of water.

The funding opportunities are available online at: http://www.grants.gov.

7.4.4 U.S. Environmental Protection Agency

The **Targeted Watershed Grants Program** administered by the Environmental Protection Agency (EPA) is designed to encourage watershed practitioners to examine local water related problems in the context of the larger watershed in which they exist, to develop solutions to those problems by creatively applying the full array of available tools, including community-based approaches and management techniques to protect and restore the nation's waters. Any governmental or nonprofit non-governmental entity is eligible to receive a grant under this program, and inter jurisdictional watershed partnerships are encouraged. The assistance provided consists of grants for up to 75 percent of the total project costs. A match of at least 25 percent is required. The typical median amount awarded is $700,00 with a typical range of $300,000 to $900,000. Through these grants, EPA expects to see real environmental results, such as the return of native fish species and increased recreational opportunities and to discover innovative solutions to improving and sustaining water quality. Applications must be made by the governor and these grants are highly competitive.

The **Wetland Program Development Grants (WPDGs)** provide eligible applicants an opportunity to conduct projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys and studies relating to the causes, effects, extent, prevention, reduction and elimination of water pollution. While WPDGs can continue to be used by recipients to build and refine any element of a comprehensive wetland program, priority will be given to funding projects that address the three priority areas identified by EPA: Developing a comprehensive monitoring and assessment program; improving the effectiveness of compensatory mitigation; and refining the protection of vulnerable wetlands and aquatic resources. States, Tribes, local governments (S/T/LGs), interstate associations, intertribal consortia, and national non-profit, non-governmental organizations are eligible to apply.

7.4.5 U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats. Financial and technical assistance is available to private landowners, profit and nonprofit entities, public agencies and public-private partners under several programs addressing the management, conservation, restoration or enhancement of wildlife and aquatic habitat (including riparian areas, wetlands, streams and grasslands. These programs include:

- **Partners for Fish and Wildlife Program.** This program was established to provide technical and financial assistance to private landowners through voluntary cooperative agreements titled Wildlife Extension Agreements (WEA). The program targets:

    - Wetland restoration, creation, and enhancement
    - Grassland restoration and grazing management
    - Riparian restoration and management
    - River and stream restoration
    - Threatened and endangered species habitat restoration
    - Outreach and education

    Upland acres enhanced are primarily grazing systems developed with individual landowners to manage the grassland for wildlife and livestock production. Incentives such as water developments, fencing, cattle guards, etc., are our chief tools of negotiation for developing specific wildlife and livestock use plans. Wetlands, restored or enhanced, provide habitat for waterfowl and other water birds, while at the same time are providing alternative watering sources for cattle producers. One of our main focuses for instream restoration is the removal of fish entrainment structures and barriers. Typically, restoration results in a narrowing and deepening of the existing river channel using instream structures to provide stream stability. Riparian fencing goes hand in hand with stream restoration, as well as grazing systems.

Under the WEA, private landowners agree to maintain the restoration projects as specified in the agreement but otherwise retain full control of the land. Depending on the number of partners, the cost share may vary but is typically 75% partners and 25% landowner.

- **North American Wetlands Conservation Act Grant Program**. This grant program provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands conservation projects for the benefit of wetlands-associated migratory birds and other wildlife. There is a Standard and a Small Grants Program. Both are competitive grants programs and require that grant requests be matched by partner contributions at no less than a 1-to-1 ratio. Funds from U.S. Federal sources may contribute towards a project, but are not eligible as match. The *Standard Grants Program* supports projects that involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats. The *Small Grants Program* supports the same type of projects and adheres to the same selection criteria and administrative guidelines as the Standard Grants Program however project activities are usually smaller in scope and involve fewer project dollars. Grant requests may not exceed $75,000, and funding priority is given to grantees or partners new to the Act's Grants Program.

- **Wildlife Conservation and Appreciation Program**. This program provides grants to state fish and wildlife agencies to fund projects that bring together USFWS, state agencies and private organizations and individuals. Projects include identification of significant problems that can adversely affect fish and wildlife and their habitats, actions to conserve species and their habitats, actions that will provide opportunities for the public to use and enjoy fish and wildlife through non-consumptive activities, monitoring of species and identification of significant habitats.

- **Cooperative Endangered Species Conservation Fund**. This program is available to states that have a cooperative agreement with the Secretary of Interior. The intent is to provide Federal assistance to any state to assist in the development of programs for the conservation of endangered and threatened species. Potential programs include animal, plant and habitat surveys, research, planning, management, land acquisition, protection and public education. Single states may receive up to 75% of program costs

- **Landowner Incentive Program (non-Tribal**). This program provides funding directly to lead Wyoming Game and Fish Department for programs to provide landowners with financial and technical support to benefit at-risk species on private land. Wyoming will focus on projects throughout the State's grasslands, sagebrush, and prairie aquatic habitats. At risk species to benefit from habitat enhancement and restoration work include black-tailed prairie dogs, swift fox, burrowing owls, upland sandpipers, greater sage grouse, brewer's sparrow, sage sparrow, shovelnose sturgeon, flathead chub, plains minnow and silvery minnow.

- **State Wildlife Grants Program.** This program provides federal grant funds for developing and implementing programs that benefit wildlife and their habitats, including species not hunted or fished. Priority is placed on projects that benefit species of greatest conservation concern. Grant funds must be used to address conservation needs, such as research, surveys, species and habitat management, and monitoring, identified within a **State's Comprehensive Wildlife Conservation Plan/Strategy.**

7.4.6 Rural Utilities Service

The United States Department of Agriculture, Rural Development's utilities program is authorized to provide financial assistance for water and waste disposal facilities in rural areas and towns of up to 10,000 people. This program is intended for Non-profit corporations and public bodies such as municipalities, counties, and special purpose districts and authorities. Priority is given to entities serving less than 5,500 people with preference given to small, low income communities.

Funding may be obtained through Rural Development only when the applicant is unable to secure funding from other sources at reasonable rates and terms. The applicant must have legal capacity to borrow and repay loans, to pledge security for loans and to operate and maintain the facilities. The applicant must be financially sound and able to manage the facility effectively as well as have a financially sound facility based upon taxes, assessments, revenues, fees or other satisfactory sources of income to pay costs of operating, debt service and reserve. Grants are also available and are used to supplement loans to reduce debt service where necessary to achieve reasonable user rates. Areas with median household incomes above $37,769 are not grant eligible. Assistance is also available on how to assemble information concerning engineering, financing and management of proposed improvements.

Loans and grants may be used to construct, repair, improve, expand or modify rural water supplies and distribution facilities such as reservoirs, pipelines, wells and pumping stations, waste collection, pumping, treatment or other disposal facilities. This assistance may also be used to acquire a water supply or water right or finance facilities in conjunction with funds from other agencies or those provided by the applicant. These funds can be used to pay legal and engineering fees connected with the development of a facility or pay other costs related to development including rights-of-way or easements and relocation of roads or utilities. Loan terms are a maximum of 40 years, State Statute, or the useful life, whichever is less with interest rates based on current market yields for municipal obligations.

USDA Rural Development also guarantees loans to eligible commercial lenders to improve, develop or finance water or waste disposal facilities in rural areas. This guarantee is a warrant to protect the lender and may cover up to 90% of the principal advanced. The guarantee fee is 1% of the loan amount multiplied by the percent of the guarantee. Interest rates will be negotiated between the lender and the borrower. More information is available at the following websites: http://www.rurdev.usda.gov/wy and http://www.usda.gov/rus/water/index.htm.

7.5 PRIVATE OR NON-PROFIT ORGANIZATIONS

7.5.1 Ducks Unlimited

Ducks Unlimited, Inc. is a potential funding source for wetlands and waterfowl restoration. Ducks Unlimited (DU) conducts program development through a "Partner" agency in providing short term project funding assistance. Money availability is limited to what is within the organizational system. Generally, there is $20,000 to $30,000 available annually statewide with additional funding support from project specific donations.

Ducks Unlimited offers a waterfowl habitat development and protection program called **MARSH** which stands for **Matching Aid to Restore States Habitat**. This is a reimbursement program that provides matching funds for restoration, protection or enhancement of wetlands. The financial extent of this program is dependent on DU's income within the state.

MARSH projects must significantly benefit waterfowl. Projects receiving funding support must be on lands that can demonstrate at least a 30 year project life at a minimum. Groups requesting assistance must be able to demonstrate capacity to execute long-term habitat agreements, deliver and manage projects, and be willing to assume project liability. DU's goal is to match MARSH funds equally with private, state or federal sources. Their objective is to obtain maximum leverage possible to maximize benefit to waterfowl. Therefore, leveraged projects have a greater likelihood of being approved.

Additional information on DU's funding programs and opportunities is available in the Water Management & Conservation Assistance Program Directory referenced previously.

7.5.2 National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) is a private, non-profit, tax exempt organization chartered by Congress in 1984 to sustain, restore and enhance the Nation's fish, wildlife, plants and habitats. NFWF provides funding on a competitive basis through their Keystone Initiative Grants and Special Grant Program. Some of the grants/programs that may be applicable to potential projects in the Kirby Creek Watershed include, but are not limited to the following:

- **Pulling Together Initiative (PTI)** – provides support on a competitive basis for the formation of local Cooperative Weed Management Areas partnerships that include federal resource agencies, state and local governments, private landowners, and other interested parties in developing long-term weed management projects within the scope of an integrated pest management plan; a minimum 1:1 nonfederal match is required.
- **Five-Star Restoration Program** – provides modest financial assistance on a competitive basis to support community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach and training activities; average grant is $13,000.
- **Bring Back the Natives Grant Program** – funds on-the-ground efforts to restore, protect, and enhance native aquatic species to their historic range provided by BLM, Bureau of Reclamation, FWS, Forest Service, and NFWF, minimum of 2:1 nonfederal match is required.

- **National Plant Conservation Initiative (NPCI)** –provides support for on-the-ground conservation projects that protect, enhance, and/or restore native plant communities, including pollinators, on public and private lands. Projects fall into one of six categories: conservation, education, restoration, research, sustainability, and creating data linkages for native plant conservation.

Additional information about all of these and other NFWF grants/programs is available at their website: http://nfwf.org/

7.5.3 Trout Unlimited

The Wyoming Council of Trout Unlimited provides funding and volunteer labor for a wide variety of stream and watershed projects such as erosion control and fish habitat structures, willow and other riparian plantings and stream protection fencing. Embrace-A-Stream grants are available for up to $10,000 per project. Partnerships are encouraged to include local conservation districts and state and federal agencies.

7.5.4 Water for Wildlife

Water for Wildlife is a conservation program designed to benefit wildlife. The initial emphasis focuses on antelope preservation and management through the development of supplemental water resources in selected areas where both the habitat and wildlife are being impaired by lack of this vital resource. The State Game and Fish Department and the Bureau of Land Management cooperate jointly with the One Shot Antelope Hunt Foundation in the creation and development of this conservation program. The antelope herds, as well as, other big game animals are dependent on their habitat for water, feed, and cover. This conservation project provides additional water sources for wildlife including all non-game animals, songbirds, raptors and waterfowl, as well as, domestic livestock.

Table 7.1. Reference Guide to Potential Funding Sources

Agency	Program Name	Assistance	Project Types (s)	Maximum Financial Award								Contact	Email Address & Phone Number	Internet Site
				None	Under $10,000	Under $25,000	Under $50,000	Under $100,000	Over $100,000	Varies widely	Match required			
LOCAL														
Worland Grazing District	**Range Improvement Fund**	Financial	Range and related improvement projects							X		Dick Loper Karen Hepp	wsgb@wyoming.com 307-332-2601 (Dick Loper) 307-347-5138 (Karen Hepp)	NA
Hot Springs Conservation District	**NA**	Technical	Liaisons between landowners and government agencies, in-kind administrative and technical assistance, program coordination/partnering	X								Carla Thomas	carla.thomas@wy.nacdnet.net 307-864-3488	www.conservewy.con/hscd.html
Hot Springs Weed and Pest District	**NA**	Technical	Noxious weed and undesirable plant control, education, and scholarships	X								Marvin Andreen	mandreen@rtconnect.net 307-864-2278	http://www.wyoweed.org.org
STATE														
Wyoming Department of Environmental Quality	**Nonpoint Source Implementation Grants - 319 Program**	Financial, technical	Water quality BMP's								X	Jennifer Zygmunt	jzygmu@wyo.gov 307-777-6080	http://www.deq.state.wy.us/wqd/watershed/nps/NPS.htm
Wyoming Fish and Game Department	**Riparian Habitat Improvement Grant**	Financial, technical	Stock water development, streambank stabilization		X						X	Gary Butler	gbutle@state.wy.us 307-777-4565	http://gf.state.wy.us.index.asp
	Water Development/ Maintenance Habitat Project Grant	Financial, technical	Water developments (springs, windmills, water protection, pumps)		X						X	Gary Butler	gbutle@state.wy.us 307-777-4565	http://gf.state.wy.us.index.asp
	Upland Development Grant	Financial, technical	Range management, grazing plans, prescribed burning, food plots, reseeding		X						X	Gary Butler	gbutle@state.wy.us 307-777-4565	http://gf.state.wy.us.index.asp
	Fish Wyoming	Financial, technical	Improvement public fishing opportunities		X						X	Gary Butler	gbutle@state.wy.us 307-777-4565	http://gf.state.wy.us.index.asp
	Wyoming Sage Grouse Conservation Fund	Financial, technical	Sage-grouse habitat improvement projects					X			X	Tom Christiansen	Tom.Christiansen@wgf.state.wy.us 307-875-3223	http://gf.state.wy.us/wildlife/wildlife_management/sagegrouse/index.asp
	Landowner Incentive Program (LIP)	Financial, technical	Habitat improvements and land management to benefit at-risk species							X	X	Bryce Krueger	Bryce.Krueger@wgf.state.wy.us 307-745-4046	http://gf.state.wy.us/wildlife/nongame/LIP/index.asp

Table 7.1. Reference Guide to Potential Funding Sources

Agency	Program Name	Assistance	Project Types (s)	Maximum Financial Award: None	Under $10,000	Under $25,000	Under $50,000	Under $100,000	Over $100,000	Varies widely	Match required	Contact	Email Address & Phone Number	Internet Site
Wyoming Office of State Lands and Investments	**Regular Farm Loans**	Financial	Projects involving most agricultural purposes							X		Carol Price Russell Noel	cprice@wyo.gov 307-777-6546 rnoel@wyo.gov 307-777-6635	http://slf-web.state.wy.us/
	Small Water Development Project Loans	Financial	Conversion of dry lands to irrigated land and/or water efficiency improvements							X		Rebecca Webb Brian Mark	rwebb@wyo.gov 307-777-6046 bmark@wyo.gov 307-777-6371	http://slf-web.state.wy.us/
Wyoming Water Development Commission	**Wyoming Water Development Program**	Financial (loans & grants), technical	Planning, design and construction of new reservoir storage and rehabilitation of existing reservoir storage projects							X	X	Mike Purcell Jon Wade	MPURCE@state.wy.us 307-777-7626 307-777-7626 jwade@state.wy.us	http://wwdc.state.wy.us/opcrit/final_opcrit.pdf
	Small Water Project Programs	Financial, technical	Small reservoirs and stock tanks					X			X	Mike Purcell	MPURCE@state.wy.us 307-777-7626	http://wwdc.state.wy.us/small_water_projects/small_water_project.html
Wyoming Wildlife and Natural Resource Trust	**NA**	Financial	Improve or maintain aquatic and wildlife habitat, invasive species removal/control, water development, prescribed burning, habitat preservation							X		Mike Baker	307-864-3030 (local) 307-856-4665 (district)	http://wwnrt.state.wy.us/projects
FEDERAL														
U.S. Army Corps of Engineers	**See Section 7.4.1 for details on the different programs**	Financial, technical	Flood damage reduction and management, improvement and conservation of water and related land resources, aquatic ecosystem restoration							X		Matthew Bilodeau	Matthew.A.Bilodeau@usace.army.mil 307-772-2300	https://www.nwo.usace.army.mil/html/od-rwy/Wyoming.htm

Table 7.1. Reference Guide to Potential Funding Sources

Agency	Program Name	Assistance	Project Types (s)	Maximum Financial Award								Contact	Email Address & Phone Number	Internet Site
				None	Under $10,000	Under $25,000	Under $50,000	Under $100,000	Over $100,000	Varies widely	Match required			
U.S. Department of Agriculture **Farm Service Agency**	**Conservation Reserve Program (CRP)**	Financial, technical	Removal of highly erodible lands from production							X		Cindy Hottel	cindy.hottel@wy.usda.gov 307-261-5081	http://www.wy.nrcs.usda.gov/programs/crp/CRP.html
	Continuous Sign-Up for High Priority Conservation Practices	Financial, technical	Riparian buffers, filter strips, grass waterways, shelter belts, salt tolerant vegetation, shallow waterways for wildlife							X		Cindy Hottel	cindy.hottel@wy.usda.gov 307-261-5081	http://wwdc.state.wy.us/wconsprog/WtrMgntConsDirectory.html
	Emergency Conservation Program (ECP)	Financial, technical	Farmland damaged by natural disasters, emergency livestock watering conservation in severe drought							X	X	Cindy Hottel	cindy.hottel@wy.usda.gov 307-261-5081	http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=ecp
U.S. Department of Agriculture **Natural Resources Conservation Service**	**Environmental Quality Incentive Program (EQIP)**	Financial, technical	Conservation planning, range management, irrigation rehabilitation, livestock watering, etc.							X		Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/PROGRAMS/EQIP
	Watershed Protection and Flood Prevention Program	Financial, technical	Watershed protection, water quality control, erosion and sediment control, wetland creation and enhancement, fish and wildlife enhancement, flood control, public recreation							X		Jay Mar Jim Mischke	jay.mar@wy.usda.gov 307-233-6757 jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/watershed/index.html
	Wildlife Habitat Incentives Program (WHIP)	Financial, technical	Non-federal landowners to develop, restore and enhance wildlife habitat							X		Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/whip
	Wetland Reserve Program (WRP)	Financial, technical	Wetland protection, restoration and enhancement							X		Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/wrp
	Grassland Reserve Program (GRP)	Financial, technical	Management plan to enhance plant & animal biodiversity and protect grasslands							X		Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/GRP

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Natural Resources Conservation Service	**Emergency Watershed Protection (EWP)**	Financial, technical	Remove debris from streams, protect stream banks, establish cover on eroding lands, conservation practices, and flood plain easements.							X	X[A]	Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/ewp
	Farm and Ranchlands Protection Program (FRPP)	Financial	Protects agricultural lands, implements conservations plans for highly erodible lands							X	X	Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/frpp
	Resource Conservation and Development Program (RC&D)	Financial, technical	Accelerates/improves State, local agencies and nonprofit groups in rural areas to plan, develop and carry out programs for resource conservation and development.							X		Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.nrcs.usda.gov/programs/rcd/
	Sage Grouse Restoration Project (SGRP)	Financial, technical	Restoring sagebrush-steppe ecosystems to benefit sage-grouse and other sagebrush obligates							X		Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://sgrp.usu.edu/
	Grazing Lands Conservation Initiative (GLCI) Grants	Technical	Improve health, management, and productivity, of privately owned grazing land	X								Larry Bentley Everett L. Bainter	everet.bainter@wy.usda.gov 307-967-2555 307-233-6766	http://www.nrcs.usda.gov/programs/glci/
	Conservation Security Program (CSP)	Financial, technical	Conservation & improvement of soil, water, air, energy, plant & animal life				X					Jim Mischke	jim.mischke@wy.usda.gov 307-864-3488	http://www.wy.nrcs.usda.gov/programs/csp/csp.html
U.S. Department of Interior **Bureau of Land Management**	**Riparian Habitat Management Program**	Financial, technical	Projects to maintain, restore, improve, protect and expand riparian/wetland areas to proper functioning condition							X		Rick Schuler Mark Gorges	Rick.Schuler@blm.gov 307-775-6092 Mark.Gorges@blm.gov 307-775-6100	http://www.blm.gov/wy/sten.html
	Cooperative Agreement for Range Improvements	Financial, technical	Spring developments, wells, reservoirs and associated pipelines							X		Eddie Bateson	worland_wymail@blm.gov	http://www.blm.gov/wy/st/en.html

Table 7.1. Reference Guide to Potential Funding Sources

Agency	Program Name	Assistance	Project Types (s)	Maximum Financial Award: None	Under $10,000	Under $25,000	Under $50,000	Under $100,000	Over $100,000	Varies widely	Match required	Contact	Email Address & Phone Number	Internet Site
U.S. Department in Interior **Bureau of Reclamation**	**WaterSMART Grants (formerly Water Challenge Grants)**	Financial, technical	Conserve and use water more efficiently, increase the use of renewable energy, or facilitate water markets.							X	X	Bill Cole	406-247-7643	http://www.usbr.gov/WaterSMART/
U.S. Environmental Protection Agency	**Targeted Watershed Grants Program**	Financial	Aquatic, wetland, riparian and upland habitat improvement and protection							X	X	Erin Collard	collard.erin@epa.gov 202-566-2655	http://www.epa.gov/twg/2006/2006faq.html#intro
	Wetland Program Development Grants	Financial, technical	Promote research/studies to prevent/eliminate water pollution.						X			Brent Truskowski	truskowski.brent@epa.gov 303-312-6235	http://www.epa.gov/owow/wetlands/grantsguidelines
U.S. Fish and Wildlife Service	**Partners for Wildlife Habitat Restoration**	Financial, technical	Habitat restoration to benefit federal trust species (fish and wildlife), conservation programs, and various fish and wildlife restoration projects							X	X	Mark Hogan	mark_j_hogan@fws.gov 307-332-8719	http://www.fws.gov/mountain-prairie/pfw/wy/wy1.htm
	North American Wetlands Conservation Act Program	Financial	Variety of wetland conservation projects					X		X	X	Mark Hogan	mark_j_hogan@fws.gov 307-332-8719	http://www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm
	Landowner Incentive Program (Non-tribal)	Financial, technical	Funding to WG&F to support fish, wildlife restoration and wetland conservation projects							X	X	Gary Butler	gbutle@state.wy.us 307-777-4565 MountainPrairie@fws.gov	http://federalaid.fws.gov/lip/lip.html
	State Wildlife Grants (SWG)	Financial, technical	Developing wildlife conservation plans and on-the-ground conservation projects							X	X	Gary Butler	gbutle@state.wy.us 307-777-4565	http://wsfrprograms.fws.gov/Subpages/GrantPrograms/SWG/SWG.htm

Table 7.1. Reference Guide to Potential Funding Sources

Agency	Program Name	Assistance	Project Types (s)	Maximum Financial Award								Contact	Email Address & Phone Number	Internet Site
				None	Under $10,000	Under $25,000	Under $50,000	Under $100,000	Over $100,000	Varies widely	Match required			
PRIVATE OR NON-PROFIT ORGANIZATIONS														
Ducks Unlimited	**MARSH**	Financial, technical	Waterfowl aquatic and upland habitat protection, restoration and enhancement				X			X	X	Keela Beachler	aravblood@yahoo.com 307-347-4763	http://www.ducks.org/Wyoming.html
National Fish and Wildlife Foundation (NFWF)	**Pulling Together Initiative (PTI)**	Financial, technical	Long-term invasive species/weed control							X	X			
	Five-Star Restoration Program	Financial, technical	Wetland and wildlife habitat restoration			X						Matthew Birnbaum	Matthew.Birnbaum@nfwf.org	http://www.nfwf.org/AM/Template.cfm?Section=GrantPrograms
	Bring Back the Natives Grant Program	Financial	Riverine habitat and aquatic species restoration projects				X				X	Krystyna Wolniakowski *Western Partnership Office*	503-417-8700 (Portland, OR)	http://www.nfwf.org/AM/Template.cfm?Section=GrantPrograms
	National Plant Conservation Initiative (NPCI)	Financial	Restoration of native plant communities							X		Krystyna Wolniakowski *Western Partnership Office*	503-417-8700 (Portland, OR)	http://www.nfwf.org/AM/Template.cfm?Section=GrantPrograms
Trout Unlimited	**Watershed Restoration**	Financial	Erosion control, fish habitat, structures, willow and other riparian plantings		X							Scott Yates	syates@tu.org 307-332-7700	http://www.tu.org/conservation/watershed-restoration-home-rivers-initiative
Water for Wildlife	**One-Shot Antelope**	Financial	Water development by constructing "guzzlers"			X						Becky or Penny	800-768-7743 info@waterforwildlife.com	http://waterforwildlife.com/aboutus.aspx

[A] Cost-share for traditional EWP provides funding to project sponsors for such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks. The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner. NRCS provides up to 75 percent of the funds needed to restore the natural function of a watershed and up to 90 percent in limited resource areas. The community or local sponsor of the work pays the remaining cost-share, which can be provided by cash or in-kind services. Under the floodplain easement option, a landowner voluntarily offers to sell to the NRCS a permanent conservation easement that provides the NRCS with the full (100%) authority to restore and enhance the floodplain's functions and values.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The Kirby Creek CRM Group, working in conjunction with the Hot Springs Conservation District, Wyoming Water Development Commission, and other project partners (resource agency personnel, landowners, etc.) can and should be commended for their work over the past decade to improve conditions in the Kirby Creek watershed. As evidenced by the numerous projects on the ground, and the desire to evaluate the effects of those projects on watershed function, the various stakeholders continue to seek new means and methods of improving their ranching operations. These efforts not only benefit themselves, but ultimately will result in better and more efficient use of the available resources and lead to a healthier and more sustainable environment.

This Level I Study, which occurs at roughly the five-year mark since the previous watershed study was completed (SEI 2005), aims to build upon the information and recommendations provided in that study as well as the watershed project work completed to date. A valuable component of this study has been the interaction, on the ground, with landowners and producers in the watershed to learn first-hand their issues and concerns. Much was gained from their knowledge of the landscape and their innate sense of what “works”, and what “doesn’t work”, for rangeland operations.

A Geographic Information System (GIS) serves as the primary platform for the watershed inventory and management plan. The GIS functions as a clearinghouse for all of the data that was assembled in the study. Most of the recommendations provided in the watershed management and rehabilitation plan are spatially tied to the GIS. The GIS is an integral part of this study, and will prove to be an important resource for future project planning and studies in the watershed.

8.1 CONCLUSIONS

A watershed management and rehabilitation plan was prepared based on information gained from review of existing data, field inventories, field meetings with landowners, and discussions held with the WWDC project manager, the local sponsor (HCSD), and other stakeholders. This rehabilitation plan outlines a strategy for enhancing water resources in the Kirby Creek watershed and includes project types within the following categories:

- Irrigation infrastructure improvements
- Upland wildlife/livestock watering opportunities
- In-stream pond opportunities
- Stream channel restoration opportunities
- Grazing management strategies and opportunities
- Other upland management opportunities

Conclusions regarding each of the recommended watershed improvement categories are provided in the following subsections.

8.1.1 Irrigation Infrastructure

Irrigation within the Kirby Creek watershed via surface ditches is very limited. In large part, this is due to the fact that the main stream channels (Kirby Creek, East and West Kirby Creeks, Lake Creek) have downcut substantially in the last 75 years. Channel incision has progressed to the point where surface water diversion would be very difficult to re-establish across much of the watershed. Three ditches were identified as having potential for re-activation. Conceptual-level cost estimates are provided for each of these. Further restoration efforts within the watershed to address incised channel conditions and re-connect the floodplain may open-up more opportunities in the future for additional surface water diversions and irrigation via ditch systems. Funding assistance for ditch re-activation projects may be available from the NRCS and the WWDC Small Water Projects Program (SWPP).

8.1.2 Upland Wildlife/Livestock Watering Opportunities

Landowners and operators within the Kirby Creek watershed have implemented numerous water development projects within the past decade. Many of these projects have been geared towards greater distribution of water into upland areas that lacked adequate or reliable water supplies. This in turn has opened up areas to livestock grazing that previously had either no water or unreliable sources of water. An evaluation of the spatial distribution of existing, reliable water sources, facilitated by the project GIS, revealed areas where further upland water development may be warranted. Through field discussions with landowners, additional needs for upland water development were also identified. Based on this information, fourteen (14) upland water development projects were identified. The following are specific conclusions regarding these proposed projects:

1. A majority of the projects include a pipeline/tank system for distribution of water. This type of system is well-suited to the topography and distribution of rangeland within the watershed, and is also cost-effective and fairly low-maintenance. Within the last decade alone, approximately 40 miles of water pipeline systems have been installed by landowners.
2. Water sources for the pipelines are typically existing wells. In some cases, spring development may be an option for water supply.
3. Conceptual-level plans and cost estimates were provided for each of these projects. Estimated project costs ranged from less than $10,000 each for two of the projects, to nearly $200,000.
4. Some of the proposed pipeline/stock tank systems could be modified to best serve individual landowner needs. However, the proposed layout for pipeline systems was based to some degree on an economy-of-scale, and significant modifications to the project extent would likely result in increased unit costs.

8.1.3 In-stream Pond Opportunities

There are limited opportunities for significant surface water storage projects in the Kirby Creek watershed. Two, small impoundment projects are proposed in the watershed plan. One of these projects is located on Lower Kirby Creek, and the other on Alkali Creek. Neither of these projects would store a significant volume of water (Lower Kirby Creek: 25-40 acre-feet; Alkali Creek: 8-12 acre-feet), however they would provide a source of water in areas that currently lack one.

8.1.4 Stream Channel Restoration Opportunities

Stream channel restoration opportunities are primarily geared towards arresting, and potentially reversing, ongoing and long-term channel processes that are detrimental to maintaining base flows, water storage, and overall health and functionality of the watershed. Of paramount importance is the stabilization of active headcuts such that additional loss of channel/floodplain connectivity can be reduced. Re-activation of historic channel meanders and oxbows, which will increase channel length and provide small-scale water storage opportunities, can also improve water availability and improve watershed function. Incised channel conditions have resulted in several deleterious impacts to overall watershed health including:

1. a reduction in local water tables (and corresponding impacts to riparian vegetation and forage production),
2. a loss of floodplain connectivity which further exacerbates the incision process during high-flow events, and restricts the ability of floodplain areas to attenuate flows and store water during floods, and
3. loss of ability to safely and efficiently obtain water from the creek for irrigation or stock watering purposes.

Site-specific projects have been identified to address high-priority locations where stream channel degradation problems currently exist ***and*** where stream restoration was determined to be feasible. In addition to the projects identified in the watershed management plan, numerous smaller, grass-roots efforts initiated by the local community could be undertaken. These include riparian planting projects and riparian area fencing. Successful planting of willow cuttings along Kirby Creek has recently been completed by Wyoming Game & Fish staff at a couple of locations.

8.1.5 Grazing Management Opportunities

Rangeland management based on the State and Transition (S/T) models provided for each Ecological Site Description (ESD) are recommended. This can be accomplished by adoption of Best Management Practices (BMPs) which includes a rest-rotation system of grazing that improves distribution of livestock across the available rangeland. Optimizing potential upland water development projects will also serve to increase range areas that are available to stock and result in improved grazing distribution.

Prescribed fire can be used as a tool to promote range health. Time-of-year is a major burn prescription component for obtaining desired results. Burns should be conducted when preferred plants are dormant. Warm season grasses, like buffalograss and blue grama, benefit from a spring burn.

Continued effective management of noxious weeds and pests will include participation between willing landowners, and local, state, and federal land management agencies. Continued support of the Weed and Pest District in acquiring grant funding, as well as volunteering with in-kind efforts during planning sessions and workshops will be important.

8.2 RECOMMENDATIONS

Based on the existing conditions in the watershed, field meetings with landowners, and discussions with interested stakeholders, coupled with the results of analyses in this study, the following recommendations for moving forward are offered:

1. Most of the recommended upland water development projects could be reasonably taken to the next level of design and permitting evaluation based on the information presented in this study. Furthermore, many of these projects are potentially eligible for funding through the WWDC's Small Water Projects Program (SWPP).
2. Local landowners, the Kirby Creek CRM, and other interested stakeholders have been very active in this watershed over the past decade. In order to keep this momentum going, it is recommended that some of the projects outlined herein be advanced to the next level of planning and analysis such that a heightened level of awareness and interest in watershed projects is maintained.
3. In regards to the identified in-stream pond opportunities (including historic meander re-activation and oxbow development projects) and stream channel restoration opportunities (entrenched channel restoration and headcut stabilization), **the stabilization of active headcuts is clearly considered a priority**. Continued channel incision, left unchecked, will further exacerbate degraded conditions in the watershed and hinder efforts to make substantive improvements to watershed function through implementation of restoration projects and application of improved grazing management practices.
4. Numerous potential funding sources (outside of those administered by the WWDC) are available for the types of projects outlined in this study (refer to **Section 7.0**). This study presents a good medium through which representatives of resource agencies and other funding sources could be introduced to the ongoing efforts in the watershed (if they are not already aware). Collaborative approaches to funding and financing of projects can be investigated in greater detail once a short-list of projects is identified for further consideration.
5. Since streamflow data for Kirby Creek is relatively old, additional streamflow measurements within the watershed would likely be beneficial for future water development planning. **Section 3.4.4.4** identifies potential locations for installation of streamflow measurement devices.

9.0 REFERENCES CITED

Bureau of Land Management (BLM). 1988. Riparian Area Information Data System (RAIDS) database. BLM User Guide 6601-2.

Bureau of Land Management (BLM). 2009. Solid Mineral Occurrence and Development Report, Bighorn Basin Resource Management Plan Revision Project. Cody Field Office and Worland Field Office, WY. April 9, 2009. 148 p.

Bureau of Land Management (BLM). 1993. Mineral Potential Report for the Grass Creek Resource Area RMP/Environmental Impact Statement (EIS). U.S. Department of the Interior, Bureau of Land Management, Worland District Office, Worland, WY.

Bureau of Land Management (BLM). 2007. Wyoming State Office website – accessed July 2010. Available URL: http://www.blm.gov/wy/st/en/programs/grazing/standards_and_guidelines.html. U.S. Department of the Interior, Bureau of Land Management (BLM).

Case, J.C., and J.A. Green. 2000. Earthquakes in Wyoming. Information Pamphlet 6. Wyoming State Geological Survey. Laramie, WY. Available URL: http://www.wsgs.uwyo.edu/Publications/OnlinePubs/docs/earthquakes.pdf. Site accessed June 2010.

Case, J.C., C.S. Arneson, and L.L. Hallberg. 1998. GIS shapefile and metadata for, "Surficial Geology for Wyoming at 1:500,000". Wyoming Geographic Information Science Center, Wyoming State Geological Survey. Laramie, WY.

Curtis, J., and K. Grimes. 2004. Wyoming Climate Atlas, Chapter 10: Evaporation. Available URL: http://www.wrds.uwyo.edu/sco/climateatlas/evaporation.html#foot87. Site accessed June 2010.

Fischenich, C., and J. Morrow, Jr. 2000. Reconnection of Floodplains with Incised Channels, EMRRP *Technical Notes Collection* (ERDC TN-EMRRP-SR-09), U.S. Army Engineer Research and Development Center, Vicksburg, MS. URL: http://el.erdc.usace.army.mil/emrrp/. Accessed Sept. 2010.

Fisser, Herbert G. 1964. Excerpt from University of Wyoming range study.

Hammersmark, C.T. 2008. Assessing the Hydroecological Effects of Stream Restoration. PhD Dissertation. Univ. of California - Davis. Available URL: http://watershed.ucdavis.edu/pdf/Hammersmark-2008.pdf. Accessed Sept. 2010.

Hot Springs Conservation District (HSCD). 2009. Summary of Projects Completed between 1999 and Fall 2009 in the Kirby Creek Watershed. HSCD and Kirby Creek CRM.

King, Calvin. 1992. History of Wildlife in the Big Horn Basin of Wyoming.

Lageson, D., and D. Spearing. 1988. Roadside Geology of Wyoming. Mountain Press Publishing Company. Missoula, MT. 165 p.

Lewis, L., Clark, L., Krapf, R., Manning, M., Staats, J., Subirge, T., Townsend, L., Ypsilantis, B. Riparian area management: Riparian-wetland soils. Technical Reference 1737-19. Denver, CO: Bureau of Land Management (BLM); 2003. BLM/ST/ST-03/001+1737. 109 p. Available URL: http://www.blm.gov/nstc/library/pdf/FinalTR1737-19.pdf. Site accessed June 2010.

Libra, R., Doremus, D., and Goodwin, C., 1981, Volume II-A, Occurrence and characteristics of groundwater in the Bighorn Basin, Wyoming: Wyoming Water Resources Research Institute, University of Wyoming.

Milek, D.G. 2001. Kirby Creek Country. Prepared for the Hot Springs County Conservation District. November 2001. 55 p.

MWH Americas, Inc. (MWH). 2010. Draft Report: Wind-Bighorn Basin Plan Update. Prepared for: Wyoming Water Development Commission (WWDC). March 2010. 188 p.

National Research Council (NRC). 2002. RIPARIAN AREAS: Functions and Strategies for Management. Committee on Riparian Zone Functioning and Strategies for Management; Water Science and Technology Board; Board on Environmental Studies and Toxicology; Division on Earth and Life Studies. Washington, D.C.: National Academy Press; 2002. 428 p.

Natural Resources Conservation Service (NRCS). 2010. Field Indicators of Hydric Soils in the United States, Version 7.0. A guide for identifying and delineating hydric soils. L.M. Vasilas, G.W. Hurt, C.V. Noble (eds.). USDA-NRCS, in cooperation with the National Technical Committee for Hydric Soils.

Natural Resources Conservation Service (NRCS). 2010. Ecological Site Information System (ESIS). Available URL: http://esis.sc.egov.usda.gov/ Site accessed July 2010.

Natural Resources Conservation Service (NRCS). 2010. FY 2009 Wyoming Payment Schedule and Guideline Sheet. Environmental Quality Incentives Program (EQIP). Electronic Field Office Technical Guide (eFOTG). Hot Springs County, WY. Cost Data. Available URL: http://efotg.sc.egov.usda.gov/treemenuFS.aspx. Site accessed July 2010.

Natural Resources Conservation Service (NRCS). 2002. Climate data for WETS Station: BLACK MOUNTAIN, WY0778. State FIPS/County (FIPS): 56017. Hot Springs County, WY. Start yr. - 1971 End yr. – 2000. Creation Date: 09/10/2002. Available URL: http://www.wcc.nrcs.usda.gov/ftpref/support/climate/wetlands/wy/56017.txt. Site accessed June 2010.

Natural Resources Conservation Service (NRCS). 2007. Hydric soil definition. Available URL: http://soils.usda.gov/use/hydric/intro.html. Site accessed June 2010.

Oregon State University (OSU). 2006. Average Monthly or Annual Precipitation, 1971-2000. PRISM Maps, Oregon Climate Service, Oregon State University.

Plafcan, M., and K.M. Ogle. 1994. Water Resources of Hot Springs County, WY. Water-Resources Investigations Report 93-4141. U.S. Geological Survey. Prepared in cooperation with the Wyoming State Engineer. Cheyenne, WY. 95 p.

Pritchard, D., J. Andersen, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian area management: a user guide to assessing proper functioning condition and the supporting science for lotic areas. TR 1737- 15. Denver, CO: U.S. Department of the Interior, Bureau of Land Management.

Rosgen, D. 1994. *A classification of natural rivers*. Catena 22:169-199.

Rosgen, Dave. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Rotar, M., and K. Boyd. 1999. Restoration of an Incised Channel in Southeastern Nebraska. Proceedings of the International Erosion Control Association Annual Meeting. Palm Springs, CA. 2000.

Smith, R.D., A. Ammann, C. Bartoldus, M. M. Brinson. 1995. An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices. Technical Report WRP-DE-9. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS. 88 p.

Stillwell, D.P, S.W. Davis-Lawrence, and A.M. Elser. 2009. DRAFT - Reasonable Foreseeable Development Scenario for Oil and Gas, Bighorn Basin Planning Area, WY. Bureau of Land Management. Wyoming State Office Reservoir Management Group. May 6, 2009. 153 p.

Sunrise Engineering, Inc. (SEI). 2005. Kirby Creek Watershed Plan – Level I Study. Prepared for the Wyoming Water Development Commission (WWDC). September 12, 2005. 68 p.

U.S. Bureau of Reclamation (BOR). 2010. AgriMet-The Pacific Northwest Cooperative Agricultural Weather Network: Monthly Average Reference Evapotranspiration. Available URL: http://www.usbr.gov/pn/agrimet/monthlyet.html. Site accessed June 2010.

U.S. Fish and Wildlife Service (USFWS). 2010. National Wetland Inventory GIS data.

U.S. Forest Service - Mapped-Atmosphere-Plant-Soil System (USFS-MAPSS). 2008. Mapped-Atmosphere-Plant-Soil System Study website. Available URL: http://www.fs.fed.us/pnw/mdr/mapss/about/modeloutput/index.shtml. Site last updated March 17, 2008. Site accessed June 1, 2010.

U.S. Geological Survey (USGS). 2010a. Earthquake Hazards Program. Available URL: http://earthquake.usgs.gov/ . Site accessed June 2010.

U.S. Geological Survey (USGS). 2010b. The National Map LANDFIRE: LANDFIRE National Existing Vegetation Type layer. Available URL: http://gisdata.usgs.net/website/landfire/ Site accessed June 2010.

U.S. Geological Survey (USGS). 2008. National Geologic Map Database – Geologic Names Lexicon (GeoLex) Database. Available URL: http://ngmdb.usgs.gov/Geolex/. Site accessed in June 2010. Site last updated May 2, 2008.

U.S. Geological Survey (USGS). 1994. GIS shapefile and metadata for, "Bedrock Geology for Wyoming at 1:500,000". Wyoming Geographic Information Science Center. USGS. Denver, CO.

U.S. Geological Survey (USGS) and Wyoming State Geological Survey (WYGS). 1994a. GIS shapefile and metadata for, "Geological Faults for Wyoming at 1:500,000". Wyoming Geographic Information Science Center. USGS. Denver, CO.

U.S. Geological Survey (USGS) and Wyoming State Geological Survey (WYGS). 1994b. GIS shapefile and metadata for, "Geological Dykes for Wyoming at 1:500,000". Wyoming Geographic Information Science Center. USGS. Denver, CO.

Washington – Integrated Streambank Protection Guidelines (WISPG). 2003. Published by Washington State Aquatic Habitat Guidelines Program.

Western Regional Climate Center (WRCC). 2010. Precipitation, Snowfall and Temperature Data, Black Mountain, Wyoming Station ID #480778. Period of Record: October 1963 thru April 23, 2009. Available URL: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wy0778 . Site last updated April 15, 2010. Site accessed June 2010.

Western Regional Climate Center (WRCC). 2009. Comparative data for the Western States. Available URL: http://www.wrcc.dri.edu/COMPARATIVE.html. Site accessed July 2009.

Wikipedia. 2010. Online Free Encyclopedia. Available URL: http://en.wikipedia.org/wiki/Main_Page. Site accessed June 2010.

Wyoming Department of Agriculture. 2010. Weed and Pest Declared List (by County). Amended February 2010. Available URL:
http://www.wyoweed.org/Documents/DocumentPage/2010%20Declared%20List.pdf
Site accessed July 2010.

Wyoming Department of Environmental Quality. 2001. Wyoming Surface Water Classification List. Prepared by Wyoming Department of Environmental Quality, Water Quality Division, Surface Water Standards Section.

Wyoming Department of Environmental Quality (WYDEQ). 2005, Water quality rules and regulations, Chapter VIII, Quality standards for Wyoming groundwater. Cheyenne, WY: Wyoming Secretary of State.

Wyoming Department of Environmental Quality. 2010. Wyoming Water Quality Assessment and Impaired Waters List (2010 Integrated 305(b) and 303(d) Report). Prepared by Wyoming Department of Environmental Quality, Water Quality Division, Watershed Section.

Wyoming Game and Fish Department. 2010. Landowner Incentive Program (LIP). Best Management Practices. Available URL: http://gf.state.wy.us/wildlife/nongame/LIP/BestMgmtPractices/index.asp Site accessed July 2010.

Wyoming Geographic Information Science Center (WYGISC). 1998. Draft estimated net annual aquifer recharge for Wyoming at 1:100,000. Laramie, WY.

Wyoming Geographic Information Science Center (WYGISC). 1997. Depth to initial ground water in feet for Wyoming at 1:100,000. Laramie, WY.

Wyoming Natural Diversity Database. 2010. Data compilation for M. Rotar, completed July 19, 2010. Unpublished report. Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Wyoming State Engineer's Office (WYSEO). 2010. Surface water right database. Available URL: http://seo.state.wy.us/wrdb/PS_DRAINAGE_ADV.aspx. Site accessed July 2010.

Wyoming State Engineer's Office (WYSEO). 2005. GIS shapefile and metadata for, "Water Wells for Wyoming at 1:500,000". State Engineer's Office. Laramie, WY.

Wyoming State Geological Survey (WYGS). 2010. Bighorn Basin, including stratigraphy for different geologic time periods. Available URL:
http://www.wsgs.uwyo.edu/StratWeb/BigHornBasin/Default.aspx. Site accessed June 2010.

Wyoming State Water Plan. 2007. Statewide Framework Water Plan – GIS Products. Wyoming Water Development Office (WWDO). Available URL:
http://waterplan.state.wy.us/plan/statewide/gis/pod.html . Site accessed July 2010.

Appendix A

GEODATABASE CONTENTS

Kirby Creek Watershed Study, Hot Springs County, Wyoming

Table A.1. Generalized Contents of Kirby Creek Watershed Study Geodatabase

Feature Dataset	Source	Data Link
Base Data		
Base_River	Wyoming Geographic Information Science Center, 1996	http://piney.wygisc.uwyo.edu/data/water/hydrom.zip
Base_River_Anno	Annotation based on Base_River Data set Created By PBS&J	
City	Census 2000 Tiger Data	
KC_County_Bounds	Bureau of Land Management, 1999	http://www.blm.gov/pgdata/etc/medialib/blm/wy/resources/gis/state/zips.Par.42171.File.dat/cnty_s.zip
County _Anno	Annotation based on KC_County_Bounds Data set Created By PBS&J	
Mask	Created By PBS&J 2009-2010	
Watershed Area	Wyoming Geographic Information Science Center, 2002	http://piney.wygisc.uwyo.edu/data/water/wy_hu12poly.zip
Geology		
KC_Bedrock	U.S. Geological Survey, 1994	http://datagateway.nrcs.usda.gov/
KC_Landslide	U.S. Geological Survey, 1994	xx
KC_Surfgeol	James C. Case, Christopher S. Arneson, and Laura L. Hallberg, 1998	http://www.wsgs.uwyo.edu/GIS/DigitalData/shapefiles/surgeol_500k.zip
GPS		
Area Gen 01-12-10	Digitized By PBS&J 2009-2010	
Cros_Se_04-20-10	Digitized By PBS&J 2009-2010	
Line_gen_01-12-10	Digitized By PBS&J 2009-2010	
Line_gen_05-28-10	Digitized By PBS&J 2009-2010	
Master Area	Digitized By PBS&J 2009-2010	
Master Line	Digitized By PBS&J 2009-2010	
Master Point	Digitized By PBS&J 2009-2010	
Point_ge_01-12-10	Digitized By PBS&J 2009-2010	
Point_ge_04-20-10	Digitized By PBS&J 2009-2010	
Point_ge_05-28-10	Digitized By PBS&J 2009-2010	
Grazing Allotments		
Grazing Allotments_id	Bureau of Land Management, 2002	http://www.blm.gov/pgdata/etc/medialib/blm/wy/resources/gis/office/range/Worland_Field_Office/zips.Par.71126.File.dat/wfo-allotmentss.zip
Grazing Allotments_Anno_new_Project	Annotation based on Grazing Allotments Data set Created By PBS&J	
Ground Water		
Depth_to_Ground_Water	Wyoming Geographic Information Science Center, 1997	http://piney.wygisc.uwyo.edu/data/water/dtw100.zip
Headcuts		
KC_Headcuts	Digitized By PBS&J 2009-2010	
KC_HeadcutsAnno	Annotation based on KC_Headcuts Data set, Created By PBS&J 2009-2010	
Historic Meanders		
Historic Meanders	Digitized By PBS&J 2009-2010	
Historic Meanders Buffers	Digitized By PBS&J 2009-2010	
LANDFIRE		
Biophysical	LANDFIRE (Landscape Fire and Resource Management Planning Tools Project), 2004-2009	http://www.landfire.gov/
Mining and Minerals		
Mining_Claims_Active	Bureau of Land Management	http://www.geocommunicator.gov/GeoComm/index.shtm
Mining_Claims_Closed	Bureau of Land Management	http://www.geocommunicator.gov/GeoComm/index.shtm
NWI		
KC_NWI_ID	U.S. Fish and Wildlife	http://wetlandsfws.er.usgs.gov/imf/imf.jsp?site=NWI_CONUS
Oil		
Pipeline	NPMS, 2008	https://www.npms.phmsa.dot.gov/
Wellbuffs	Created By PBS&J 2009-2010	
On Stream Ponds		
On_Stream_Ponds	Digitized By PBS&J 2009-2010	
Ownership		
KC_Ownership	Hot Springs County Assessor	
Permitted Discharge Locations		
Permitted Discharge Locations	Wyoming DEQ	
Points of Diversion		
KC Points of Diversion	Digitized By PBS&J 2009-2010	
KC Points of DiversionAnno	Annotation based on KC Points of Diversion , Created By PBS&J 2009-2010	
Potential Streamflow Gage Sites		
Potential Streamflow Gage Sites	Digitized By PBS&J 2009-2010	
Precipitation		
Historic Annual Precip	USDA/NRCS - National Cartography & Geospatial Center, 1970-2001	http://datagateway.nrcs.usda.gov/
Weather Stations	Wyoming Geographic Information Science Center, 2001	http://piney.wygisc.uwyo.edu/data/climate/precip.zip
Projects		
New Projects	Digitized By PBS&J 2009-2010	
New Projects Anno	Annotation based on New Projects , Created By PBS&J 2009-2010	
New ProjectsBuffers	Created By PBS&J 2009-2010	

Feature Dataset	Source	Data Link
RAIDS		
Raids ID	Bureau of Land Management, Jared Dalebout	
RIP Fence		
RipFence	Wyoming Game and Fish Dept., Worland NRCS Office, Amy Anderson	
RipFencePolygon	Wyoming Game and Fish Dept., Worland NRCS Office, Amy Anderson	
Rosgen Level Classification		
KC_Rosgen_E	SCI, 2005	
KC_Rosgen_G	SCI, 2005	
RosgenLevel_1_LakeCreek	Digitized By PBS&J 2009-2010	
RosgenLevel_1_LakeAnno	Annotation based on . Created By PBS&J 2009-2010	
Soils		
KC_Soil	Wyoming Geographic Information Science Center, 1998	http://piney.wygisc.uwyo.edu/data/geology/soil500k.zip
Springs		
Springs	Digitized By PBS&J 2009-2010	
Stock Ponds		
Stockponds	Digitized By PBS&J 2009-2010	
Stockponds_Buffer	Created By PBS&J 2009-2010	
Stockponds_Buffer_MultipleRingBu	Created By PBS&J 2009-2010	
Stock Tanks		
StockTanks	Digitized By PBS&J 2009-2010	
StockTanks_Proposed	Created By PBS&J 2009-2010	
Storage Tanks		
Storage Tanks	Digitized By PBS&J 2009-2010	
Stream Classififcation		
StreamALL Stream_Class Stream_AnnoLake_Rosgen	Wyoming Geographic Information Science Center, 1996 Created By PBS&J 2009-2010 Annotation based on StreamALL. Created By PBS&J 2009-2010	http://piney.wygisc.uwyo.edu/data/water/hydrom.zip
Geologic Structure		
KC_Area_Faults	US Geological Survey, 1994	http://www.wsgs.uwyo.edu/GIS/DigitalData/shapefiles/Faults_500k.zip
Sub-Watersheds		
KC_SubWatershed	Wyoming Geographic Information Science Center, 2002	http://piney.wygisc.uwyo.edu/data/water/wy_hu12poly.zip
Transmission Lines		
Power_Lines	Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver, 2004	http://sagemap.wr.usgs.gov/ftp/regional/usgs/powerlines_wus_can_sgca.zip
Transportation		
Roads	Wyoming Geographic Information Science Center, 1997	http://piney.wygisc.uwyo.edu/data/transportation/roadm.zip
Upland Points		
Inventoried Upland Range Points	Digitized By PBS&J 2009-2010	
Inventoried Upland Range Points_anno	Digitized By PBS&J 2009-2010	
USGS Gaging Stations		
Gaging_Station	USGS, Water Resources Data System, 2005	http://waterplan.state.wy.us/plan/statewide/gis/gagingstations.zip
Water Pipelines		
Water Pipeline	Digitized By PBS&J 2009-2010	
Water Wells		
SEO_Water_Wells	State Engineers Office, 2009	ftp://seoftp.wyo.gov/geolibrary_data/SEOwells.zip

Appendix B

SOILS MAPPING DATA

Kirby Creek Watershed Study, Hot Springs County, Wyoming

Kirby Creek Watershed Study
Summary of Soils Mapping

Sub-watershed	Soil Map Unit #	Soil Map Unit Description	Acres	% of Sub-watershed
Alkali Creek-Kirby Creek	24		169	1%
Alkali Creek-Kirby Creek	102	ROCK OUTCROP	39	0.2%
Alkali Creek-Kirby Creek	111	ROCK OUTCROP(30%)-SHINGLE(25%)-TASSLE(25%) COMPLEX	240	1%
Alkali Creek-Kirby Creek	243	KIM ALKALI(50%)-KIM(30%) LOAMS	358	2%
Alkali Creek-Kirby Creek	253		102	1%
Alkali Creek-Kirby Creek	360	STONEHAM(50%)-KIM ASSOCIATION(30%)	1,895	10%
Alkali Creek-Kirby Creek	490	SHINGLE(40%)-THEDALUND(35%) LOAMS	7,395	38%
Alkali Creek-Kirby Creek	703	FORT COLLINS(50%)-CUSHMAN(30%) COMPLEX	188	1%
Alkali Creek-Kirby Creek	705	KIM(50%)-THEDALUND(30%) LOAMS	2,948	15%
Alkali Creek-Kirby Creek	708	RENOHILL(40%)-CUSHMAN(20%)-WORFKA(20%) COMPLEX	184	1%
Alkali Creek-Kirby Creek	709	RENOHILL(40%)-CADOMA(25%)-WORFKA(20%) COMPLEX	160	1%
Alkali Creek-Kirby Creek	722	BLAZON LOAM	409	2%
Alkali Creek-Kirby Creek	723	BLAZON(40%)-DELPHIL(35%)LOAMS	369	2%
Alkali Creek-Kirby Creek	725	BLAZON(40%)-DIAMONDVILLE(35%)	47	0.2%
Alkali Creek-Kirby Creek	730	FORELLE(45%)-DIAMONDVILLE(35%) LOAMS	43	0.2%
Alkali Creek-Kirby Creek	732	THERMOPOLIS(40%)-ROCK OUTCROP(35%) COMPLEX	266	1%
Alkali Creek-Kirby Creek	735	PATENT(45%)-FORELLE(35%) ASSOCIATION	191	1%
Alkali Creek-Kirby Creek	753	GAYNOR(40%)-SAMSIL(40%) CLAYS	614	3%
Alkali Creek-Kirby Creek	902	SAMSIL(50%)-SHINGLE(20%)-ROCK OUTCROP(15%) COMPLEX	2,339	12%
Alkali Creek-Kirby Creek	929	RENTSAC(60%)-ROCK OUTCROP(20%) COMPLEX	1,143	6%
Alkali Creek-Kirby Creek	930	RENTSAC VARIANT(40%)-RENTSAC(30%)-CLAYBURN VARIANT (15%) COMPLEX	334	2%
Alkali Creek-Kirby Creek	unk		66	0.3%
Lake Creek-Kirby Creek	68	CADOMA(50%)-EPSIE(25%) COMPLEX	6,773	27%
Lake Creek-Kirby Creek	73	ABSTED(40%)-STONEHAM(30%)-ULM(20%) LOAMS	1,416	6%
Lake Creek-Kirby Creek	102	ROCK OUTCROP	93	0.4%
Lake Creek-Kirby Creek	111	ROCK OUTCROP(30%)-SHINGLE(25%)-TASSLE(25%) COMPLEX	891	4%

Sub-watershed	Soil Map Unit #	Soil Map Unit Description	Acres	% of Sub-watershed
Lake Creek-Kirby Creek	190	EPSIE(45%)-SHINGLE(30%)-COMPLEX	2,119	8%
Lake Creek-Kirby Creek	243	KIM ALKALI(50%)-KIM(30%) LOAMS	1,658	7%
Lake Creek-Kirby Creek	322	NIHILL(45%)-SHINGLE(30%) GRAVELLY LOAMS	164	1%
Lake Creek-Kirby Creek	360	STONEHAM(50%)-KIM ASSOCIATION(30%)	6	0.02%
Lake Creek-Kirby Creek	490	SHINGLE(40%)-THEDALUND(35%) LOAMS	2,907	11%
Lake Creek-Kirby Creek	705	KIM(50%)-THEDALUND(30%) LOAMS	0.04	0.0002%
Lake Creek-Kirby Creek	708	RENOHILL(40%)-CUSHMAN(20%)-WORFKA(20%) COMPLEX	130	1%
Lake Creek-Kirby Creek	709	RENOHILL(40%)-CADOMA(25%)-WORFKA(20%) COMPLEX	3,224	13%
Lake Creek-Kirby Creek	720	BLAZON(45%)-ROCK OUTCROP(30%) COMPLEX	88	0.3%
Lake Creek-Kirby Creek	722	BLAZON LOAM	92	0.4%
Lake Creek-Kirby Creek	723	BLAZON(40%)-DELPHIL(35%)LOAMS	250	1%
Lake Creek-Kirby Creek	735	PATENT(45%)-FORELLE(35%) ASSOCIATION	3	0.01%
Lake Creek-Kirby Creek	753	GAYNOR(40%)-SAMSIL(40%) CLAYS	2,655	10%
Lake Creek-Kirby Creek	802	ROCK OUTCROP(50%)-STARMAN(40%) COMPLEX	78	0.3%
Lake Creek-Kirby Creek	806	STARLEY(50%)-STARMAN(20%)-ROCK OUTCROP(15%) COMPLEX	297	1%
Lake Creek-Kirby Creek	902	SAMSIL(50%)-SHINGLE(20%)-ROCK OUTCROP(15%) COMPLEX	1,796	7%
Lake Creek-Kirby Creek	910	CADOMA(30%)-THEDALUND(25%)-EPSIE(25%) COMPLEX	0.3	0.001%
Lake Creek-Kirby Creek	920	STONEHAM(25%)-THEDALUND(25%)-ULM(25%) COMPLEX	560	2%
Lake Creek-Kirby Creek	930	RENTSAC VARIANT(40%)-RENTSAC(30%)-CLAYBURN VARIANT (15%) COMPLEX	10	0.04%
Lake Creek-Kirby Creek	931	CLAYBURN VARIANT(45%)-RENTSAC VARIANT(35%) COMPLEX	81	0.3%
Lower Kirby Creek	68	CADOMA(50%)-EPSIE(25%) COMPLEX	104	0.5%
Lower Kirby Creek	69	KIM LOAM	581	3%
Lower Kirby Creek	73	ABSTED(40%)-STONEHAM(30%)-ULM(20%) LOAMS	29	0.1%
Lower Kirby Creek	74	PETRIE(45%)-ULM(30%) COMPLEX	74	0.3%
Lower Kirby Creek	102	ROCK OUTCROP	660	3%
Lower Kirby Creek	111	ROCK OUTCROP(30%)-SHINGLE(25%)-TASSLE(25%) COMPLEX	562	3%

Sub-watershed	Soil Map Unit #	Soil Map Unit Description	Acres	% of Sub-watershed
Lower Kirby Creek	243	KIM ALKALI(50%)-KIM(30%) LOAMS	2,549	12%
Lower Kirby Creek	346	NELSON(30%)-TERRY(30%)-OTERO(20%) COMPLEX	12	0.1%
Lower Kirby Creek	360	STONEHAM(50%)-KIM ASSOCIATION(30%)	3,307	16%
Lower Kirby Creek	389	SPEARFISH(50%)-NEVILLE(30%) ASSOCIATION	0.4	0.002%
Lower Kirby Creek	390		67	0.3%
Lower Kirby Creek	398	TASEL(30%)-BOWBAC(30%)-TERRY(25%) COMPLEX	13	0.1%
Lower Kirby Creek	445	REKOP(45%)-GYSTRUM(35%) LOAMS	19	0.1%
Lower Kirby Creek	446	ROCK OUTCROP(35%)-TRAVESSILLA(25%)-SPEARFISH(20%) COMPLEX	76	0.4%
Lower Kirby Creek	490	SHINGLE(40%)-THEDALUND(35%) LOAMS	2,247	11%
Lower Kirby Creek	546	SPEARFISH(35%)-ROCK OUTCROP(30%)-NEVILLE(20%) COMPLEX	1,357	6%
Lower Kirby Creek	700	STONEHAM(50%)-CUSHMAN(30%) LOAMS	10	0.04%
Lower Kirby Creek	705	KIM(50%)-THEDALUND(30%) LOAMS	2,251	11%
Lower Kirby Creek	753	GAYNOR(40%)-SAMSIL(40%) CLAYS	200	1%
Lower Kirby Creek	902	SAMSIL(50%)-SHINGLE(20%)-ROCK OUTCROP(15%) COMPLEX	3,358	16%
Lower Kirby Creek	910	CADOMA(30%)-THEDALUND(25%)-EPSIE(25%) COMPLEX	3,732	18%
Middle Kirby Creek	68	CADOMA(50%)-EPSIE(25%) COMPLEX	4,985	20%
Middle Kirby Creek	102	ROCK OUTCROP	493	2%
Middle Kirby Creek	111	ROCK OUTCROP(30%)-SHINGLE(25%)-TASSLE(25%) COMPLEX	1,328	5%
Middle Kirby Creek	243	KIM ALKALI(50%)-KIM(30%) LOAMS	3,279	13%
Middle Kirby Creek	322	NIHILL(45%)-SHINGLE(30%) GRAVELLY LOAMS	7	0.03%
Middle Kirby Creek	360	STONEHAM(50%)-KIM ASSOCIATION(30%)	1,014	4%
Middle Kirby Creek	446	ROCK OUTCROP(35%)-TRAVESSILLA(25%)-SPEARFISH(20%) COMPLEX	4	0.02%
Middle Kirby Creek	490	SHINGLE(40%)-THEDALUND(35%) LOAMS	3,269	13%
Middle Kirby Creek	546	SPEARFISH(35%)-ROCK OUTCROP(30%)-NEVILLE(20%) COMPLEX	566	2%
Middle Kirby Creek	700	STONEHAM(50%)-CUSHMAN(30%) LOAMS	103	0.4%
Middle Kirby Creek	703	FORT COLLINS(50%)-CUSHMAN(30%) COMPLEX	1,121	4%
Middle Kirby Creek	705	KIM(50%)-THEDALUND(30%) LOAMS	680	3%

Sub-watershed	Soil Map Unit #	Soil Map Unit Description	Acres	% of Sub-watershed
Middle Kirby Creek	708	RENOHILL(40%)-CUSHMAN(20%)-WORFKA(20%) COMPLEX	14	0.1%
Middle Kirby Creek	749	RENOHILL(45%)-WORFKA(35%) COMPLEX	211	1%
Middle Kirby Creek	753	GAYNOR(40%)-SAMSIL(40%) CLAYS	1,757	7%
Middle Kirby Creek	902	SAMSIL(50%)-SHINGLE(20%)-ROCK OUTCROP(15%) COMPLEX	6,206	24%
Middle Kirby Creek	910	CADOMA(30%)-THEDALUND(25%)-EPSIE(25%) COMPLEX	14	0.1%
Middle Kirby Creek	unk		508	2%
Upper Kirby Creek	24		267	1%
Upper Kirby Creek	68	CADOMA(50%)-EPSIE(25%) COMPLEX	2,838	8%
Upper Kirby Creek	73	ABSTED(40%)-STONEHAM(30%)-ULM(20%) LOAMS	361	1%
Upper Kirby Creek	111	ROCK OUTCROP(30%)-SHINGLE(25%)-TASSLE(25%) COMPLEX	2	0.01%
Upper Kirby Creek	243	KIM ALKALI(50%)-KIM(30%) LOAMS	1,682	5%
Upper Kirby Creek	360	STONEHAM(50%)-KIM ASSOCIATION(30%)	206	1%
Upper Kirby Creek	398	TASEL(30%)-BOWBAC(30%)-TERRY(25%) COMPLEX	144	0.4%
Upper Kirby Creek	448	TORRIFLUVENTS, SALINE	120	0.3%
Upper Kirby Creek	450	TORRIFLUVENTS(40%)-FLUVAQUENTS(40%) COMPLEX	230	1%
Upper Kirby Creek	490	SHINGLE(40%)-THEDALUND(35%) LOAMS	5,592	15%
Upper Kirby Creek	700	STONEHAM(50%)-CUSHMAN(30%) LOAMS	82	0.2%
Upper Kirby Creek	703	FORT COLLINS(50%)-CUSHMAN(30%) COMPLEX	597	2%
Upper Kirby Creek	705	KIM(50%)-THEDALUND(30%) LOAMS	704	2%
Upper Kirby Creek	708	RENOHILL(40%)-CUSHMAN(20%)-WORFKA(20%) COMPLEX	480	1%
Upper Kirby Creek	709	RENOHILL(40%)-CADOMA(25%)-WORFKA(20%) COMPLEX	869	2%
Upper Kirby Creek	720	BLAZON(45%)-ROCK OUTCROP(30%) COMPLEX	428	1%
Upper Kirby Creek	722	BLAZON LOAM	1,065	3%
Upper Kirby Creek	723	BLAZON(40%)-DELPHIL(35%)LOAMS	1,906	5%
Upper Kirby Creek	724	BLAZON(40%)-BROWNSTO(35%) COMPLEX	327	1%
Upper Kirby Creek	725	BLAZON(40%)-DIAMONDVILLE(35%)	3,367	9%
Upper Kirby Creek	730	FORELLE(45%)-DIAMONDVILLE(35%) LOAMS	77	0.2%

Sub-watershed	Soil Map Unit #	Soil Map Unit Description	Acres	% of Sub-watershed
Upper Kirby Creek	732	THERMOPOLIS(40%)-ROCK OUTCROP(35%) COMPLEX	884	2%
Upper Kirby Creek	735	PATENT(45%)-FORELLE(35%) ASSOCIATION	116	0.3%
Upper Kirby Creek	736	FORELLE(50%)-PINELLI (30%) LOAMS	730	2%
Upper Kirby Creek	753	GAYNOR(40%)-SAMSIL(40%) CLAYS	1,215	3%
Upper Kirby Creek	806	STARLEY(50%)-STARMAN(20%)-ROCK OUTCROP(15%) COMPLEX	0.1	0.0004%
Upper Kirby Creek	902	SAMSIL(50%)-SHINGLE(20%)-ROCK OUTCROP(15%) COMPLEX	3,006	8%
Upper Kirby Creek	910	CADOMA(30%)-THEDALUND(25%)-EPSIE(25%) COMPLEX	628	2%
Upper Kirby Creek	929	RENTSAC(60%)-ROCK OUTCROP(20%) COMPLEX	2,218	6%
Upper Kirby Creek	930	RENTSAC VARIANT(40%)-RENTSAC(30%)-CLAYBURN VARIANT (15%) COMPLEX	3,585	10%
Upper Kirby Creek	931	CLAYBURN VARIANT(45%)-RENTSAC VARIANT(35%) COMPLEX	1,016	3%
Upper Kirby Creek	939	BACHUS VARIANT(35%)-ROCK OUTCROP(30%) COMPLEX	647	2%
Upper Kirby Creek	940	VONA VARIANT(50%)-BACHUS VARIANT(30%) COMPLEX	681	2%
Upper Kirby Creek	949	IRIGUL(65%)-ROCK OUTCROP(20%) COMPLEX	210	1%

Appendix C

VEGETATION COVER DATA

Kirby Creek Watershed Study, Hot Springs County, Wyoming

Kirby Creek Watershed Study

Summary of Vegetation Cover

Vegetation Type	Sub-watershed Name										TOTAL	
	Alkali Creek-Kirby Creek		Lake Creek-Kirby Creek		Lower Kirby Creek		Middle Kirby Creek		Upper Kirby Creek			
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Agriculture-Cultivated Crops and Irrigated Agriculture	0	0%	0.5	0%	40	0.2%	0	0%	1	0.002%	41	0.03%
Agriculture-Pasture and Hay	0	0%	0	0%	140	1%	0	0%	9	0.03%	149	0.1%
Artemisia tridentata ssp. vaseyana Shrubland Alliance	86	0.4%	64	0.3%	783	4%	332	1%	852	2%	2,116	2%
Barren	0	0%	1	0.01%	2	0.01%	2	0.01%	1	0.004%	7	0.01%
Colorado Plateau Pinyon-Juniper Woodland	0	0%	1	0.00%	0.4	0.00%	2	0.01%	1	0.004%	4	0.003%
Developed-Low Intensity	0	0%	0	0%	4	0.02%	0	0%	0	0%	4	0.003%
Developed-Open Space	0	0%	0	0%	19	0.1%	0	0%	0	0%	19	0.01%
Inter-Mountain Basins Big Sagebrush Shrubland	11,457	59%	15,134	60%	11,564	53%	12,818	50%	20,686	57%	71,659	56%
Inter-Mountain Basins Big Sagebrush Steppe	1,627	8%	1,552	6%	1,550	7%	3,024	12%	2,061	6%	9,814	8%
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	55	0.3%	185	1%	145	1%	39	0.2%	266	1%	690	1%
Inter-Mountain Basins Greasewood Flat	4	0.02%	4	0.02%	67	0.3%	41	0.2%	11	0.03%	127	0.1%
Inter-Mountain Basins Juniper Savanna	4	0.02%	2	0.01%	1	0.00%	0.4	0%	2	0.01%	9	0.01%
Inter-Mountain Basins Mat Saltbush Shrubland	37	0.2%	70	0.3%	355	2%	167	1%	83	0.2%	713	1%

Vegetation Type	Sub-watershed Name										TOTAL	
	Alkali Creek-Kirby Creek		Lake Creek-Kirby Creek		Lower Kirby Creek		Middle Kirby Creek		Upper Kirby Creek			
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Inter-Mountain Basins Mixed Salt Desert Scrub	1	0.01%	1	0.01%	25	0.1%	5	0.02%	5	0.01%	37	0.03%
Inter-Mountain Basins Montane Sagebrush Steppe	314	2%	534	2%	2,066	9%	1,385	5%	565	2%	4,863	4%
Inter-Mountain Basins Semi-Desert Grassland	521	3%	1,455	6%	353	2%	1,299	5%	1,002	3%	4,629	4%
Inter-Mountain Basins Semi-Desert Shrub-Steppe	48	0.2%	25	0.1%	65	0.3%	46	0.2%	43	0.1%	227	0.2%
Inter-Mountain Basins Sparsely Vegetated Systems	0.2	0.001%	0	0%	1	0.00%	0.4	0%	0.2	0%	2	0.001%
Introduced Riparian Vegetation	1,046	5%	1,688	7%	2,423	11%	2,939	12%	1,287	4%	9,383	7%
Introduced Upland Vegetation-Annual and Biennial Forbland	18	0.1%	45	0.2%	55	0.3%	76	0.3%	32	0.1%	226	0.2%
Introduced Upland Vegetation-Annual Grassland	2,135	11%	1,835	7%	560	3%	1,484	6%	1,148	3%	7,163	6%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	3	0.01%	26	0.1%	0	0%	0	0%	32	0.1%	61	0.0%
Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	164	1%	130	1%	197	1%	349	1%	104	0.3%	944	1%
Northern Rocky Mountain Subalpine Woodland and Parkland	0	0%	0	0%	0	0%	0	0%	5	0.01%	5	0.004%
Northwestern Great Plains Mixedgrass Prairie	4	0.02%	10	0.04%	4	0.02%	22	0.1%	11	0.03%	51	0.04%
Open Water	0	0%	0	0%	0	0%	2	0.01%	0	0.0%	2	0.0%

Vegetation Type	Sub-watershed Name										TOTAL	
	Alkali Creek-Kirby Creek		Lake Creek-Kirby Creek		Lower Kirby Creek		Middle Kirby Creek		Upper Kirby Creek			
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Rocky Mountain Aspen Forest and Woodland	2	0.0%	15	0.1%	27	0.1%	8	0.03%	52	0.1%	104	0.1%
Rocky Mountain Foothill Limber Pine-Juniper Woodland	520	3%	1,472	6%	573	3%	433	2%	3,768	10%	6,765	5%
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	0	0%	0	0%	0	0%	0.2	0.001%	0	0%	0	0.0%
Rocky Mountain Lower Montane-Foothill Shrubland	466	2%	87	0.3%	0	0%	0.3	0.001%	2,091	6%	2,645	2%
Rocky Mountain Montane Riparian Systems	173	1%	13	0.1%	6	0.03%	12	0.05%	340	1%	545	0.4%
Rocky Mountain Subalpine/Upper Montane Riparian Systems	23	0.1%	22	0.1%	0.4	0.002%	1	0.002%	224	1%	271	0.2%
Rocky Mountain Subalpine-Montane Mesic Meadow	9	0.04%	9	0.03%	4	0.0%	9	0.04%	8	0.02%	39	0.03%
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	0	0%	5	0.02%	0	0%	0	0%	10	0.03%	15	0.01%
Southern Rocky Mountain Ponderosa Pine Woodland	1	0.01%	14	0.1%	1	0.01%	1	0.004%	14	0.04%	32	0.02%
Western Great Plains Depressional Wetland Systems	1	0.003%	0	0%	164	1%	85	0.3%	0.4	0%	249	0.2%
Western Great Plains Floodplain Systems	592	3%	549	2%	264	1%	355	1%	1,121	3%	2,881	2%
Western Great Plains Shortgrass Prairie	89	0.5%	123	0.5%	448	2%	534	2%	56	0.2%	1,249	1%

Vegetation Type	Sub-watershed Name										TOTAL	
	Alkali Creek-Kirby Creek		Lake Creek-Kirby Creek		Lower Kirby Creek		Middle Kirby Creek		Upper Kirby Creek			
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	92	0.5%	206	1%	41	0.2%	80	0.3%	370	1%	789	1%
Total	**19,489**	**100%**	**25,278**	**100%**	**21,948**	**100%**	**25,551**	**100%**	**36,263**	**100%**	**128,530**	**100%**

Source: LANDFIRE vegetation data (USGS 2010b)

Appendix D

ECOLOGICAL SITE DESCRIPTIONS

Kirby Creek Watershed Study, Hot Springs County, Wyoming

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

ECOLOGICAL SITE DESCRIPTION (Old Format Report)

ECOLOGICAL SITE CHARACTERISTICS

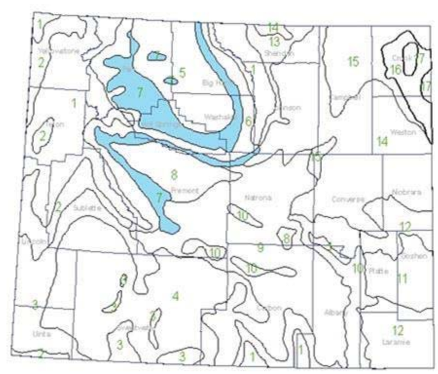
Site Type: Rangeland

Site Name: Loamy (Ly) 10-14" East Precipitation Zone

Site ID: R032XY322WY

Major Land Resource Area: 032-Northern Intermountain Desertic Basins

Precipitation Zones for Rangeland Ecological Site Descriptions



Physiographic Features

This site occurs on near level to gently undulating rolling land and on slope generally less than 20%.

Land Form: (1) Hill
(2) Alluvial fan
(3) Ridge

	Minimum	Maximum
Elevation (feet):	5400	7500
Slope (percent):	0	30
Water Table Depth (inches):		
Flooding:		
Frequency:		
Duration:	None	None
Ponding:		
Depth (inches):	0	0
Frequency:		
Duration:	None	None
Runoff Class:	Negligible	High

Aspect: No Influence on this site

Climatic Features

Annual precipitation ranges from 10-14 inches per year. The normal precipitation pattern shows the least amount of precipitation in December, January, and February, increasing to a peak during the latter part of May. Amounts decrease through June, July, and August and then increase some in September. Much of the moisture that falls in the latter part of the summer is lost by evaporation and much of the moisture that falls during the winter is lost by sublimation. Average snowfall exceeds 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring.

Winds are generally not strong as compared to the rest of the state. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 75 mph.

Growth of native cool-season plants begins about April 15 and continues to about July 15. Cool weather and moisture in September may produce some green up of cool season plants that will continue to late October.

The following information is from the “Thermopolis 2” climate station:
Minimum Maximum 5 yrs. out of 10 between
Frost-free period (days): 74 149 May 23 – September 16
Freeze-free period (days): 112 180 May 8 – October 1
Annual Precipitation (inches): 7.6 21.9

Mean annual precipitation: 12.35 inches
Mean annual air temperature: 46.2 F (30.1 F Avg. Min. to 62.3 F Avg. Max.)
For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/ website. Other climate station(s) representative of this precipitation zone include” Grass Creek 1E”, “Thermopolis”, Thermopolis 25NW”, “Buffalo Bill Dam” and “Black Mountain”.

	Minimum	Maximum
Frost-free period (days):	74	149
Freeze-free period (days):	112	180
Mean annual precipitation (inches):	10.0	14.0

Monthly precipitation (inches) and temperature (°F):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precip. Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Precip. Max.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temp. Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temp. Max.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Climate Stations:

Influencing Water Features

Stream Type: None

Wetland Description:	System	Subsystem	Class

Representative Soil Features

The soils of this site are very deep to moderately deep (greater than 20" to bedrock), moderately well to well-drained & moderately slow to moderate permeable. The soil characteristic having the most influence on plant community is the available moisture and the potential to develop soluble salts near the surface.

Major Soil Series correlated to this site include: Lupinto, Frisite, Rock River, Sinkson, Elkol, Grieves, Yamac, Luhon, Rootel

Parent Materials:
Kind:
Origin:

Surface Texture: (1) Loam
(2) Fine sandy loam
(3) Sandy loam

Subsurface Texture Group: Loamy

	Minimum	Maximum
Surface Fragments <=3" (% Cover):	0	10
Surface Fragments > 3" (% Cover):	0	0
Subsurface Fragments <=3" (% Volume):	0	15
Subsurface Fragments > 3" (% Volume):	0	10

Drainage Class: Moderately well drained To Well drained

Permeability Class: Moderately slow To Moderate

	Minimum	Maximum
Depth (inches):	20	60
Electrical Conductivity (mmhos/cm):	0	8
Sodium Absorption Ratio:	0	13
Calcium Carbonate Equivalent (percent):	0	20

Soil Reaction (1:1 Water):	7.4	9.0
Soil Reaction (0.01M CaCl2):		
Available Water Capacity (inches):	3.0	6.3

Plant Communities

Ecological Dynamics of the Site

Potential vegetation on this site is dominated by mid cool-season perennial grasses. Other significant vegetation includes winterfat, big sagebrush, and a variety of forbs. The expected potential composition for this site is about 75% grasses, 10% forbs and 15% woody plants. The composition and production will vary naturally due to historical use, fluctuating precipitation and fire frequency.

As this site deteriorates species such as blue grama, Sandberg bluegrass, and big sagebrush will increase. Plains pricklypear and weedy annuals will invade. Cool-season grasses such as Griffiths and bluebunch wheatgrass, rhizomatous wheatgrasses, needleandthread, and Indian ricegrass will decrease in frequency and production.

Big sagebrush may become dominant on areas with an absence of fire and sufficient amount of precipitation. Wildfires are actively controlled in recent times and as a resulted old decadent stands of big sagebrush persist. Chemical control using herbicides has replaced the historic role of fire on this site. Recently, prescribed burning has regained some popularity.

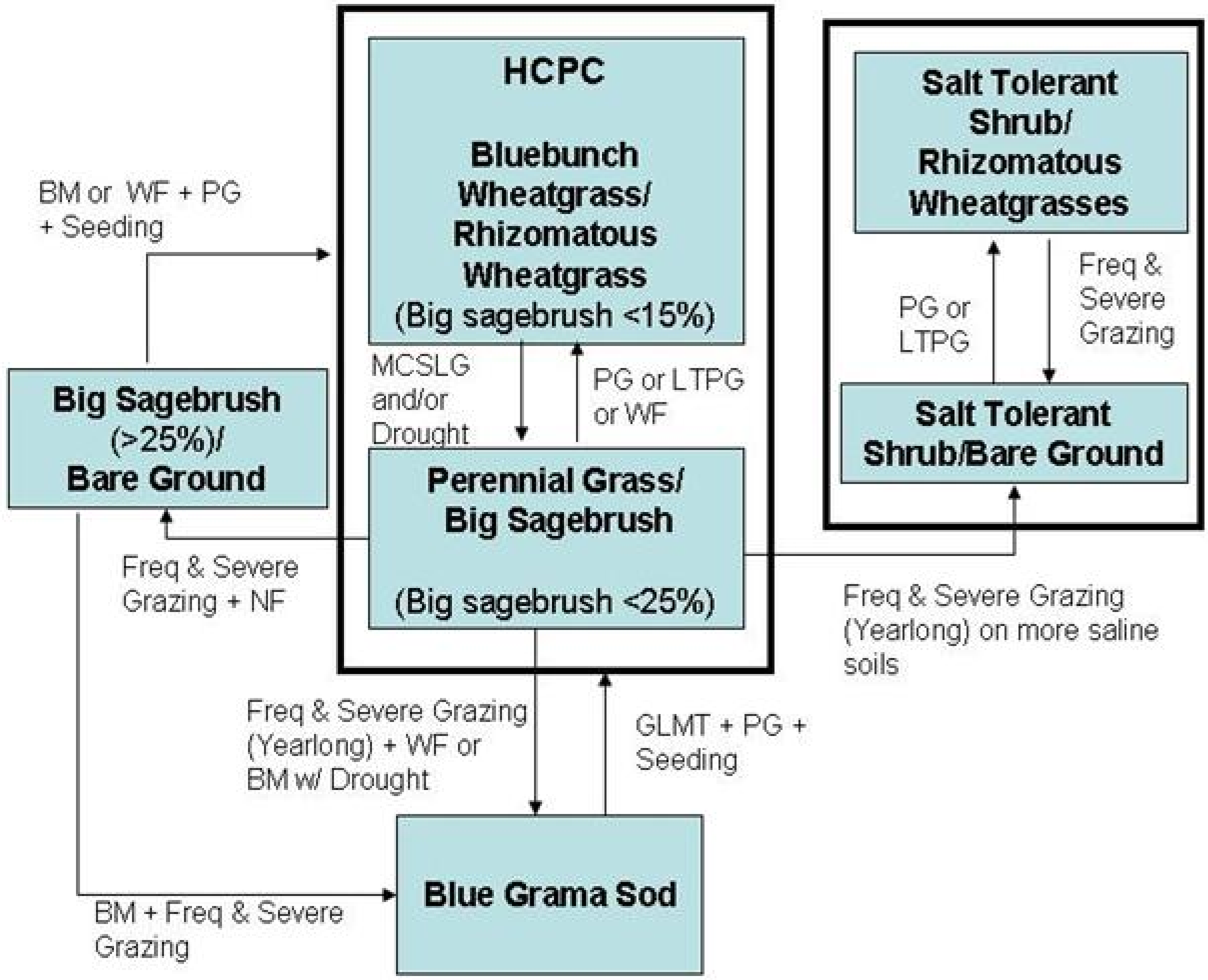
Due to the amount and pattern of the precipitation, the big sagebrush component may not be resilient once it has been removed or severely reduced if a vigorous stand of grass exists and is maintained. On these areas, blue grama may become dominant if the area is subjected to a combination of frequent and severe grazing especially yearlong grazing. As a result, a dense sod cover of blue grama will become established.

The Historic Climax Plant Community (description follows the plant community diagram) has been determined by study of rangeland relic areas, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have also been used.

The following is a State and Transition Model Diagram that illustrates the common plant communities (states) that can occur on the site and the transitions between these communities. The ecological processes will be discussed in more detail in the plant community narratives following the diagram.

Plant Community Narratives
Following are the narratives for each of the described plant communities. These plant communities may not represent every possibility, but they probably are the most prevalent and repeatable plant communities. The plant composition tables shown above have been developed from the best available knowledge at the time of this revision. As more data is collected, some of these plant communities may be revised or removed, and new ones may be added. None of these plant communities should necessarily be thought of as “Desired Plant Communities”. According to the USDA NRCS National Range and Pasture Handbook, Desired Plant Communities (DPC’s) will be determined by the decision-makers and will meet minimum quality criteria established by the NRCS. The main purpose for including any description of a plant community here is to capture the current knowledge and experience at the time of this revision.

Site Type: Rangeland **Loamy 10-14" E**
MLRA: 32 – Northern Intermountain Desertic Basins **032XY322WY**



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-term 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)
WF - Wildfire (Natural or Human Caused)

Technical Guide **USDA-NRCS**
Section IIE **Rev. 11-01-05**

Bluebunch Wheatgrass/Rhizomatous Wheatgrass

This plant community is the interpretive plant community for this site and is considered to be the Historic Climax Plant Community (HCPC). This state evolved with grazing by large herbivores and periodic fires. The cyclical natural of the fire regime in this community prevented big sagebrush from being the dominant landscape. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and on areas receiving occasional short periods of rest. The potential vegetation is about 75% grasses or grass-like plants, 10% forbs, and 15% woody plants. This state is dominated by cool season mid-grasses.

The major grasses include Griffiths and bluebunch wheatgrasses, rhizomatous wheatgrasses, needleandthread, and Indian ricegrass. Other grasses occurring in this state include bottlebrush squirreltail, prairie junegrass, and Sandberg bluegrass. Big sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 15% of the annual production. Winterfat is a common component found on this site. A variety of forbs also occurs in this state and plant diversity is high (see Plant Composition Table).

The total annual production (air-dry weight) of this state is about 800 lbs./acre, but it can range from about 500 lbs./acre in unfavorable years to about 1100 lbs./acre in above average years.

This plant community is extremely stable and well adapted to the Northern Intermountain Desertic Basins 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).

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

• Moderate, continuous season-long grazing will convert the plant community to the Perennial Grass/Big Sagebrush Plant Community. Prolonged drought will exacerbate this transition.

Bluebunch Wheatgrass/Rhizomatous Wheatgrass Plant Species Composition:

Grass/Grasslike

Group	Group Name	Common Name	Symbol	Scientific Name	Annual Production in Pounds Per Acre Low	High
1					280	400
		Montana wheatgrass	ELAL7	*Elymus albicans*	280	400
		bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	280	400
2					0	80
		needle and thread, needleandthread	HECO26	*Hesperostipa comata*	0	80
3					40	120
		western wheatgrass	PASM	*Pascopyrum smithii*	40	120
4					0	80
		green needlegrass	NAVI4	*Nassella viridula*	0	80
5					0	80
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	80
6					0	80

Group	Group Name	Common Name	Symbol	Scientific Name	Low	High
		spike fescue, kingspike fescue	LEKI2	*Leucopoa kingii*	0	80
7					0	80
		Grass, perennial, other perennial grass	2GP		0	40
		blue grama	BOGR2	*Bouteloua gracilis*	0	40
		threadleaf sedge	CAFI	*Carex filifolia*	0	40
		squirreltail, bottlebrush squirreltail	ELEL5	*Elymus elymoides*	0	40
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	40
		basin wildrye	LECI4	*Leymus cinereus*	0	40
		Sandberg bluegrass	POCA	*Poa canbyi(syn)*	0	40
		Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	POSE	*Poa secunda*	0	40

Forb

Group	Group Name	Common Name	Symbol	Scientific Name	Annual Production in Pounds Per Acre Low	High
8					40	120
		Forb, perennial, other perennial forb	2FP		0	40
		textile onion	ALTE	*Allium textile*	0	40
		small-leaf pussytoes	ANPA4	*Antennaria parvifolia*	0	40
		rosy pussytoes, rose pussytoes	ANRO2	*Antennaria rosea*	0	40
		prairie sagewort, fringed sagewort	ARFR4	*Artemisia frigida*	0	40
		Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0	40
		wavyleaf Indian paintbrush	CAAPM	*Castilleja applegatei ssp. martinii*	0	40
		bastard toadflax	COUM	*Comandra umbellata*	0	40
		tapertip hawksbeard	CRAC2	*Crepis acuminata*	0	40
		little larkspur, showy larkspur	DEBI	*Delphinium bicolor*	0	40
		threadleaf fleabane	ERFI2	*Erigeron filifolius*	0	40
		parsnipflower buckwheat	ERHE2	*Eriogonum heracleoides*	0	40
		bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0	40
		leafy wildparsley	MUDI	*Musineon divaricatum*	0	40
		white locoweed	OXSES2	*Oxytropis sericea var. speciosa*	0	40
		beardtongue, penstemon	PENST	*Penstemon*	0	40
		spiny phlox, Hood's phlox	PHHO	*Phlox hoodii*	0	40
		scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0	40
		stemless mock goldenweed	STAC	*Stenotus acaulis*	0	40
		smooth woodyaster	XYGL	*Xylorhiza glabriuscula*	0	40
		meadow deathcamas	ZIVE	*Zigadenus venenosus*	0	40

Shrub/Vine

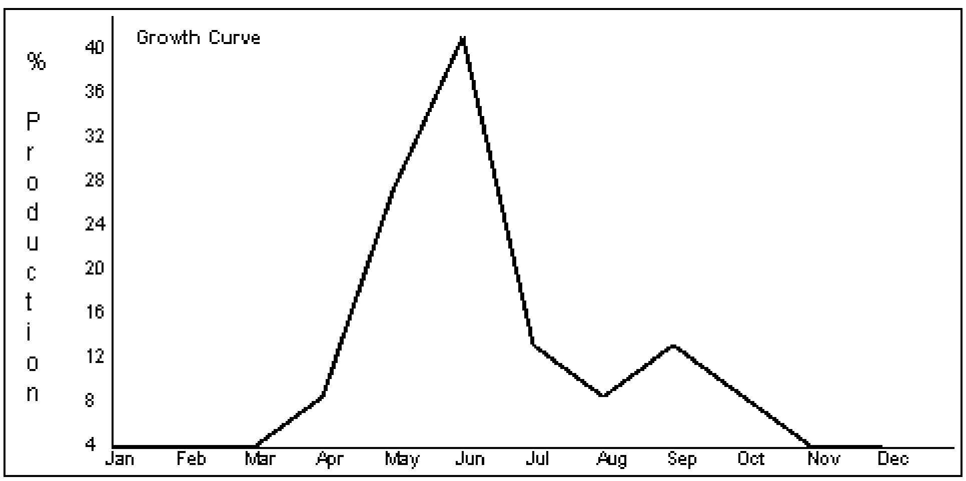
Group	Group Name	Common Name	Symbol	Scientific Name	Annual Production in Pounds Per Acre Low	High
9					40	120
		big sagebrush	ARTR2	*Artemisia tridentata*	40	120
10					0	40

	antelope bitterbrush	PUTR2	*Purshia tridentata*	0	40
11				0	40
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0	40
12				0	40
	winterfat	KRASC	*Krascheninnikovia*	0	40
13				0	40
	Shrub (>.5m)	2SHRUB		0	40

Plant Growth Curve:
Growth Curve Number: WY0701
Growth Curve Name: 10-14E upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	10	5	10	5	0	0



Perennial Grass/ Big Sagebrush

Historically, this plant community evolved under grazing and a low fire frequency. Currently, it is found under moderate, season-long grazing by livestock and will be exacerbated by prolonged drought conditions. In addition, the fire regime for this site has been modified and extended periods without fire is now common. This plant community is still dominated by cool-season grasses, while short warm-season grasses and miscellaneous forbs account for the balance of the understory. Wyoming big sagebrush is now a conspicuous part of the overall production and accounts for the majority of the overstory.

The dominant grasses include Griffiths and bluebunch wheatgrasses, rhizomatous wheatgrasses, and needleandthread. Grasses and grass-like species of secondary importance include prairie junegrass, blue grama, Sandberg bluegrass, and threadleaf sedge. Forbs commonly found in this plant community include scarlet globemallow, fringed sagewort, wavyleaf paintbrush, little larkspur, and Hood's phlox. Sagebrush can make up to 25% of the annual production. The overstory of sagebrush and understory of grasses and forbs provide a diverse plant community.

When compared to the Historic Climax Plant Community, big sagebrush and blue grama have increased. Plains pricklypear cactus will also have invaded, but occurs only in small patches. Indian ricegrass has decreased and may occur in only trace amounts under the sagebrush canopy or within the patches of pricklypear. In addition, the amount of winterfat may or may not have changed depending on the season of use.

The total annual production (air-dry weight) of this state is about 600 pounds per acre, but it can range from about 400 lbs./acre in unfavorable years to about 900 lbs./acre in above average years.

This plant community is resistant to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

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

• Prescribed grazing or possibly long-term prescribed grazing, will convert this plant community to the HCPC. The probability of this occurring is high especially if rotational grazing along with short deferred grazing is implemented as part of prescribed method of use. In addition, the removal of fire suppression will allow a somewhat natural fire regime to reoccur to more easily transition between this plant community and the HCPC. A prescribed fire treatment can be useful to hasten this transition, if desired.

• Frequent and severe grazing plus no fire on soils with limited soluble salts, will convert the plant community to the Big Sagebrush/Bare Ground Plant Community. The probability of this occurring is high. This is especially evident on areas with historically higher precipitation and the sagebrush stand is not adversely impacted by drought or heavy browsing.

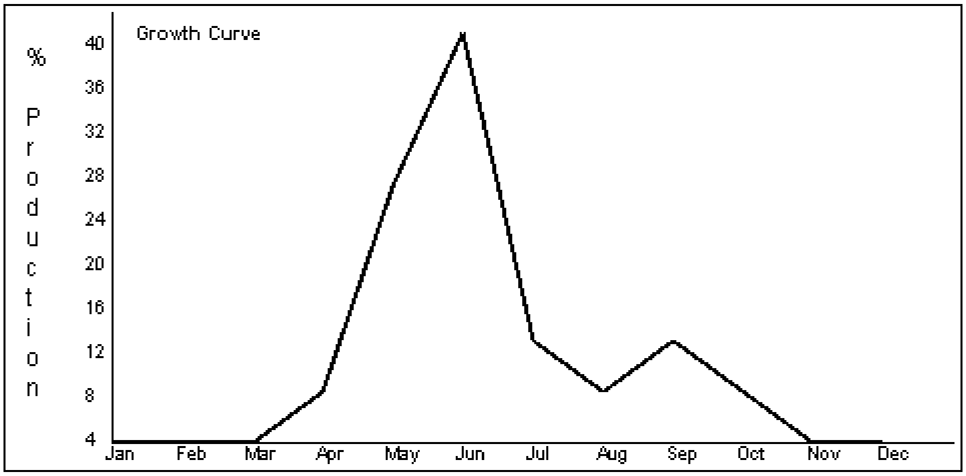
• Frequent and severe grazing (yearlong grazing) plus wildfire or brush control, will convert the plant community to the Blue Grama Sod Plant Community. The probability of this occurring is high, especially if the sagebrush stand has been severely affected by drought or heavy use or has been removed altogether.

• Frequent and severe grazing (yearlong grazing) on more saline soils, will convert the plant community to the Salt Tolerant Shrub/Bare Ground Plant Community. The probability of this occurring is high especially on soils with elevated salts and the sagebrush stand has been severely affected by drought and heavy use or has been removed altogether.

Plant Growth Curve:
Growth Curve Number: WY0701
Growth Curve Name: 10-14E upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	10	5	10	5	0	0



Big Sagebrush/ Bare ground

This plant community is the result of frequent and severe grazing and protection from fire. Sagebrush dominates this plant community, as the annual production of sagebrush excess 25%. Wyoming big sagebrush is a significant component of the plant community and the preferred cool season grasses have been greatly reduced.

The dominant grasses are prairie junegrass, Sandberg bluegrass, and blue grama. Weedy annual species such as cheatgrass may occupy the site if a seed source is available. Cactus and sageworts often invade. Noxious weeds such as Russian knapweed, leafy spurge, or Canada thistle may invade the site if a seed source is available. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. As compared with the HCPC or the Perennial Grass/Big Sagebrush Plant Communities, the annual production is less, but the shrub production compensates for some of the decline in the herbaceous production.

The total annual production (air-dry weight) of this state is about 500 pounds per acre, but it can range from about 300 lbs./acre in unfavorable years to about 700 lbs./acre in above average years.

This plant community is resistant to change as the stand becomes more decadent. These areas may actually be more resistant to fire as less fine fuels are available and the bare ground between the sagebrush plants is increased. Continued frequent and severe grazing or the removal of grazing does not seem to affect the composition or structure of the plant community. Plant diversity is moderate to poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably less when compared to the HCPC.

Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling are obvious. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces and gullies may be establishing where rills have concentrated down slope.

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

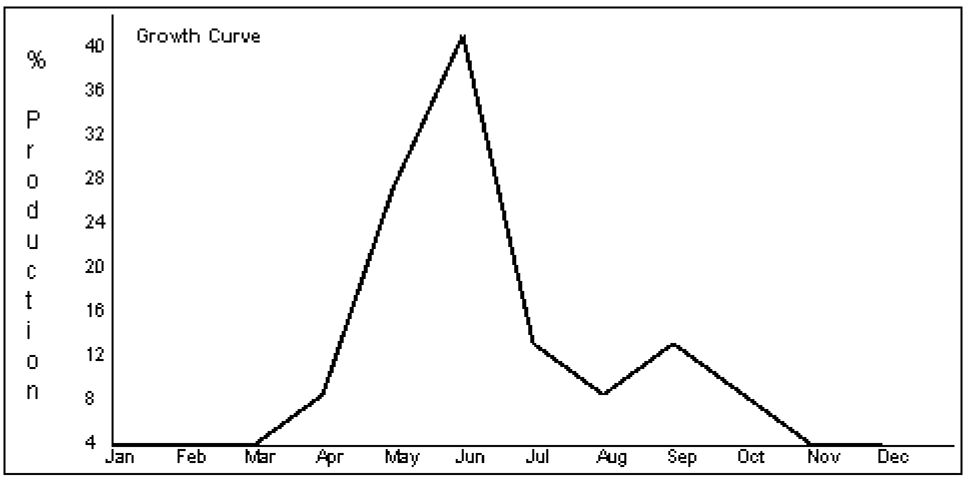
• Brush management, followed by prescribed grazing, will return this plant community at or near the HCPC. If prescribed fire is used as a means to reduce or remove the shrubs, sufficient fine fuels will need to be present. This may require deferment from grazing prior to treatment. Post management is critical to ensure success. This can range from two or more years of rest to partial growing season deferment, depending on the condition of the understory at the time of treatment and the growing conditions following treatment. In the case of an intense wildfire that occurs when desirable plants are not completely dormant, the length of time required to reach the HCPC may be increased and seeding of natives is recommended.

• Brush management, followed by frequent and severe grazing, will convert the plant community to the Blue Grama Sod Plant Community.

Plant Growth Curve:
Growth Curve Number: WY0701
Growth Curve Name: 10-14E upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	10	5	10	5	0	0



Blue grama Sod

This plant community is the result of frequent and severe yearlong grazing, which has adversely affected the perennial grasses as well as impacted the shrub component. Other factors that can affect the shrubs include drought, heavy browsing, wildfires, and/or human brush control measures. A dense sod of blue grama with patches of threadleaf sedge dominates this state. Pricklypear cactus can become dense enough in patches so that livestock cannot graze forage growing within the cactus clumps. Big sagebrush has been reduced to small patches or in some cases removed. Rubber rabbitbrush may be the sole remaining shrub on the site.

When compared to the Historic Climax Plant Community, blue grama and threadleaf sedge,have increased. Pricklypear has invaded. All cool-season mid-grasses, forbs, and most shrubs have been greatly reduced. Production has been significantly decreased.

The total annual production (air-dry weight) of this state is about 200 pounds per acre, but it can range from about 100 lbs./acre in unfavorable years to about 300 lbs./acre in above average years.

This sod is extremely resistant to change and continued frequent and severe grazing or the removal of grazing does not seem to affect the plant composition or structure of the plant community. The biotic integrity of this state is not functional and plant diversity is extremely low. The plant vigor is significantly weakened and replacement capabilities are limited due to the reduced number of cool-season grasses.

This sod bound plant community is very resistant to water infiltration. While this sod protects the site itself, off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in the bare ground areas and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites.

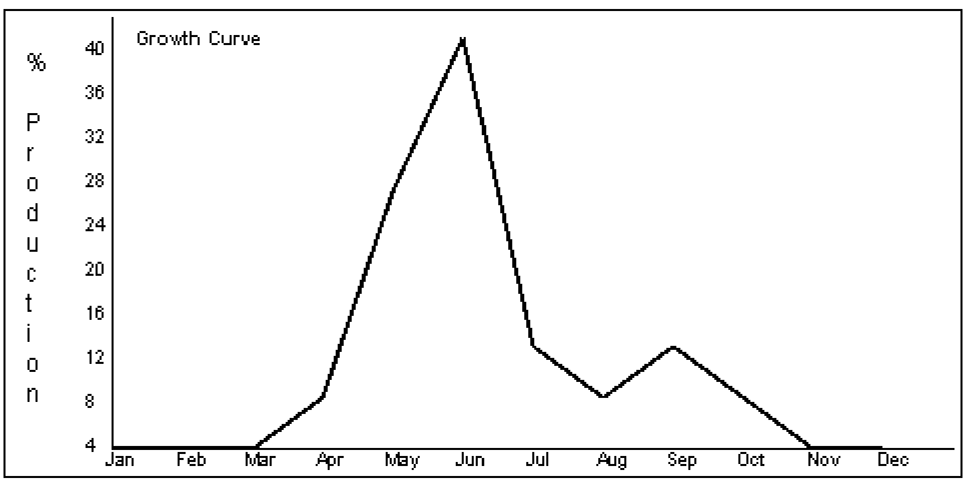
Transitions or pathways leading to other plant communities are as follows:

• Grazing land mechanical treatment (chiseling, etc.) and pricklypear cactus control (if needed), followed by prescribed grazing, and possibly seeding of natives will return this plant community to near Historic Climax Plant Community condition.

Plant Growth Curve:
Growth Curve Number: WY0701
Growth Curve Name: 10-14E upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	10	5	10	5	0	0



Salt Tolerant Shrub/ Bare Ground

This plant community can occur on sites subjected to frequent and severe grazing and on soils influenced by elevated amounts of soluble salts. Salt tolerant shrubs replace Wyoming big sagebrush as the major overstory species while the preferred cool season grasses have been eliminated or greatly reduced. Bare ground and weedy grasses and forbs dominate the understory.

This state is dominated by an overstory of salt tolerant shrubs, such as greasewood, birdfoot sagebrush and saltbushes, which can vary widely in their composition and production. The leaves of some of these plants contain high amounts of sodium and other salts, and when shed these soluble salts are transferred to the soils underneath the plants. Consequently, the soil can exhibit wide variations in soluble salts, which can explain the variation in shrub composition. Big sagebrush and rubber rabbitbrush are present but are mostly in small patches.

Perennial cool season mid-grasses have been removed leaving mostly patches of blue grama and annuals. Cheatgrass and weedy annual forbs such as halogeton, Russian thistle, and kochia, will occupy the site if a seed source is available. Noxious weeds such as Russian knapweed may also invade the site. Plant diversity is moderate to poor.

When compared to the HCPC, grass production has diminished but is off set by the increase in shrub production. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. Surface salts have increased, especially on sites dominated by greasewood and saltbushes.

The total annual production (air-dry weight) of this state is about 450 pounds per acre, but it can range from about 250 lbs./acre in unfavorable years to about 550 lbs./acre in above average years.

This plant community is resistant to change. These areas are actually more resistant to fire as less fine fuels are available and the bare ground between the shrubs has increased. Continued frequent and severe grazing does not affect the composition or structure of the plant community. Plant diversity is moderate to poor. The biotic integrity of this state is mostly dysfunctional because of the predominant salt tolerant shrub overstory and absence of perennial cool-season grasses.

Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling are obvious. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces and gullies may be establishing where rills have concentrated down slope.

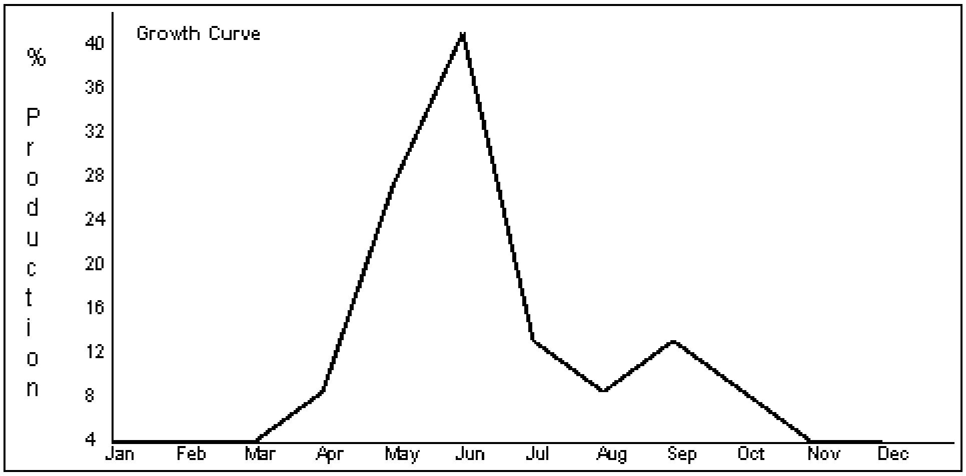
Transitions or pathways leading to other plant communities are as follows:

• Prescribed grazing or possibly long-term prescribed grazing, will convert this plant community to the Salt Tolerant Shrub/Rhizomatous Wheatgrass Plant community. Recovery to near Historic Climax Plant Community condition is difficult to impossible due to the resistance of these shrubs to herbicides and other brush management techniques. In addition, the increase in surface salts has had accumulated effects on the soil so most of the herbaceous plants associated with the HCPC are no longer suitable for this site. The most notable exception is the rhizomatous wheatgrasses and bottlebrush squirreltail. Soil remediation to reduce the surface salts is not recommended, as this is mostly ineffective and extremely costly. Seeding more salt-tolerant native grasses and forbs will improve the productivity of site and plant cover.

Plant Growth Curve:
Growth Curve Number: WY0701
Growth Curve Name: 10-14E upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	10	5	10	5	0	0



Salt Tolerant Shrub/ Rhizomatous Wheatgrasses

This plant community can occur where the Salt Tolerant/Bare Ground Plant Community is rested and a prescribed grazing management practice is implemented. Salt tolerant shrubs and Wyoming big sagebrush remain a significant component of the plant community but preferred cool season grasses have reestablished.

This site is dominated by an overstory of a variety of shrubs, such as Wyoming big sagebrush, rubber rabbitbrush, greasewood, and a variety of saltbushes. Some perennial cool season mid-grasses have once again reestablished such as rhizomatous wheatgrasses and bottlebrush squirreltail. Other important grasses include prairie junegrass, Sandberg bluegrass and blue grama. Patches of annuals such as cheatgrass and other weedy annual forbs such as halogeton, Russian thistle, and kochia, will persist on this site. Noxious weeds such as Russian knapweed may also remain if not treated. The interspaces between plants will have diminished in size. When compared with the HCPC or the Perennial Grass/Big Sagebrush Plant Communities, the annual production is somewhat similar, but the plant species are mostly unique.

The total annual production (air-dry weight) of this state is about 650 pounds per acre, but it can range from about 400 lbs./acre in unfavorable years to about 800 lbs./acre in above average years.

This plant community is mostly resistant to change, but species composition can be altered through long-term overgrazing. The herbaceous component is stable, but does not include most climax species. Plant vigor and replacement capabilities are sufficient. The biotic community is not intact because of the predominant salt tolerant shrub overstory and lack of climax grass species. Plant diversity is moderate.

Soils are mostly stable and recent soil loss is minimal. This should not be confused with evidence of remnant erosion. Water flow patterns and litter movement is stable but is still occurring on steeper slopes. Incidence of pedestalling is improving. The watershed may or may not be functioning

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

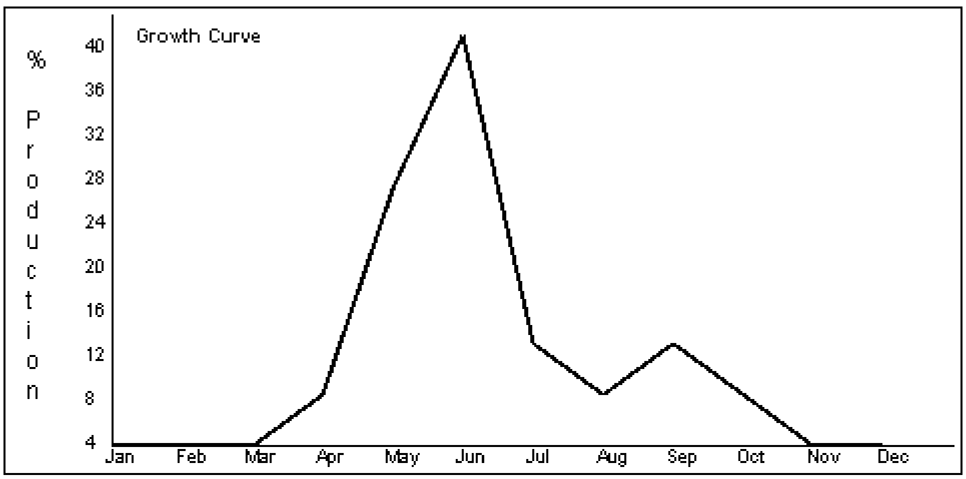
• Frequent and severe grazing will convert the plant community to the Salt Tolerant Shrub/Bare Ground Plant Community.

• Recovery to near Historic Climax Plant Community condition is difficult to impossible due to the resistance of these shrubs to herbicides and other brush management techniques. In addition, the increase in surface salts has had accumulated effects on the soil so most of the herbaceous plants associated with the HCPC are no longer suitable for this site. The most notable exception is the rhizomatous wheatgrasses and bottlebrush squirreltail. Soil remediation to reduce the surface salts is not recommended, as this is mostly ineffective and extremely costly. Seeding more salt-tolerant grasses and forbs will improve the productivity of site and plant cover, but will not improve the biotic integrity.

Plant Growth Curve:
Growth Curve Number: WY0701
Growth Curve Name: 10-14E upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	10	5	10	5	0	0



Ecological Site Interpretations

Animal Community:
Animal Community – Wildlife Interpretations
Bluebunch Wheatgrass/Rhizomatous Wheatgrasses (HCPC): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. When found adjacent to sagebrush dominated states, this plant community may provide brood rearing/foraging areas for sage grouse, as well as lek sites. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland obligate small mammals would occur here.

Perennial Grass/Big Sagebrush Plant Community: The combination of an overstory of sagebrush and an understory of grasses and forbs provide a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer and antelope may use this state for foraging and cover year-round, as would cottontail and jack rabbits. It provides important winter, nesting, brood-rearing, and foraging habitat for sage grouse. Brewer's sparrows' nest in big sagebrush plants and hosts of other nesting birds utilize stands in the 20-30% cover range.

Big Sagebrush/Bare Ground Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides excellent escape and thermal cover for large ungulates, as well as nesting habitat for sage grouse.

Blue Grama Sod Plant Community: These communities provide limited foraging for antelope and other grazers. They may be used as a foraging site by sage grouse if proximal to woody cover and if the Historic Climax Plant Community or the Perennial Grass/ Big Sagebrush Plant Community is limited. Generally, these are not target plant communities for wildlife habitat management.

Salt Tolerant Shrub/Bare Ground Plant Community: This plant community exhibits a low level of plant species diversity due to the accumulation of salts near the soil surface. It may provide some thermal and escape cover for deer and antelope if no other woody community is nearby, but in most cases, it is not a desirable plant community to select as a wildlife habitat management objective.

Salt Tolerant Shrub/Rhizomatous Wheatgrass Plant Community: The combination of an overstory of sagebrush and an understory of grasses and forbs provide a diverse plant community for wildlife. The crowns of these shrubs tend to break up hard crusted snow on winter ranges, so mule deer and antelope may use this state for foraging and cover year-round, as would cottontail and jack rabbits. It provides important winter nesting, brood-rearing, and foraging habitat for sage grouse and other upland birds. Brewer's sparrows' nest in big sagebrush plants and hosts of other nesting birds utilize stands in the 20-30% cover range.

Animal Community – Grazing Interpretations

The following table lists suggested stocking rates for cattle under continuous season-long grazing under normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies can result in an increased carrying capacity. If distribution problems occur, stocking rates must be reduced to maintain plant health and vigor.

Plant Community Production Carrying Capacity*
(lb./ac) (AUM/ac)
Bluebunch Wheatgrass/ Rhizomatous Wheatgrasses 500-1100 .40
Perennial Grass/Big Sagebrush 400-900 .30
Big Sagebrush/Bare Ground 300-700 .20
Blue Grama Sod 100-300 .10
Salt Tolerant Shrub/Bare Ground 250-550 .13
Salt Tolerant Shrub/Rhizomatous Wheatgrasses 400-800 .22

* - Continuous, season-long grazing by cattle under average growing conditions.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide yearlong forage for cattle, sheep, or horses. During the dormant period, the forage for livestock use needs to be supplemented with protein because the quality does not meet minimum livestock requirements.

Plant Preference by Animal Kind:

Animal Kind: ALLAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
agoseris, mountain dandelion, dandelion	*Agoseris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
textile onion	*Allium textile*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
threeawn	*Aristida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
birdfoot sagebrush	*Artemisia pedatifida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Fendler threeawn, red threeawn	*Aristida purpurea var. longiseta*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
milkvetch	*Astragalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fourwing saltbush	*Atriplex canescens*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shadscale saltbush	*Atriplex confertifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Gardner's saltbush	*Atriplex gardneri*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
blue grama	*Bouteloua gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
golden sedge	*Carex aurea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
threadleaf sedge	*Carex filifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland sedge	*Carex interior*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
prairie sandreed	*Calamovilfa longifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Nebraska sedge	*Carex nebrascensis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beaked sedge	*Carex rostrata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pond water-starwort	*Callitriche stagnalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Indian paintbrush, paintbrush	*Castilleja*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
yellow rabbitbrush, green rabbitbrush, low rabbitbrush, Douglas rabbitbrush	*Chrysothamnus viscidiflorus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
pale bastard toadflax	*Comandra umbellata ssp. pallida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
tufted hairgrass	*Deschampsia caespitosa(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
larkspur	*Delphinium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland saltgrass	*Distichlis spicata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Canada wildrye	*Elymus canadensis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	*Elymus elymoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass	*Elymus lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	*Elymus trachycaulus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
horsetail	*Equisetum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
fleabane	*Erigeron*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

buckwheat	*Eriogonum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
rubber rabbitbrush	*Ericameria nauseosa*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
aster	*Eucephalus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spiny hopsage	*Grayia spinosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread, needleandthread	*Hesperostipa comata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Rocky Mountain juniper	*Juniperus scopulorum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
winterfat	*Krascheninnikovia lanata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
basin wildrye	*Leymus cinereus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
desertparsley, biscuitroot	*Lomatium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted evening-primrose	*Oenothera caespitosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
nailwort	*Paronychia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beardtongue, penstemon	*Penstemon*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bud sagebrush, bud sagewort	*Picrothamnus desertorum*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: allAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Sandberg bluegrass	*Poa juncifolia(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: ALLAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
cottonwood	*Populus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Nuttall's alkaligrass	*Puccinellia nuttalliana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
skunkbush sumac	*Rhus trilobata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Woods' rose	*Rosa woodsii var. woodsii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
greasewood	*Sarcobatus vermiculatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver buffaloberry	*Shepherdia argentea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
blue-eyed grass	*Sisyrinchium*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: AllAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali sacaton	*Sporobolus airoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
scarlet globemallow	*Sphaeralcea coccinea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sand dropseed	*Sporobolus cryptandrus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: allAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali cordgrass	*Spartina gracilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
princesplume	*Stanleya*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
stemless four-nerve daisy	*Tetraneuris acaulis var. acaulis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arrowgrass	*Triglochin*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
salsify	*Tragopogon porrifolius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
false carrot	*Turgenia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
woodyaster	*Xylorhiza*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
yucca	*Yucca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
agoseris, mountain dandelion, dandelion	*Agoseris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
textile onion	*Allium textile*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threeawn	*Aristida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
birdfoot sagebrush	*Artemisia pedatifida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Fendler threeawn, red threeawn	*Aristida purpurea var. longiseta*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
milkvetch	*Astragalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fourwing saltbush	*Atriplex canescens*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shadscale saltbush	*Atriplex confertifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Gardner's saltbush	*Atriplex gardneri*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
blue grama	*Bouteloua gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
golden sedge	*Carex aurea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threadleaf sedge	*Carex filifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland sedge	*Carex interior*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
prairie sandreed	*Calamovilfa longifolia*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nebraska sedge	*Carex nebrascensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beaked sedge	*Carex rostrata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pond water-starwort	*Callitriche stagnalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Indian paintbrush, paintbrush	*Castilleja*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
yellow rabbitbrush, green rabbitbrush, low rabbitbrush, Douglas rabbitbrush	*Chrysothamnus viscidiflorus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pale bastard toadflax	*Comandra umbellata ssp. pallida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
tufted hairgrass	*Deschampsia caespitosa(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	*Delphinium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland saltgrass	*Distichlis spicata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Canada wildrye	*Elymus canadensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
squirreltail, bottlebrush														

squirreltail	*Elymus elymoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass	*Elymus lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	*Elymus trachycaulus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
horsetail	*Equisetum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
fleabane	*Erigeron*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
buckwheat	*Eriogonum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
rubber rabbitbrush	*Ericameria nauseosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
aster	*Eucephalus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spiny hopsage	*Grayia spinosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread, needleandthread	*Hesperostipa comata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Rocky Mountain juniper	*Juniperus scopulorum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
winterfat	*Krascheninnikovia lanata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
basin wildrye	*Leymus cinereus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
desertparsley, biscuitroot	*Lomatium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted evening-primrose	*Oenothera caespitosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
nailwort	*Paronychia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beardtongue, penstemon	*Penstemon*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bud sagebrush, bud sagewort	*Picrothamnus desertorum*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: allCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Sandberg bluegrass	*Poa juncifolia(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
cottonwood	*Populus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nuttall's alkaligrass	*Puccinellia nuttalliana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
skunkbush sumac	*Rhus trilobata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Woods' rose	*Rosa woodsii var. woodsii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
greasewood	*Sarcobatus vermiculatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver buffaloberry	*Shepherdia argentea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
blue-eyed grass	*Sisyrinchium*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: AllCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali sacaton	*Sporobolus airoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: ALLCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
scarlet globemallow	*Sphaeralcea coccinea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sand dropseed	*Sporobolus cryptandrus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: allCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali cordgrass	*Spartina gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
princesplume	*Stanleya*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
stemless four-nerve daisy	*Tetraneuris acaulis var. acaulis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arrowgrass	*Triglochin*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
salsify	*Tragopogon porrifolius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
false carrot	*Turgenia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
woodyaster	*Xylorhiza*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
yucca	*Yucca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
agoseris, mountain dandelion, dandelion	*Agoseris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
textile onion	*Allium textile*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
threeawn	*Aristida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
birdfoot sagebrush	*Artemisia pedatifida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Fendler threeawn, red threeawn	*Aristida purpurea var. longiseta*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
milkvetch	*Astragalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fourwing saltbush	*Atriplex canescens*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shadscale saltbush	*Atriplex confertifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Gardner's saltbush	*Atriplex gardneri*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
blue grama	*Bouteloua gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
golden sedge	*Carex aurea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
threadleaf sedge	*Carex filifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland sedge	*Carex interior*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
prairie sandreed	*Calamovilfa longifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Nebraska sedge	*Carex nebrascensis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beaked sedge	*Carex rostrata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pond water-starwort	*Callitriche stagnalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Indian paintbrush, paintbrush	*Castilleja*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
yellow rabbitbrush, green rabbitbrush, low														

rabbitbrush, Douglas rabbitbrush	Chrysothamnus viscidiflorus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
pale bastard toadflax	Comandra umbellata ssp. pallida	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland saltgrass	Distichlis spicata	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Canada wildrye	Elymus canadensis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	Elymus elymoides	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
streambank wheatgrass	Elymus lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
horsetail	Equisetum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
buckwheat	Eriogonum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
rubber rabbitbrush	Ericameria nauseosa	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spiny hopsage	Grayia spinosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread, needleandthread	Hesperostipa comata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
iris	Iris	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	Juncus balticus(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Rocky Mountain juniper	Juniperus scopulorum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
prairie Junegrass	Koeleria macrantha	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
winterfat	Krascheninnikovia lanata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
basin wildrye	Leymus cinereus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
desertparsley, biscuitroot	Lomatium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted evening-primrose	Oenothera caespitosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
nailwort	Paronychia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	Pascopyrum smithii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beardtongue, penstemon	Penstemon	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	Phlox	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bud sagebrush, bud sagewort	Picrothamnus desertorum	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: allDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Sandberg bluegrass	Poa juncifolia(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: ALLDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
cottonwood	Populus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	Poa secunda	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	Pseudoroegneria spicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Nuttall's alkaligrass	Puccinellia nuttalliana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
skunkbush sumac	Rhus trilobata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Woods' rose	Rosa woodsii var. woodsii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
greasewood	*Sarcobatus vermiculatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver buffaloberry	*Shepherdia argentea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
blue-eyed grass	*Sisyrinchium*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: AllDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali sacaton	*Sporobolus airoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
scarlet globemallow	*Sphaeralcea coccinea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sand dropseed	*Sporobolus cryptandrus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: allDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali cordgrass	*Spartina gracilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
princesplume	*Stanleya*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
stemless four-nerve daisy	*Tetraneuris acaulis var. acaulis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arrowgrass	*Triglochin*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
salsify	*Tragopogon porrifolius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
false carrot	*Turgenia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
woodyaster	*Xylorhiza*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
yucca	*Yucca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
agoseris, mountain dandelion, dandelion	*Agoseris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
textile onion	*Allium textile*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threeawn	*Aristida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
birdfoot sagebrush	*Artemisia pedatifida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Fendler threeawn, red threeawn	*Aristida purpurea var. longiseta*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
big sagebrush	*Artemisia tridentata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
milkvetch	*Astragalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fourwing saltbush	*Atriplex canescens*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shadscale saltbush	*Atriplex confertifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Gardner's saltbush	*Atriplex gardneri*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
blue grama	*Bouteloua gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
golden sedge	*Carex aurea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threadleaf sedge	*Carex filifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland sedge	*Carex interior*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
prairie sandreed	*Calamovilfa longifolia*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Nebraska sedge	Carex nebrascensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
sedge	Carex	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beaked sedge	Carex rostrata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pond water-starwort	Callitriche stagnalis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Indian paintbrush, paintbrush	Castilleja	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
yellow rabbitbrush, green rabbitbrush, low rabbitbrush, Douglas rabbitbrush	Chrysothamnus viscidiflorus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale bastard toadflax	Comandra umbellata ssp. pallida	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland saltgrass	Distichlis spicata	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Canada wildrye	Elymus canadensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
squirreltail, bottlebrush squirreltail	Elymus elymoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass	Elymus lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
horsetail	Equisetum	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
buckwheat	Eriogonum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
rubber rabbitbrush	Ericameria nauseosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spiny hopsage	Grayia spinosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread, needleandthread	Hesperostipa comata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
iris	Iris	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	Juncus balticus(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Rocky Mountain juniper	Juniperus scopulorum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
prairie Junegrass	Koeleria macrantha	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
winterfat	Krascheninnikovia lanata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
basin wildrye	Leymus cinereus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
desertparsley, biscuitroot	Lomatium	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
tufted evening-primrose	Oenothera caespitosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
nailwort	Paronychia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	Pascopyrum smithii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beardtongue, penstemon	Penstemon	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	Phlox	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bud sagebrush, bud sagewort	Picrothamnus desertorum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: allHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Sandberg bluegrass	Poa juncifolia(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
cottonwood	Populus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nuttall's alkaligrass	*Puccinellia nuttalliana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
skunkbush sumac	*Rhus trilobata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Woods' rose	*Rosa woodsii var. woodsii*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
greasewood	*Sarcobatus vermiculatus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver buffaloberry	*Shepherdia argentea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
blue-eyed grass	*Sisyrinchium*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: AllHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali sacaton	*Sporobolus airoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: ALLHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
scarlet globemallow	*Sphaeralcea coccinea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sand dropseed	*Sporobolus cryptandrus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: allHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali cordgrass	*Spartina gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
princesplume	*Stanleya*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
stemless four-nerve daisy	*Tetraneuris acaulis var. acaulis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arrowgrass	*Triglochin*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
salsify	*Tragopogon porrifolius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
false carrot	*Turgenia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
woodyaster	*Xylorhiza*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
yucca	*Yucca*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
agoseris, mountain dandelion, dandelion	*Agoseris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
textile onion	*Allium textile*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threeawn	*Aristida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
birdfoot sagebrush	*Artemisia pedatifida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Fendler threeawn, red threeawn	*Aristida purpurea var. longiseta*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
milkvetch	*Astragalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fourwing saltbush	*Atriplex canescens*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shadscale saltbush	*Atriplex confertifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Gardner's saltbush	*Atriplex gardneri*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
blue grama	*Bouteloua gracilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
golden sedge	*Carex aurea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threadleaf sedge	*Carex filifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland sedge	*Carex interior*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
prairie sandreed	*Calamovilfa longifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Nebraska sedge	*Carex nebrascensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beaked sedge	*Carex rostrata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pond water-starwort	*Callitriche stagnalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Indian paintbrush, paintbrush	*Castilleja*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
yellow rabbitbrush, green rabbitbrush, low rabbitbrush, Douglas rabbitbrush	*Chrysothamnus viscidiflorus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pale bastard toadflax	*Comandra umbellata ssp. pallida*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
tufted hairgrass	*Deschampsia caespitosa(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	*Delphinium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
inland saltgrass	*Distichlis spicata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Canada wildrye	*Elymus canadensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
squirreltail, bottlebrush squirreltail	*Elymus elymoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass	*Elymus lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	*Elymus trachycaulus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
horsetail	*Equisetum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
fleabane	*Erigeron*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
buckwheat	*Eriogonum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
rubber rabbitbrush	*Ericameria nauseosa*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
aster	*Eucephalus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spiny hopsage	*Grayia spinosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread, needleandthread	*Hesperostipa comata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Rocky Mountain juniper	*Juniperus scopulorum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
winterfat	*Krascheninnikovia lanata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
basin wildrye	*Leymus cinereus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
tufted evening-primrose	*Oenothera caespitosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
nailwort	*Paronychia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
beardtongue, penstemon	*Penstemon*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bud sagebrush, bud sagewort	*Picrothamnus desertorum*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: allSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Sandberg bluegrass	*Poa juncifolia(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

Animal Kind: ALLSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
cottonwood	*Populus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nuttall's alkaligrass	*Puccinellia nuttalliana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
skunkbush sumac	*Rhus trilobata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Woods' rose	*Rosa woodsii var. woodsii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
greasewood	*Sarcobatus vermiculatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver buffaloberry	*Shepherdia argentea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
blue-eyed grass	*Sisyrinchium*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: AllSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali sacaton	*Sporobolus airoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: ALLSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
scarlet globemallow	*Sphaeralcea coccinea*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sand dropseed	*Sporobolus cryptandrus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Animal Kind: allSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
alkali cordgrass	*Spartina gracilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
princesplume	*Stanleya*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
stemless four-nerve daisy	*Tetraneuris acaulis var. acaulis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arrowgrass	*Triglochin*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
salsify	*Tragopogon porrifolius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
false carrot	*Turgenia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
woodyaster	*Xylorhiza*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
yucca	*Yucca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

Legend: P = Preferred D = Desirable U = Undesirable N = Not consumed E = Emergency T = Toxic X = Used, but degree of utilization unknown

Hydrology Functions:

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B and C, with localized areas in hydrologic group D. Infiltration ranges from moderately slow to moderate. Runoff potential for this site varies from low to moderate depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where short-grasses form a strong sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information).

Rills and gullies should not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals are only slightly present in association with bunchgrasses. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non-existent. Cryptogamic crusts are present, but only cover 1-2% of the soil surface.

Recreational Uses:

This site provides hunting opportunities for upland game species. The wide varieties of plants which bloom from spring until fall have an esthetic value that appeals to visitors.

Wood Products:

No appreciable wood products are present on the site.

Other Products:

none noted

Other Information:

Supporting Information

Associated Sites:

Site Name	Site ID	Site Narrative
Clayey (Cy) 10-14" East Precipitation Zone	R032XY304WY	
Lowland (LL) 10-14" East Precipitation Zone	R032XY328WY	
Sandy (Sy) 10-14" East Precipitation Zone	R032XY350WY	
Shallow Loamy (SwLy) 10-14" East Precipitation Zone	R032XY362WY	

Similar Sites:

Site Name	Site ID	Site Narrative
Loamy (Ly) 5-9” Big Horn Basin Precipitation Zone	R032XY122WY	
Loamy (Ly) 5-9” Wind River Basin Precipitation Zone	R032XY222WY	

State Correlation:

This site has been correlated with the following states:
WY

Inventory Data References:

Information presented here has been derived from NRCS inventory data. Field observations from range trained personnel were also used. Those involved in developing this site include: Chris Krassin, Range Management Specialist, NRCS and Everet Bainter, Range Management Specialist. Other sources used as references include USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, USDI and USDA Interpreting Indicators of Rangeland Health Version 3, and USDA NRCS Soil Surveys from various counties.

Type Locality:

Relationship to Other Established Classifications:

Other References:

Site Description Approval:

Author	Date	Approval	Date
D. Tranas	10/31/2002	E. Bainter	5/23/2008

Reference Sheet

Author(s)/participant(s): Ray Gullion, E. Bainter

Contact for lead author:ray.gullion@wy.usda.gov or 307-347-2456

Date:5/1/2008 **MLRA:**032X **Ecological Site:**Loamy (Ly) 10-14" East Precipitation ZoneR032XY322WY This *must* be verified based on soils and climate (see Ecological Site Description). Current plant community cannot be used to identify the ecological site.

Composition (indicators 10 and 12) based on: XAnnual Production, Foliar Cover, Biomass

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Indicators. For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years for **each** community and natural disturbance regimes within the reference state, when appropriate and (3) cite data. Continue descriptions on separate sheet.

1. **Number and extent of rills:** Rare to nonexistent. Where present, short and widely spaced.
2. **Presence of water flow patterns:** Barely observable.
3. **Number and height of erosional pedestals or terracettes:** Rare to nonexistent.
4. **Bare ground from Ecological Site Description or other studies (rock, litter, standing dead, lichen, moss, plant canopy are not bare ground):** Bare ground can range from 10-30%.
5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present.
6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent.
7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous litter expected to move only in small amounts (to leeward side of shrubs). Large woody debris

from sagebrush will show no movement.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil Stability Index ratings range from 1 (interspaces) to 6 (under plant canopy), but average values should be 3.0 or greater.

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9. **Soil surface structure and SOM content (include type and strength of structure, and A-horizon color and thickness):** Soil data is limited for this site. Described A-horizons vary from 1-12 inches (3-30 cm) with OM of 1 to 2%.

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10. **Effect on plant community composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Plant community consists of 55-75% grasses, 15% forbs, and 10-30% shrubs. Evenly distributed plant canopy (50-75%) and litter plus moderate to moderately rapid infiltration rates result in minimal runoff. Basal cover is typically less than 5% for this site and does very little to effect runoff on this site.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground weight using symbols: >>, >, = to indicate much greater than, greater than, and equal to) with dominants and sub-dominants and "others" on separate lines:**
    Dominant: Mid-size, cool season bunchgrasses>> perennial shrubs=cool season rhizomatous grasses>>perennial forbs>short cool season bunchgrasses
    Sub-dominant:
    Other:
    Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal decadence, typically associated with shrub component.

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14. **Average percent litter cover (30 - 70 %) and depth (.1 - .4 inches):** Litter ranges from 5-30% of total canopy measurement with total litter (including beneath the plant canopy) from 30-70% expected. Herbaceous litter depth typically ranges from 3-10mm. Woody litter can be up to a couple inches (4-6 cm).

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15. **Expected annual production (this is TOTAL above-ground production, not just forage production):** English: 500-1100 lb/ac (800 lb/ac average); Metric 560-1232 kg/ha (896 kg/ha average).

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16. **Potential invasive (including noxious) species (native and non-native). List Species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive**

plants. Note that unlike other indicator, we are describing what in NOT expected in the reference state for the ecological site: Bare ground greater than 50% is the most common indicator of a threshold being crossed. Blue grama, Sandberg bluegrass, big sagebrush, buckwheat, and phlox are common increasers. Annual weeds such as kochia, mustards, lambsquarter, and Russian thistle are common invasive species in disturbed sites.

17. **Perennial plant reproductive capability:** All species are capable of reproducing, except in drought years.

Reference Sheet Approval:

Approval	Date
E. Bainter	5/1/2008

UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE

ECOLOGICAL SITE DESCRIPTION (Old Format Report)

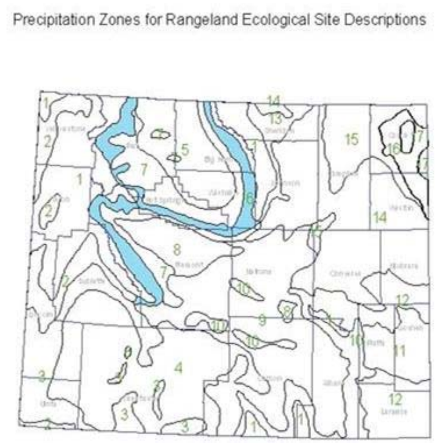
ECOLOGICAL SITE CHARACTERISTICS

Site Type: Rangeland

Site Name: Loamy (Ly) 15-19” Foothills and Mountains East Precipitation Zone

Site ID: R043BY322WY

Major Land Resource Area: 043B-Central Rocky Mountains



Physiographic Features

This site typically occurs on gently undulating rolling land, but can occur on steeper gradual slopes.

Land Form:
(1) Hill
(2) Alluvial fan
(3) Ridge

	Minimum	Maximum
Elevation (feet):	6000	9000
Slope (percent):	0	30
Water Table Depth (inches):		
Flooding:		
Frequency:	None	None
Duration:	None	None
Ponding:		
Depth (inches):	0	0
Frequency:	None	None
Duration:	None	None
Runoff Class:	Negligible	High

Aspect: No Influence on this site

Climatic Features

Annual precipitation ranges from 15-19 inches per year. June is generally the wettest month. July, August, and September are somewhat less with daily amounts rarely exceeding one inch.

Snowfall is quite heavy in the area. Annual snowfall averages about 150 inches.

Because of the varied topography, the wind will vary considerably for different parts of the area. The wind is usually much lighter at the lower elevations and in the valleys as compared with the higher terrain. The average winter wind velocity is 8.5 mph while the summer wind velocity averages 7.5 mph. Winds during storms and on ridges may exceed 45 mph.

Growth of native cool-season plants begins about May 1 to May 15 and continues to about October 10.

The following information is from the “Crandall Creek” climate station, at the lower end of this precipitation zone:
Minimum Maximum 5 yrs. out of 10 between
Frost-free period (days): 16 80 July 8 – August 20
Freeze-free period (days): 37 120 June 17 – September 5
Mean Annual Precipitation (inches): 10.24 21.23

Mean annual precipitation: 14.90 inches
Mean annual air temperature: 38.16 F (21.88 F Avg. Min. to 54.66 F Avg. Max.)
For detailed information, visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/ website. There are no other climate station(s) known to be representative of this precipitation zone.

	Minimum	Maximum
Frost-free period (days):	16	80
Freeze-free period (days):	37	120
Mean annual precipitation (inches):	15.0	19.0

Monthly precipitation (inches) and temperature (°F):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precip. Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Precip. Max.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temp. Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temp. Max.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Climate Stations:

Influencing Water Features

Stream type: None

Wetland
Description: System Subsystem Class

Representative Soil Features

The soils of this site are deep to moderately deep (greater than 20" to bedrock), moderately well to well-drained & moderately slow to moderately permeable. The surface soil will vary from 3" to 6" in thickness depending on the texture and permeability of the subsoil. The soil characteristic having the most influence on the plant community is the available moisture and depth to a root restrictive barrier.

Parent Materials:
Kind:
Origin:

Surface Texture: (1) Loam
(2) Silt loam
(3) Very fine sandy loam

Subsurface Texture Group: Loamy

	Minimum	Maximum
Surface Fragments <=3" (% Cover):	0	0
Surface Fragments > 3" (% Cover):	0	10
Subsurface Fragments <=3" (% Volume):	0	15
Subsurface Fragments > 3" (% Volume):	0	10

Drainage Class: Moderately well drained To Well drained
Permeability Class: Moderately slow To Moderate

	Minimum	Maximum
Depth (inches):	20	60
Electrical Conductivity (mmhos/cm):	0	4
Sodium Absorption Ratio:	0	5
Calcium Carbonate Equivalent (percent):	0	10
Soil Reaction (1:1 Water):	6.6	8.4
Soil Reaction (0.01M CaCl2):		
Available Water Capacity (inches):	3.0	6.3

Plant Communities

Ecological Dynamics of the Site

Ecological Dynamics of the Site:
Potential vegetation on this site is dominated by mid cool-season perennial grasses. Other significant vegetation includes big sagebrush, rubber rabbitbrush, and a variety of forbs. The expected potential composition for this site is about 75% grasses, 15% forbs and 10% woody plants. The composition and production will vary naturally due to historical use, fluctuating precipitation and fire frequency.

As this site deteriorates species such as big sagebrush, rubber rabbitbrush, and bluegrasses will increase. Cool season grasses such as Columbia needlegrass, spikefescue, and Idaho fescue will decrease in frequency and production. As conditions deteriorate further, annuals such as cheatgrass will invade.

Big sagebrush may become dominant on areas with an absence of fire and a sufficient amount of precipitation. Wildfires are actively controlled in recent times and as a result old decadent stands of big sagebrush persist. Chemical and mechanical controls have replaced the historic role of fire on this site. Recently, prescribed burning has regained some popularity.

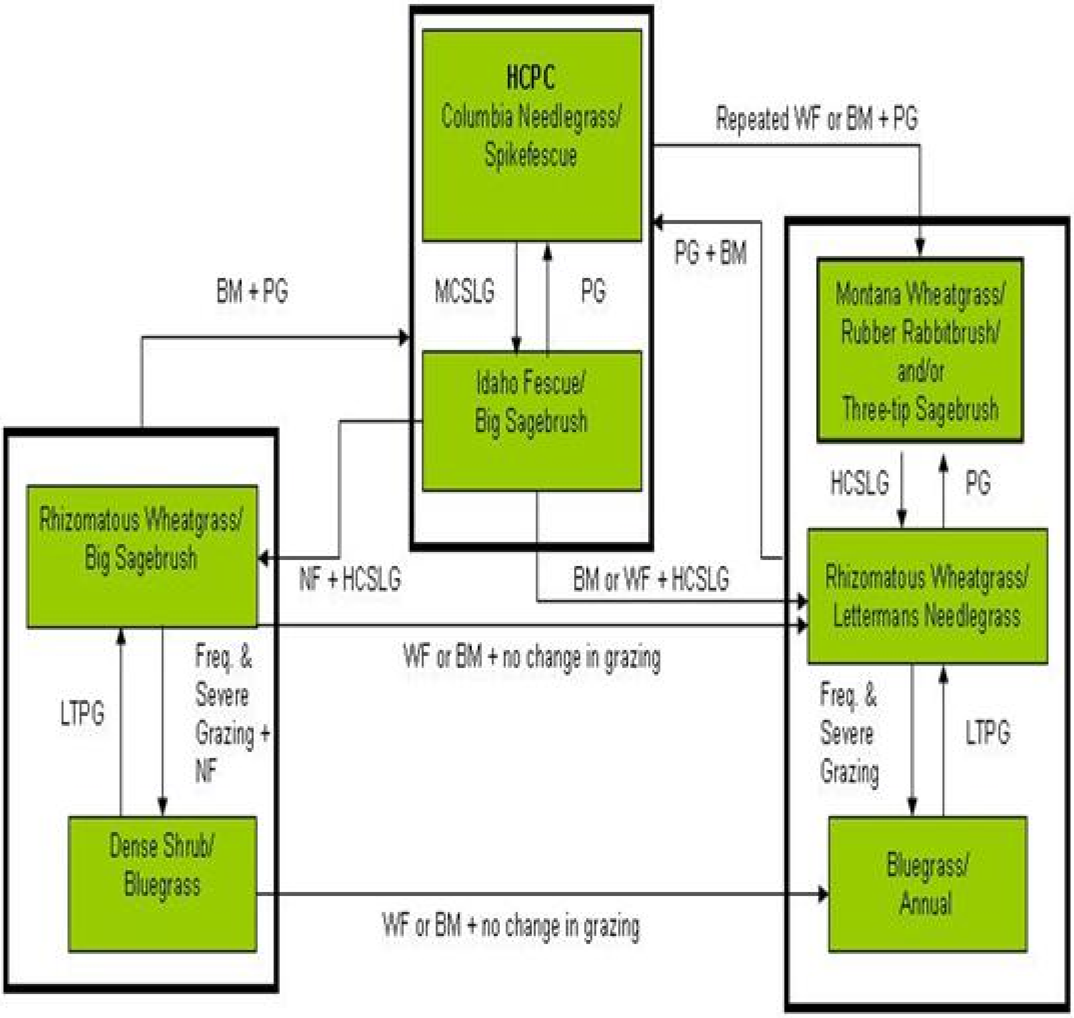
The big sagebrush component may not be as resilient once it has been removed or severely reduced, if a vigorous stand of grass exists and is maintained. The exception to this is where the herbaceous component is severely degraded at the time of treatment, growing conditions are unfavorable after treatment, and/or recovery of herbaceous species are inadequate due to poor grazing management. Regeneration of big sagebrush may also be suppressed if three-tip sagebrush and rubber rabbitbrush are established. This situation is more likely to develop in areas where fires have occurred in a relatively short cycle. Three-tip sagebrush and rubber rabbitbrush are strong resprouters and will out compete other shrubs where a site is disturbed. Any thinning project should be designed in a way to maintain the viability of the stand and to consider wildlife requirements.

The Historic Climax Plant Community (description follows the plant community diagram) has been determined by study of rangeland relic areas, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have also been used.

The following is a State and Transition Model Diagram that illustrates the common plant communities (states) that can occur on the site and the transitions between these communities. The ecological processes will be discussed in more detail in the plant community narratives following the diagram.

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Loamy (Ly) 15"-19" East P.Z.
R043BY322WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF – Wildfire

Columbia Needlegrass/Spikefescue Plant Community

The interpretive plant community for this site is the Historic Climax Plant Community. This state evolved with grazing by large herbivores and periodic fires. Potential vegetation is about 75% grasses or grass-like plants, 15% forbs, and 10% woody plants. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and on areas receiving periods of rest. The cyclical nature of the fire regime in this community prevents big sagebrush from being the dominant landscape.

Cool season midgrasses dominate the site. The major grasses include Columbia needlegrass, spikefescue, Idaho fescue, and bluebunch wheatgrass. Big sagebrush is a conspicuous element of this site, occurs in a mosaic pattern, and makes up 5 to 10% of the annual production. Natural fire occurred in this community and prevented sagebrush from being the dominant landscape. A variety of forbs also occurs in this state and plant diversity is high (see Plant Composition Table).

Annual production on this site ranges from 1100 to 1600 pounds depending on climatic conditions.

This plant community is extremely stable and well adapted to the Central Rocky Mountains 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).

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

• Moderate, continuous season-long grazing will convert the plant community to the Idaho Fescue/Big Sagebrush Plant Community.

• Repeated Wild Fire or Brush Management + Prescribed Grazing will convert the HCPC to the Montana Wheatgrass/Rubber Rabbitbrush and/or Three-tip Sagebrush Plant Community.

Columbia Needlegrass/Spikefescue Plant Community Plant Species Composition:

Grass/Grasslike

Group	Group Name	Common Name	Symbol	Scientific Name	Annual Production in Pounds Per Acre Low	High
1					135	338
		Columbia needlegrass, subalpine needlegrass	ACNE9	*Achnatherum nelsonii*	135	338
2					135	338
		spike fescue, kingspike fescue	LEKI2	*Leucopoa kingii*	135	338
3					135	338
		Idaho fescue	FEID	*Festuca idahoensis*	135	338
4					68	203
		bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	68	203
5					135	338
		Grass, perennial, other perennial grass	2GP		0	68
		Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	0	68

		Common Name	Symbol	Scientific Name	Low	High
		nodding brome	BRAN	Bromus anomalus	0	68
		Pumpelly's brome	BRINP5	Bromus inermis ssp. pumpellianus var. pumpellianus	0	68
		mountain brome	BRMA4	Bromus marginatus	0	68
		sedge	CAREX	Carex	0	68
		California oatgrass, California danthonia	DACA3	Danthonia californica	0	68
		onespike danthonia, onespike oatgrass	DAUN	Danthonia unispicata	0	68
		Montana wheatgrass	ELAL7	Elymus albicans	0	68
		slender wheatgrass	ELTR7	Elymus trachycaulus	0	68
		needle and thread, needleandthread	HECO26	Hesperostipa comata	0	68
		prairie Junegrass	KOMA	Koeleria macrantha	0	68
		western wheatgrass	PASM	Pascopyrum smithii	0	68
		Sandberg bluegrass	POAM	Poa ampla(syn)	0	68
		Sandberg bluegrass	POCA	Poa canbyi(syn)	0	68
		muttongrass, mutton bluegrass	POFE	Poa fendleriana	0	68
		Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	POSE	Poa secunda	0	68
		spike trisetum	TRSP2	Trisetum spicatum	0	68

Forb

Group	Group Name	Common Name	Symbol	Scientific Name	Annual Production in Pounds Per Acre Low	High
6 - null					68	203
		Forb, perennial, other perennial forb	2FP		0	68
		yarrow	ACHIL	Achillea	0	68
		agoseris, mountain dandelion, dandelion	AGOSE	Agoseris	0	68
		pussytoes	ANTEN	Antennaria	0	68
		milkvetch	ASTRA	Astragalus	0	68
		balsamroot	BALSA	Balsamorhiza	0	68
		corn gromwell	BUAR3	Buglossoides arvensis	0	68
		Indian paintbrush, paintbrush	CASTI2	Castilleja	0	68
		field chickweed	CEAR4	Cerastium arvense	0	68
		tapertip hawksbeard	CRAC2	Crepis acuminata	0	68
		buckwheat	ERIOG	Eriogonum	0	68
		green gentian	FRASE	Frasera	0	68
		common sneezeweed, yellow sneezeweed	HEAU	Helenium autumnale	0	68
		flax	LINUM	Linum	0	68
		wild bergamot	MOFI	Monarda fistulosa	0	68
		lousewort	PEDIC	Pedicularis	0	68
		beardtongue, penstemon	PENST	Penstemon	0	68
		phlox	PHLOX	Phlox	0	68
		silky phacelia	PHSE	Phacelia sericea	0	68
		American vetch	VIAM	Vicia americana	0	68
		mule-ears, mules-ears	WYETH	Wyethia	0	68

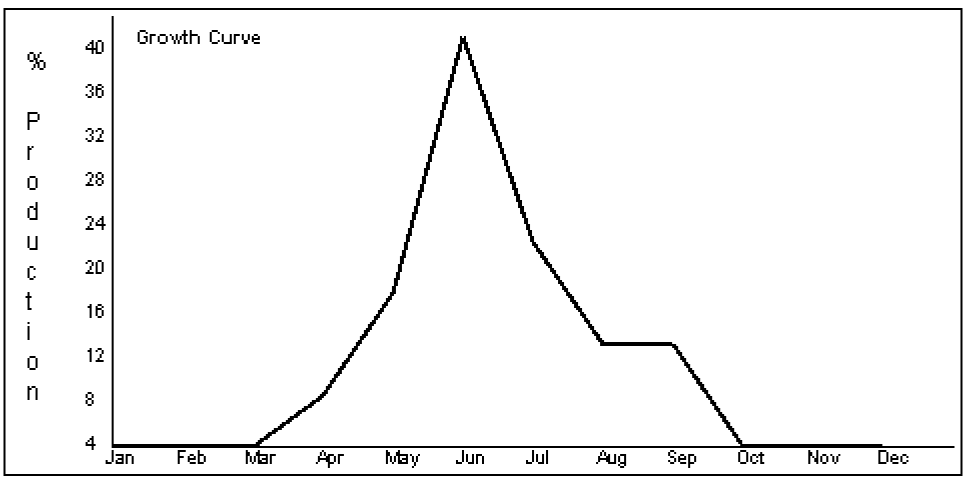
Shrub/Vine

Group	Group Name	Common Name	Symbol	Scientific Name	Annual Production in Pounds Per Acre Low	High
7					0	135
		big sagebrush	ARTR2	*Artemisia tridentata*	0	135
8					0	68
		rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0	68
9					0	68
		Shrub (>.5m)	2SHRUB		0	68

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Idaho Fescue/Big Sagebrush Plant Community

Historically, this plant community evolved under grazing by large ungulates and a low fire frequency. Currently, this site is normally found under a moderate, season-long grazing regime and will be exacerbated by prolonged drought conditions. In addition, the fire regime for this site has been modified and extended periods without fire is now common. Big sagebrush is an important component of this plant community. Cool-season grasses make up the majority of the understory with the balance made up of miscellaneous forbs.

Dominant grasses include Idaho fescue and bluebunch wheatgrass and of less frequency Columbia needlegrass and spikefescue. Grasses of secondary importance include prairie junegrass, rhizomatous wheatgrasses, bluegrasses, and spike trisetum. Forbs commonly found in this plant community include agoseris, balsamroot, phlox, buckwheat, pussytoes, hawksbeard, paintbrush, and western yarrow. Sagebrush and rubber rabbitbrush make up to 20% of the total annual production.

When compared to the Historical Climax Plant Community, big sagebrush, rubber rabbitbrush, rhizomatous wheatgrasses, and bluegrasses have increased. Columbia needlegrass and spikefescue have decreased, often occurring only where protected from grazing by the sagebrush canopy. Some weedy species such as cheatgrass and annual forbs may have invaded the site but are in small patches.

This state produces between 1000 and 1500 pounds annually, depending on the growing conditions.

This plant community is resistant to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

Transitions or pathways leading to other plant communities are as follows:
• Prescribed grazing will convert this plant community to the HCPC. The probability of this occurring is high especially if rotational grazing along with short deferred grazing is implemented as part of the prescribed method of use. In addition, the removal of fire suppression will allow a somewhat natural fire regime to reoccur to more easily transition between this plant community and the HCPC. A prescribed fire treatment can be useful to hasten this transition if desired.

• Heavy, continuous, season-long grazing plus no fires will convert the plant community to the Rhizomatous Wheatgrass/ Big Sagebrush Plant Community. The probability of this occurring is high. This is especially evident on areas where drought or heavy browsing does not adversely impact the shrub stand.

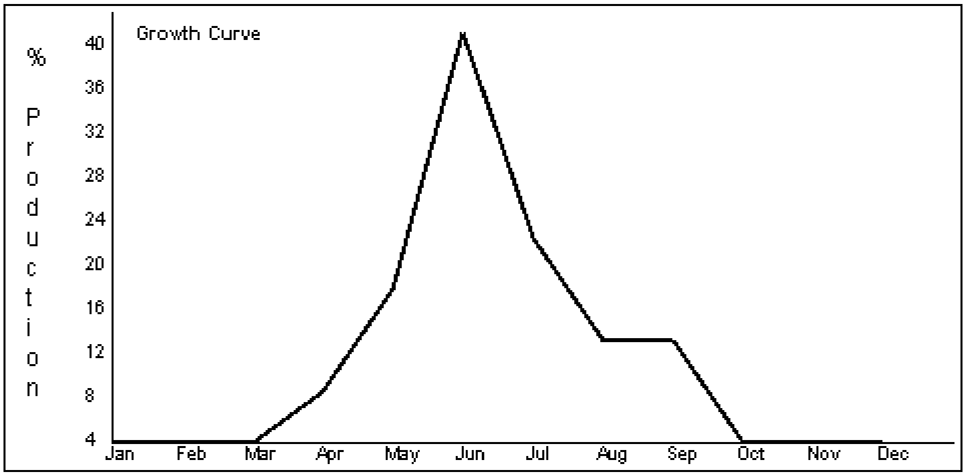
• Heavy, continuous, season-long grazing plus wildfire or brush management, will convert the plant community to a Rhizomatous Wheatgrass/Lettermans Needlegrass Plant Community. The probability for this is high, especially on areas were the shrubs have been heavily browsed or removed by natural or human causes. Drought can also exacerbate this transition.

• Repeated Wild Fire or Brush Management plus Prescribed Grazing will convert the this plant community to the Montana Wheatgrass/Rubber Rabbitbrush and/or Three-tip Sagebrush Plant Community.

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Rhizomatous Wheatgrass/Big Sagebrush Plant Community

This plant community currently is found under heavy continuous season-long grazing by livestock and protection from fire. Big sagebrush is a significant component of this plant community although rubber rabbitbrush may be as abundant. Cool-season grasses make up the majority of the understory, but some of the preferred grasses have been reduced or are absent.

Dominant grasses include rhizomatous wheatgrasses, Lettermans needlegrass, bluegrasses, and of less frequency Columbia needlegrass, spikefescue, Idaho fescue and bluebunch wheatgrass. Grasses of secondary importance include prairie junegrass, slender wheatgrass, spike trisetum and native bromes. Forbs commonly found in this plant community include balsamroot, hawksbeard, paintbrush, groundsel, buckwheat, phlox, lupine, larkspur, sneezeweed, pussytoes, and American vetch. Big Sagebrush and rubber rabbitbrush can make up to 30% of the total annual production.

When compared to the Historic Climax Plant Community, big sagebrush, rubber rabbitbrush, bluegrasses, Lettermans needlegrass, and rhizomatous wheatgrasses have increased. Most of the preferred grasses have been reduced and some are absent. Some annuals, such as cheatgrass, as well as noxious weeds such as leafy spurge have invaded the site, but are not yet abundant.

Annual production ranges from 800 to 1300 pounds.

This plant community is resistant to change as the shrubs become more abundant. These areas may actually be more resistant to fire as less fine fuels are available and the bare ground between the shrubs is increased. The herbaceous component is not as diverse and plant vigor and species regeneration capabilities of some cool-season perennials are deficient. The removal of grazing does not seem to affect the plant composition or structure of the plant community.

Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling is more noticeable. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces on steeper areas and gullies may be establishing where rills have concentrated down slope.

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

• Prescribed grazing plus brush management will convert this plant community to near HCPC. If prescribed fire is used as a means to reduce or remove the shrubs, sufficient fine fuels will need to be present. This may require deferment from grazing prior to treatment. Post management is critical to ensure success. This can range from two or more years of rest to partial growing season deferment, depending on the condition of the understory at the time of treatment and the growing conditions following treatment. Seeding will be required regardless of the brush treatment to reestablish the major cool-season grasses.

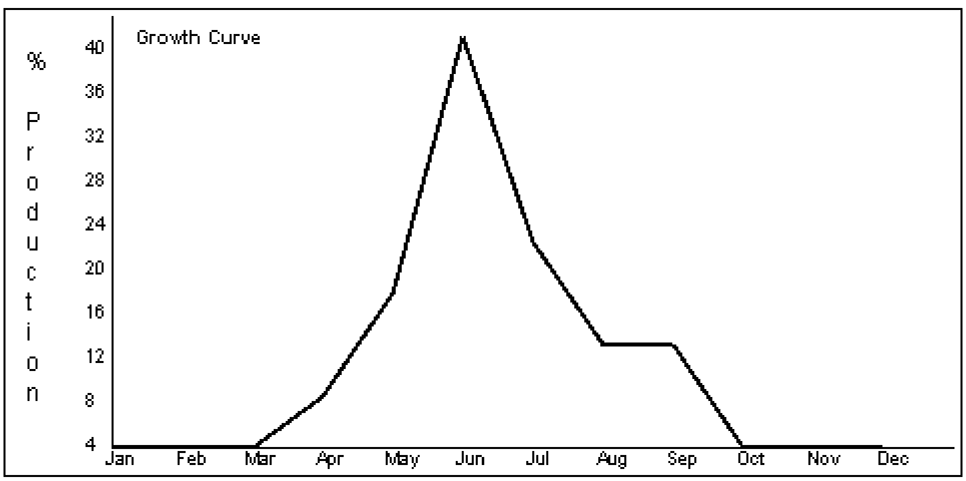
• Frequent and severe grazing plus no fires will convert the plant community to the Dense Shrub/Bluegrass Plant Community. The probability of this occurring is high and is especially evident on areas where drought or heavy browsing does not adversely impact the shrub stand.

• Brush management or Wildfire with no change in grazing management will convert this plant community to the Rhizomatous Wheatgrass/Lettermans Needlegrass Plant Community.

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Dense Shrub/Bluegrass Plant Community

This plant community is the result of frequent and severe grazing and protection from fire. Big sagebrush and rubber rabbitbrush are the dominant shrubs of this plant community as the annual production will exceed 30%. Preferred cool season grasses have been eliminated or greatly reduced. The interspaces between plants have expanded leaving the amount of bare ground more prevalent and more soil surface exposed to erosive elements.

Bluegrasses such as Sandberg, mutton, big, and Canby dominate the understory. Weedy annual species such as cheatgrass, kochia, Russian thistle, and a variety of mustards may occupy the site. Noxious weeds such as Canada thistle and leafy spurge may invade the site if a seed source is available. When compared with the HCPC the annual production is less, as the major cool-season grasses are reduced, but the shrub production has increased significantly and compensates for some of the decline in the herbaceous production.

Annual production ranges from 700 to 1000 pounds.

This plant community is resistant to change as the stand becomes more decadent. These areas may actually be more resistant to fire as less fine fuels are available and the bare ground between the shrubs is increased. The herbaceous component is not as diverse and plant vigor and species regeneration capabilities of cool-season perennials are deficient. The removal of grazing does not seem to affect the plant composition or structure of the plant community.

Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling are obvious. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces and gullies may be establishing where rills have concentrated down slope.

Transitions or pathways leading to other plant communities are as follows:
• Prescribed grazing plus brush management will convert this plant community to near HCPC. If prescribed fire is used as a means to reduce or remove the shrubs, sufficient fine fuels will need to be present. This may require deferment from grazing prior to treatment. Post management is critical to ensure success. This can range from two or more years of rest to partial growing season deferment, depending on the condition of the understory at the time of treatment and the growing conditions following treatment. Seeding will be required regardless of the brush treatment to reestablish the major cool-season grasses.

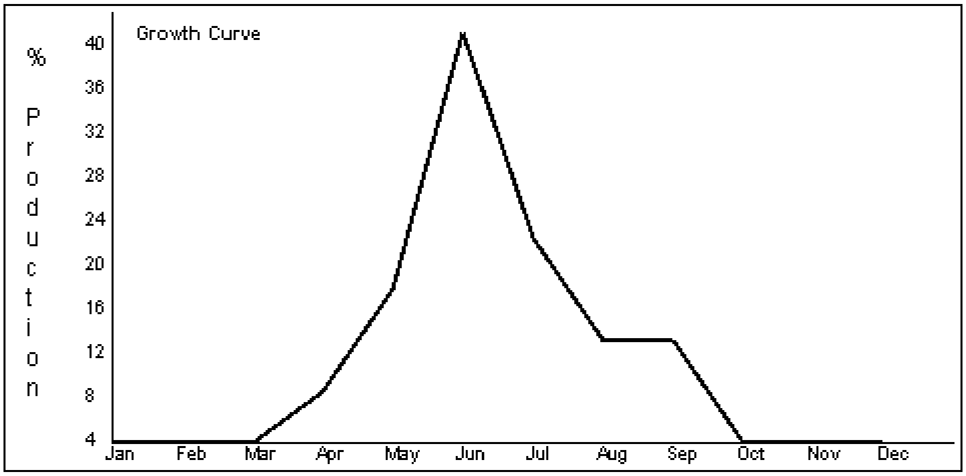
• Long-term prescribed grazing will convert this plant community to the Rhizomatous Wheatgrass/Big Sagebrush Plant Community.

• Brush management or Wildfire with no change in grazing management will convert this plant community to the Bluegrass/Annual Plant Community.

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Montana Wheatgrass/Rubber Rabbitbrush and/or Three-tip Sagebrush Plant Community

This plant community currently is found under prescribed grazing or possibly no use by livestock and is perpetuated by a fire cycle that maintains the removal of big sagebrush. Rubber rabbitbrush and three-tip sagebrush are significant components of this plant community. Cool-season grasses remain an important component, but some bunchgrasses are not as abundant.

Dominant grasses include Montana wheatgrass, Lettermans needlegrass, and rhizomatous wheatgrasses, and of less frequency Columbia needlegrass, Idaho fescue, bluebunch wheatgrass, and spikefescue. Grasses of secondary importance include prairie junegrass, slender wheatgrass, spike trisetum, and bluegrasses. Forbs commonly found in this plant community include balsamroot, paintbrush, phlox, groundsel, penstemon, larkspur, lupine, pussytoes, hawksbeard, and American vetch. Rubber rabbitbrush and/or three-tip sagebrush can comprise as much as 25% of the total production.

When compared to the Historical Climax Plant Community, Montana wheatgrass, rhizomatous wheatgrasses, three-tip sagebrush and rubber rabbitbrush have increased. Columbia needlegrass, bluebunch wheatgrass, spikefescue, and Idaho fescue have decreased. Production of cool-season grasses has remained about the same. Cheatgrass can be common and in large patches, but mostly invaded areas are relatively small.

Annual production ranges from 1000 to 1500 pounds.

This plant community is resistant to change as once three-tip sagebrush and rubber rabbitbrush become the dominant shrubs it is difficult for other shrubs to become established. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

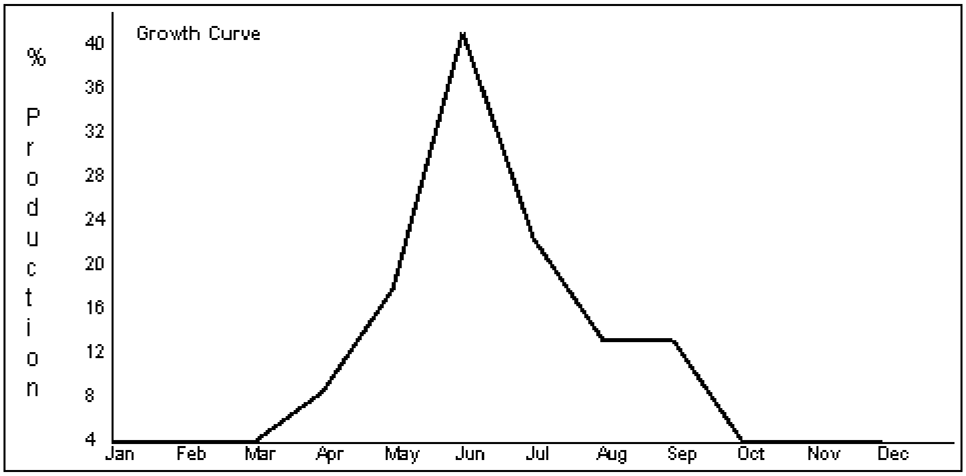
Transitions or pathways leading to other plant communities are as follows:
• Prescribed grazing and brush management will convert this plant community to the HCPC. Controlling three-tip sagebrush and rubber rabbitbrush is difficult as both are strong resprouters. Reestablishing the big sagebrush stand may be difficult and may take many years.

• Heavy, continuous, season-long grazing will convert this plant community to a Rhizomatous Wheatgrass/Lettermans Needlegrass Plant Community. More than likely, three-tip sage and rubber rabbitbrush will persist in varying degrees, as both are strong resprouters and difficult to control.

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Rhizomatous Wheatgrass/Lettermans Needlegrass Plant Community

This plant community currently is found under heavy continuous season-long grazing by livestock and is perpetuated by either brush management or a wildfire, which removes big sagebrush from this plant community. Three-tip sagebrush and/or rubber rabbitbrush can be significant components of this plant community, but also may be lacking. Some of the major cool-season bunchgrasses have been reduced and some may have been removed.

Dominant grasses include rhizomatous wheatgrasses, Lettermans needlegrass, bluegrasses, prairie junegrass, spike trisetum, and Montana wheatgrass, and of less frequency Columbia needlegrass, Idaho fescue, bluebunch wheatgrass, and spikefescue. Forbs commonly found in this plant community include phlox, groundsel, balsamroot, paintbrush, larkspur, lupine, pussytoes, hawksbeard, and American vetch. Three-tip sagebrush and/or rubber rabbitbrush can comprise as much as 25% of the total production.

When compared to the Historical Climax Plant Community, rhizomatous wheatgrass, prairie junegrass, Montana wheatgrass, three-tip sagebrush and rubber rabbitbrush have increased. Columbia needlegrass, bluebunch wheatgrass, Idaho fescue, and big sagebrush have decreased or been removed. Production of the preferred cool-season grasses has been reduced. Cheatgrass can be common and in large patches, but mostly invaded areas are relatively small.

Annual production ranges from 700 to 1000 pounds.

This plant community is resistant to change as the herbaceous species present are well adapted to grazing and if three-tip and rubber rabbitbrush become the dominant shrubs it is difficult for other shrubs to become established. However, species composition can be altered through long-term overgrazing. The herbaceous component is mostly intact, but some cool-season bunchgrasses associated with the site have been reduced or removed. Plant vigor and replacement capabilities are sufficient for some species but not all. Water flow patterns and litter movement is occurring but only on steeper slopes. Incidence of pedestalling is moderate to slight. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is partially intact.

Transitions or pathways leading to other plant communities are as follows:
• Prescribed grazing plus brush management will convert this plant community to near HCPC.

Controlling three-tip sagebrush and rubber rabbitbrush, if present, is difficult as these are strong resprouters. Reestablishing big sagebrush may be difficult and may take many years. Seeding may be required to reestablish any of the lost major bunchgrasses.

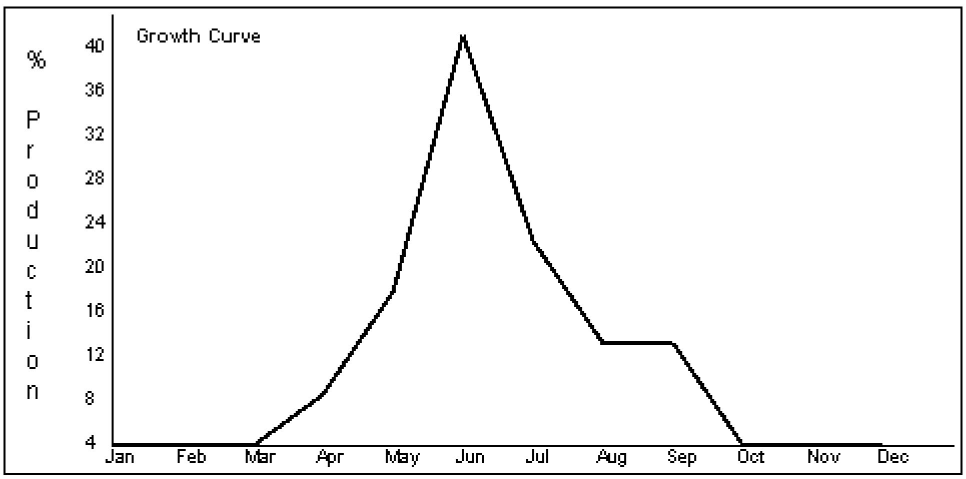
• Prescribed grazing will convert this plant community to the Montana Wheatgrass/Rubber Rabbitbrush and/or Three-tip Sagebrush Plant Community.

• Frequent and severe grazing will convert this plant community to a Bluegrass/Annual Plant Community. If three-tip sage and rubber rabbitbrush are present more than likely, they will persist in varying degrees as both are difficult to control.

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Bluegrass/Annual Plant Community

This plant community evolved under frequent and severe heavy grazing and the big sagebrush shrub component has been removed by heavy browsing, wildfire or human means. Weedy annuals and bluegrasses are the most dominant plants and occupy any open bare ground area. Three-tip sagebrush and rubber rabbitbrush may or may not be present. However, it is common for these shrubs to occur as both are strong resprouters and may quickly re-establish the site after a disturbance.

Compared to the HCPC, weedy annual species and bluegrasses are widespread and virtually all of the major cool-season mid-grasses are absent or severely decreased. Big sagebrush has also been removed. Weedy annuals may include cheatgrass, kochia, Russian thistle, and a variety of mustards. Bluegrass species will include Sandberg, mutton, Canby, and big. Noxious weeds such as Canada thistle and leafy spurge may invade the site if a seed source is available. The interspaces between plants have expanded leaving the amount of bare ground more prevalent and more soil surface exposed to erosive elements.

Annual production ranges from 350 to 650 pounds.

This plant community is relatively stable and resistant to overgrazing. Annuals and bluegrasses are effectively competing against the establishment of perennial cool-season grasses. Plant diversity is greatly altered and the herbaceous component is not intact. Recruitment of the major perennial grasses is not occurring and the replacement potential is absent. The biotic integrity is missing.

The soils are unstable and not protected from excessive erosion. Rill channels and maybe even gullies may be present on site and adjacent areas are impacted by excessive runoff. Water flow patterns and pedestalling are obvious. The watershed is not functioning.

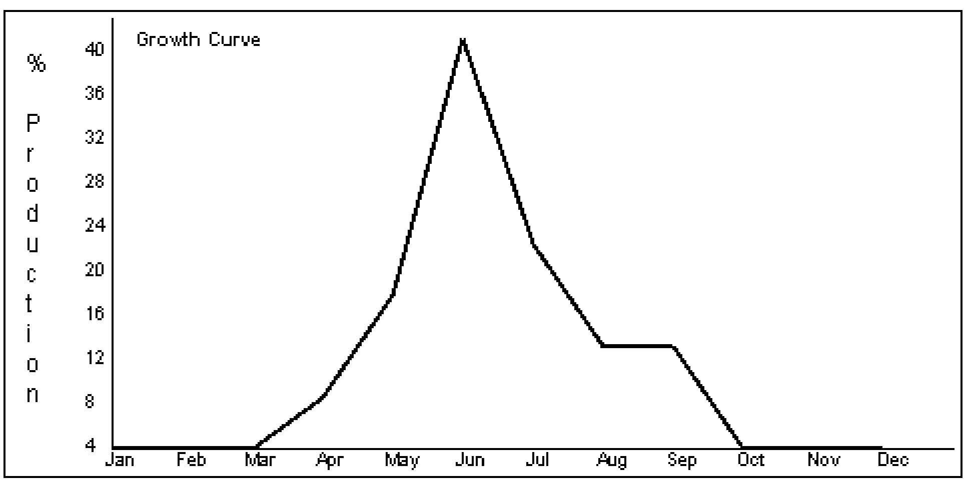
Transitions or pathways leading to other plant communities are as follows:
• Prescribed grazing plus brush management may convert this plant community to near HCPC, although it will require major investment and time. Controlling three-tip sagebrush and rubber rabbitbrush, if present, is difficult as both are strong resprouters. Reestablishing the big sagebrush stand may be difficult and may take many years. Seeding will be required to reestablish any of the lost major bunchgrasses.

• Prescribed grazing will convert this plant community to the Rhizomatous Wheatgrass/Lettermans Needlegrass Plant Community.

Plant Growth Curve:
Growth Curve Number: WY0601
Growth Curve Name: 15-19E all upland sites
Growth Curve Description:

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	40	20	10	10	0	0	0



Ecological Site Interpretations

Animal Community:
Animal Community – Wildlife Interpretations

Columbia Needlegrass/Spikefescue Plant Community (HCPC): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as deer, bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. Due to the location of these sites on the foot slopes of mountains they are valuable for elk and deer winter ranges. When found adjacent to sagebrush dominated states, this plant community may provide brood rearing/foraging areas for sage grouse, as well as lek sites. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous hawks, and golden eagles. Many grassland obligate small mammals would occur here.

Idaho Fescue/Big Sagebrush Plant Community: The combination of an overstory of big sagebrush and an understory of grasses and forbs provides a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer, elk, and antelope may use this state for foraging and cover year-round, as would cottontail and jack rabbits. It provides important winter, nesting, brood-rearing, and foraging habitat for sage grouse. Brewer’s sparrows’ nest in big sagebrush plants and hosts of other nesting birds utilize stands in the 20-30% cover range. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous hawks, and golden eagles.

Rhizomatous Wheatgrass/Big Sagebrush Plant Community: The combination of an overstory of big sagebrush and an understory of grasses and forbs provides a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer, elk, and antelope may use this state for foraging and cover year-round, as would cottontail and jack rabbits. It provides important winter, nesting, brood-rearing, and foraging habitat for sage grouse. Brewer’s sparrows’ nest in big sagebrush plants and hosts of other nesting birds utilize stands in the 20-30% cover range. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous hawks, and golden eagles.

Dense Shrub/Bluegrass Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides escape and thermal cover for large ungulates, as well as nesting and brood rearing habitat for sage grouse. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous hawks, and golden eagles.
Due to the lack of herbaceous production and diversity of mid cool season grasses on this site, it is not as beneficial to grazers.

Montana Wheatgrass/Rubber Rabbitbrush and/or Three-tip Sagebrush Plant Community: The production of herbaceous species provided for good foraging to grazers. However, the lack of tall or mid growing shrubs does not benefit browsers nor provides cover for many wildlife species. As these site greens-up sooner in the spring, this site tends to provide early new growth for foraging large and small mammals. If located adjacent to shrub dominated sites, It provides good foraging habitat for sage grouse. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous hawks, and golden eagles.

Rhizomatous Wheatgrass/Lettermans Needlegrass Plant Community: The production of herbaceous species provided for good foraging for grazers. However, the lack of tall or mid growing shrubs does not benefit browsers nor provides cover for many wildlife species. As these site greens-up sooner in the spring, this site tends to provide early new growth for foraging large and small mammals. If located adjacent to shrub dominated sites, It provides good foraging habitat for sage grouse.

Bluegrass/Annual Plant Community: This community provides limited foraging for elk and other grazers. They may be used as a foraging site by sage grouse if proximal to woody cover. Generally, these are not target plant communities for wildlife habitat management.

Animal Community – Grazing Interpretations

The following table lists suggested stocking rates for cattle under continuous season-long grazing under normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies can result in an increased carrying capacity. If distribution problems occur, stocking rates must be reduced to maintain plant health and vigor.

Plant Community Production Carrying Capacity*
(lb./ac) (AUM/ac)
Columbia Needlegrass/Spikefescue 1100-1600 .6
Idaho Fescue/Big Sagebrush 1000-1500 .5
Rhizomatous WG/Big Sagebrush 800-1300 .4
Dense Shrub/Bluegrass 700-1000 .3
Montana WG/R. Rabbitbrush/Three-tip Sagebrush 1000-1500 .5
Rhizomatous WG/Lettermans Needlegrass 700-1000 .3
Bluegrass/Annual 350-650 .2

* - Continuous, season-long grazing by cattle under average growing conditions.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide seasonal forage for cattle, sheep, or horses. During the dormant period, the forage for livestock use needs to be supplemented with protein because the quality does not meet minimum livestock requirements.

Plant Preference by Animal Kind:

Animal Kind: ALLAntelope

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	*Achnatherum lettermanii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
western yarrow	*Achillea millefolium var. occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Columbia needlegrass, subalpine needlegrass	*Achnatherum nelsonii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
boxelder	*Acer negundo var. interius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	*Agoseris glauca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Saskatoon serviceberry, serviceberry	*Amelanchier alnifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

pussytoes	Antennaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	Artemisia cana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
sandwort	Arenaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	Arnica	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	Artemisia nova	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	Artemisia tridentata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threetip sagebrush	Artemisia tripartita	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water birch	Betula occidentalis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	Betula pumila	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	Bromus anomalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Pumpelly's brome	Bromus inermis ssp. pumpellianus var. pumpellianus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain brome	Bromus marginatus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water sedge	Carex aquatilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Macoun's reedgrass	Calamagrostis canadensis var. macouniana	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Nebraska sedge	Carex nebrascensis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slough sedge	Carex obnupta	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	Carex phaeocephala	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	Carex	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	Calamagrostis stricta ssp. inexpansa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
field chickweed	Cerastium arvense	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	Cercocarpus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
snowbrush ceanothus	Ceanothus velutinus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
rabbitbrush	Chrysothamnus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
water hemlock	Cicuta	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	Cornus sericea	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
California oatgrass, California danthonia	Danthonia californica	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
shrubby cinquefoil	Dasiphora floribunda(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	Danthonia intermedia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
onespike danthonia, onespike oatgrass	Danthonia unispicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	Elymus albicans	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	Elymus elymoides ssp. elymoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	Festuca idahoensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	Fragaria vesca	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fowl mannagrass	Glyceria elata(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread	Hesperostipa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	Hordeum brachyantherum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	Hydrophyllum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
alpine laurel, bog kalmia	*Kalmia microphylla*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	*Leucopoa kingii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
lupine	*Lupinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	*Muhlenbergia montana*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mat muhly	*Muhlenbergia richardsonis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	*Oligoneuron*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	*Phleum alpinum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	*Pinus flexilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	*Pinus ponderosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	*Poa ampla(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	*Polygonum bistortoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	*Poa canbyi(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	*Poa fendleriana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	*Prunus virginiana var. virginiana*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
antelope bitterbrush	*Purshia tridentata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	*Symphoricarpos occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	*Trisetum spicatum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mule-ears, mules-ears	*Wyethia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLBighorn Sheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	*Achnatherum lettermanii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Columbia needlegrass, subalpine needlegrass	*Achnatherum nelsonii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
boxelder	*Acer negundo var. interius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	*Agoseris glauca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Saskatoon serviceberry, serviceberry	*Amelanchier alnifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sandwort	*Arenaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	*Arnica*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

threetip sagebrush	*Artemisia tripartita*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water birch	*Betula occidentalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	*Betula pumila*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	*Bromus anomalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Pumpelly's brome	*Bromus inermis ssp. pumpellianus var. pumpellianus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain brome	*Bromus marginatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Macoun's reedgrass	*Calamagrostis canadensis var. macouniana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Nebraska sedge	*Carex nebrascensis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slough sedge	*Carex obnupta*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	*Carex phaeocephala*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	*Calamagrostis stricta ssp. inexpansa*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
field chickweed	*Cerastium arvense*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	*Cercocarpus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
snowbrush ceanothus	*Ceanothus velutinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
rabbitbrush	*Chrysothamnus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water hemlock	*Cicuta*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	*Cornus sericea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
California oatgrass, California danthonia	*Danthonia californica*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
shrubby cinquefoil	*Dasiphora floribunda(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	*Danthonia intermedia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
onespike danthonia, onespike oatgrass	*Danthonia unispicata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted hairgrass	*Deschampsia caespitosa(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
larkspur	*Delphinium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	*Elymus albicans*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	*Elymus elymoides ssp. elymoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	*Elymus trachycaulus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fleabane	*Erigeron*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	*Eucephalus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	*Festuca idahoensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	*Fragaria vesca*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fowl mannagrass	*Glyceria elata(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
needle and thread	*Hesperostipa*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	*Hordeum brachyantherum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	*Hydrophyllum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
alpine laurel, bog kalmia	*Kalmia microphylla*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike														

fescue	*Leucopoa kingii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
lupine	*Lupinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	*Muhlenbergia montana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	*Muhlenbergia richardsonis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	*Oligoneuron*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	*Phleum alpinum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	*Pinus flexilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	*Pinus ponderosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	*Poa ampla(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	*Polygonum bistortoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	*Poa canbyi(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	*Poa fendleriana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	*Prunus virginiana var. virginiana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
antelope bitterbrush	*Purshia tridentata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	*Symphoricarpos occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	*Trisetum spicatum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mule-ears, mules-ears	*Wyethia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLCattle

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	*Achnatherum lettermanii*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
western yarrow	*Achillea millefolium var. occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Columbia needlegrass, subalpine needlegrass	*Achnatherum nelsonii*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
boxelder	*Acer negundo var. interius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	*Agoseris glauca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Saskatoon serviceberry, serviceberry	*Amelanchier alnifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sandwort	*Arenaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	*Arnica*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threetip sagebrush	*Artemisia tripartita*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water birch	*Betula occidentalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	*Betula pumila*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	*Bromus anomalus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
	Bromus inermis ssp. pumpellianus													

Pumpelly's brome	var. pumpellianus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
mountain brome	Bromus marginatus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
water sedge	Carex aquatilis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Macoun's reedgrass	Calamagrostis canadensis var. macouniana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nebraska sedge	Carex nebrascensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
slough sedge	Carex obnupta	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	Carex phaeocephala	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	Carex	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	Calamagrostis stricta ssp. inexpansa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
field chickweed	Cerastium arvense	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	Cercocarpus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
snowbrush ceanothus	Ceanothus velutinus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
rabbitbrush	Chrysothamnus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water hemlock	Cicuta	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	Cornus sericea	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
California oatgrass, California danthonia	Danthonia californica	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shrubby cinquefoil	Dasiphora floribunda(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	Danthonia intermedia	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
onespike danthonia, onespike oatgrass	Danthonia unispicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	Elymus albicans	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	Elymus elymoides ssp. elymoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	Festuca idahoensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	Fragaria vesca	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fowl mannagrass	Glyceria elata(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
needle and thread	Hesperostipa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	Hordeum brachyantherum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	Hydrophyllum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
iris	Iris	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	Juncus balticus(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine laurel, bog kalmia	Kalmia microphylla	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	Koeleria macrantha	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	Leucopoa kingii	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
lupine	Lupinus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	Muhlenbergia montana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	Muhlenbergia richardsonis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	Oligoneuron	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

western wheatgrass	Pascopyrum smithii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	Phleum alpinum	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	Phlox	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	Pinus flexilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	Pinus ponderosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	Poa ampla(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	Polygonum bistortoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	Poa canbyi(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	Poa fendleriana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	Poa secunda	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	Prunus virginiana var. virginiana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	Pseudoroegneria spicata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
antelope bitterbrush	Purshia tridentata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	Rumex	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	Salix	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	Sedum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	Symphoricarpos occidentalis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	Trisetum spicatum	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
mule-ears, mules-ears	Wyethia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLDeer

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	Achnatherum hymenoides	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	Achnatherum lettermanii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
western yarrow	Achillea millefolium var. occidentalis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Columbia needlegrass, subalpine needlegrass	Achnatherum nelsonii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
boxelder	Acer negundo var. interius	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	Agoseris glauca	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Saskatoon serviceberry, serviceberry	Amelanchier alnifolia	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
pussytoes	Antennaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	Artemisia cana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
sandwort	Arenaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	Arnica	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	Artemisia nova	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	Artemisia tridentata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threetip sagebrush	Artemisia tripartita	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water birch	Betula occidentalis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	Betula pumila	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	Bromus anomalus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Pumpelly's brome	Bromus inermis ssp. pumpellianus var. pumpellianus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain brome	Bromus marginatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	Carex aquatilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Macoun's reedgrass	Calamagrostis canadensis var. macouniana	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Nebraska sedge	*Carex nebrascensis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slough sedge	*Carex obnupta*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	*Carex phaeocephala*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	*Calamagrostis stricta ssp. inexpansa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
field chickweed	*Cerastium arvense*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	*Cercocarpus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
snowbrush ceanothus	*Ceanothus velutinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
rabbitbrush	*Chrysothamnus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water hemlock	*Cicuta*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	*Cornus sericea*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
California oatgrass, California danthonia	*Danthonia californica*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
shrubby cinquefoil	*Dasiphora floribunda(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	*Danthonia intermedia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
onespike danthonia, onespike oatgrass	*Danthonia unispicata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
tufted hairgrass	*Deschampsia caespitosa(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
larkspur	*Delphinium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	*Elymus albicans*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	*Elymus elymoides ssp. elymoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	*Elymus trachycaulus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fleabane	*Erigeron*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	*Eucephalus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	*Festuca idahoensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	*Fragaria vesca*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fowl mannagrass	*Glyceria elata(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread	*Hesperostipa*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	*Hordeum brachyantherum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	*Hydrophyllum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
alpine laurel, bog kalmia	*Kalmia microphylla*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	*Leucopoa kingii*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
lupine	*Lupinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	*Muhlenbergia montana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	*Muhlenbergia richardsonis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	*Oligoneuron*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	*Phleum alpinum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	*Pinus flexilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	*Pinus ponderosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Sandberg bluegrass	Poa ampla(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	Polygonum bistortoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	Poa canbyi(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	Poa fendleriana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	Poa secunda	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	Prunus virginiana var. virginiana	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
bluebunch wheatgrass	Pseudoroegneria spicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
antelope bitterbrush	Purshia tridentata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	Rumex	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	Salix	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
stonecrop	Sedum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	Symphoricarpos occidentalis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike trisetum	Trisetum spicatum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mule-ears, mules-ears	Wyethia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLElk

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	Achnatherum hymenoides	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	Achnatherum lettermanii	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
western yarrow	Achillea millefolium var. occidentalis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Columbia needlegrass, subalpine needlegrass	Achnatherum nelsonii	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
boxelder	Acer negundo var. interius	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	Agoseris glauca	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Saskatoon serviceberry, serviceberry	Amelanchier alnifolia	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	Antennaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	Artemisia cana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sandwort	Arenaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	Arnica	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	Artemisia nova	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	Artemisia tridentata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threetip sagebrush	Artemisia tripartita	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water birch	Betula occidentalis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	Betula pumila	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	Bromus anomalus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Pumpelly's brome	Bromus inermis ssp. pumpellianus var. pumpellianus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
mountain brome	Bromus marginatus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
water sedge	Carex aquatilis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Macoun's reedgrass	Calamagrostis canadensis var. macouniana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nebraska sedge	Carex nebrascensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
slough sedge	Carex obnupta	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	Carex phaeocephala	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	Carex	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	Calamagrostis stricta ssp. inexpansa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

field chickweed	Cerastium arvense	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	Cercocarpus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
snowbrush ceanothus	Ceanothus velutinus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
rabbitbrush	Chrysothamnus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water hemlock	Cicuta	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	Cornus sericea	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
California oatgrass, California danthonia	Danthonia californica	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shrubby cinquefoil	Dasiphora floribunda(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	Danthonia intermedia	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
onespike danthonia, onespike oatgrass	Danthonia unispicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	Elymus albicans	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	Elymus elymoides ssp. elymoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	Festuca idahoensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	Fragaria vesca	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fowl mannagrass	Glyceria elata(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
needle and thread	Hesperostipa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	Hordeum brachyantherum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	Hydrophyllum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
iris	Iris	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	Juncus balticus(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine laurel, bog kalmia	Kalmia microphylla	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	Koeleria macrantha	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	Leucopoa kingii	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
lupine	Lupinus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	Muhlenbergia montana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	Muhlenbergia richardsonis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	Oligoneuron	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	Pascopyrum smithii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	Phleum alpinum	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	Phlox	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	Pinus flexilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	Pinus ponderosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	Poa ampla(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	Polygonum bistortoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	Poa canbyi(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	Poa fendleriana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass,														

big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	*Prunus virginiana var. virginiana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
antelope bitterbrush	*Purshia tridentata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	*Symphoricarpos occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	*Trisetum spicatum*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
mule-ears, mules-ears	*Wyethia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLHorses

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	*Achnatherum lettermanii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
western yarrow	*Achillea millefolium var. occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Columbia needlegrass, subalpine needlegrass	*Achnatherum nelsonii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
boxelder	*Acer negundo var. interius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	*Agoseris glauca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Saskatoon serviceberry, serviceberry	*Amelanchier alnifolia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sandwort	*Arenaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	*Arnica*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
big sagebrush	*Artemisia tridentata*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
threetip sagebrush	*Artemisia tripartita*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water birch	*Betula occidentalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	*Betula pumila*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	*Bromus anomalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Pumpelly's brome	*Bromus inermis ssp. pumpellianus var. pumpellianus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain brome	*Bromus marginatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Macoun's reedgrass	*Calamagrostis canadensis var. macouniana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Nebraska sedge	*Carex nebrascensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
slough sedge	*Carex obnupta*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	*Carex phaeocephala*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	*Calamagrostis stricta ssp. inexpansa*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
field chickweed	*Cerastium arvense*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	*Cercocarpus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
snowbrush ceanothus	*Ceanothus velutinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
rabbitbrush	*Chrysothamnus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water hemlock	*Cicuta*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T

redosier dogwood	*Cornus sericea*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
California oatgrass, California danthonia	*Danthonia californica*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shrubby cinquefoil	*Dasiphora floribunda(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	*Danthonia intermedia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
onespike danthonia, onespike oatgrass	*Danthonia unispicata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted hairgrass	*Deschampsia caespitosa(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	*Delphinium*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	*Elymus albicans*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	*Elymus elymoides ssp. elymoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	*Elymus trachycaulus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fleabane	*Erigeron*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	*Eucephalus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	*Festuca idahoensis*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	*Fragaria vesca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fowl mannagrass	*Glyceria elata(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
needle and thread	*Hesperostipa*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	*Hordeum brachyantherum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	*Hydrophyllum*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
iris	*Iris*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	*Juncus balticus(syn)*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine laurel, bog kalmia	*Kalmia microphylla*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	*Koeleria macrantha*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	*Leucopoa kingii*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
lupine	*Lupinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	*Muhlenbergia montana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	*Muhlenbergia richardsonis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	*Oligoneuron*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	*Pascopyrum smithii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	*Phleum alpinum*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	*Phlox*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	*Pinus flexilis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	*Pinus ponderosa*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	*Poa ampla(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	*Polygonum bistortoides*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	*Poa canbyi(syn)*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	*Poa fendleriana*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	*Poa secunda*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	*Prunus virginiana var. virginiana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	*Pseudoroegneria spicata*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P

antelope bitterbrush	*Purshia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dock	*Rumex*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	*Salix*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
stonecrop	*Sedum*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	*Symphoricarpos occidentalis*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	*Trisetum spicatum*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
mule-ears, mules-ears	*Wyethia*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLMoose

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	*Achnatherum hymenoides*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	*Achnatherum lettermanii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Columbia needlegrass, subalpine needlegrass	*Achnatherum nelsonii*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
boxelder	*Acer negundo var. interius*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	*Agoseris glauca*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Saskatoon serviceberry, serviceberry	*Amelanchier alnifolia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
pussytoes	*Antennaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	*Artemisia cana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sandwort	*Arenaria*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	*Arnica*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	*Artemisia nova*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	*Artemisia tridentata*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threetip sagebrush	*Artemisia tripartita*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water birch	*Betula occidentalis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	*Betula pumila*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	*Bromus anomalus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Pumpelly's brome	*Bromus inermis ssp. pumpellianus var. pumpellianus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain brome	*Bromus marginatus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water sedge	*Carex aquatilis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Macoun's reedgrass	*Calamagrostis canadensis var. macouniana*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Nebraska sedge	*Carex nebrascensis*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slough sedge	*Carex obnupta*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	*Carex phaeocephala*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	*Carex*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	*Calamagrostis stricta ssp. inexpansa*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
field chickweed	*Cerastium arvense*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	*Cercocarpus*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
snowbrush ceanothus	*Ceanothus velutinus*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
rabbitbrush	*Chrysothamnus*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
water hemlock	*Cicuta*	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	*Cornus sericea*	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
California oatgrass, California danthonia	*Danthonia californica*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
shrubby cinquefoil	*Dasiphora floribunda(syn)*	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	*Danthonia intermedia*	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

onespike danthonia, onespike oatgrass	Danthonia unispicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	Elymus albicans	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
squirreltail, bottlebrush squirreltail	Elymus elymoides ssp. elymoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	Festuca idahoensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	Fragaria vesca	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fowl mannagrass	Glyceria elata(syn)	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
needle and thread	Hesperostipa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	Hordeum brachyantherum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	Hydrophyllum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
iris	Iris	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	Juncus balticus(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
alpine laurel, bog kalmia	Kalmia microphylla	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	Koeleria macrantha	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	Leucopoa kingii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
lupine	Lupinus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	Muhlenbergia montana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	Muhlenbergia richardsonis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	Oligoneuron	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	Pascopyrum smithii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	Phleum alpinum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
phlox	Phlox	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	Pinus flexilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	Pinus ponderosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	Poa ampla(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	Polygonum bistortoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	Poa canbyi(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	Poa fendleriana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	Poa secunda	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	Prunus virginiana var. virginiana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	Pseudoroegneria spicata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
antelope bitterbrush	Purshia tridentata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	Rumex	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	Salix	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
stonecrop	Sedum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	Symphoricarpos occidentalis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	Trisetum spicatum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

mule-ears, mules-ears	Wyethia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Animal Kind: ALLSheep

Common Name	Scientific Name	Plant Part	J	F	M	A	M	J	J	A	S	O	N	D
Indian ricegrass	Achnatherum hymenoides	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Letterman's needlegrass	Achnatherum lettermanii	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
western yarrow	Achillea millefolium var. occidentalis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Columbia needlegrass, subalpine needlegrass	Achnatherum nelsonii	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
boxelder	Acer negundo var. interius	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
pale agoseris, pale mountain dandelion	Agoseris glauca	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Saskatoon serviceberry, serviceberry	Amelanchier alnifolia	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
pussytoes	Antennaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
silver sagebrush	Artemisia cana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
sandwort	Arenaria	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
arnica	Arnica	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
black sagebrush	Artemisia nova	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
big sagebrush	Artemisia tridentata	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
threetip sagebrush	Artemisia tripartita	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
water birch	Betula occidentalis	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bog birch	Betula pumila	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
nodding brome	Bromus anomalus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Pumpelly's brome	Bromus inermis ssp. pumpellianus var. pumpellianus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
mountain brome	Bromus marginatus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
water sedge	Carex aquatilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Macoun's reedgrass	Calamagrostis canadensis var. macouniana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Nebraska sedge	Carex nebrascensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
slough sedge	Carex obnupta	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
dunhead sedge, dunehead sedge	Carex phaeocephala	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
sedge	Carex	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
northern reedgrass	Calamagrostis stricta ssp. inexpansa	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
field chickweed	Cerastium arvense	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
mountain mahogany	Cercocarpus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
snowbrush ceanothus	Ceanothus velutinus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
rabbitbrush	Chrysothamnus	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
water hemlock	Cicuta	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
redosier dogwood	Cornus sericea	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
California oatgrass, California danthonia	Danthonia californica	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
shrubby cinquefoil	Dasiphora floribunda(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
timber oatgrass, timber danthonia	Danthonia intermedia	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
onespike danthonia, onespike oatgrass	Danthonia unispicata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
tufted hairgrass	Deschampsia caespitosa(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
larkspur	Delphinium	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Montana wheatgrass	Elymus albicans	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D

squirreltail, bottlebrush squirreltail	Elymus elymoides ssp. elymoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
streambank wheatgrass, thickspike wheatgrass	Elymus lanceolatus ssp. lanceolatus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
slender wheatgrass	Elymus trachycaulus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
fleabane	Erigeron	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
aster	Eucephalus	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Idaho fescue	Festuca idahoensis	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
woodland strawberry, strawberry	Fragaria vesca	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
fowl mannagrass	Glyceria elata(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
needle and thread	Hesperostipa	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
meadow barley, meadowbarley	Hordeum brachyantherum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
waterleaf	Hydrophyllum	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
iris	Iris	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Baltic rush	Juncus balticus(syn)	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
alpine laurel, bog kalmia	Kalmia microphylla	Entire plant	T	T	T	T	T	T	T	T	T	T	T	T
prairie Junegrass	Koeleria macrantha	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
spike fescue, kingspike fescue	Leucopoa kingii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
lupine	Lupinus	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mountain muhly	Muhlenbergia montana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mat muhly	Muhlenbergia richardsonis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
goldenrod	Oligoneuron	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western wheatgrass	Pascopyrum smithii	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
alpine timothy	Phleum alpinum	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
phlox	Phlox	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
limber pine	Pinus flexilis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
ponderosa pine	Pinus ponderosa	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
Sandberg bluegrass	Poa ampla(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
American bistort	Polygonum bistortoides	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
Sandberg bluegrass	Poa canbyi(syn)	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
muttongrass, mutton bluegrass	Poa fendleriana	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
Sandberg bluegrass, big bluegrass, Canby bluegrass, alkali bluegrass	Poa secunda	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
chokecherry	Prunus virginiana var. virginiana	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
bluebunch wheatgrass	Pseudoroegneria spicata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
antelope bitterbrush	Purshia tridentata	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
dock	Rumex	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
willow	Salix	Entire plant	P	P	P	P	P	P	P	P	P	P	P	P
stonecrop	Sedum	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
western snowberry	Symphoricarpos occidentalis	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U
spike trisetum	Trisetum spicatum	Entire plant	D	D	D	D	D	D	D	D	D	D	D	D
mule-ears, mules-ears	Wyethia	Entire plant	U	U	U	U	U	U	U	U	U	U	U	U

Legend: P = Preferred D = Desirable U = Undesirable N = Not consumed E = Emergency T = Toxic X = Used, but degree of utilization unknown

Hydrology Functions:

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group C, with localized areas in hydrologic group B and D. Infiltration ranges from moderately slow to moderate. Runoff potential for this site varies from low to moderate depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where short-grasses form a strong sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information).

Rills and gullies should not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals are only slightly present in association with bunchgrasses. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non-existent. Cryptogamic crusts are present, but only cover 1-2% of the soil surface.

Recreational Uses:

This site provides hunting opportunities for upland game species. The wide varieties of plants that bloom from spring until fall have an esthetic value that appeals to visitors. Other recreational uses may included hiking, camping, mountain biking, and in the winter snowshoeing and cross-country skiing.

Wood Products:

No appreciable wood products are present on the site.

Other Products:

None noted.

Other Information:

Supporting Information

Associated Sites:

Site Name	Site ID	Site Narrative
Coarse Upland (CU) 15-19” Foothills and Mountains East Precipitation Zone	R043BY308WY	Coarse Upland
Overflow (Ov) 15-19” Foothills and Mountains East Precipitation Zone	R043BY330WY	Overflow
Shallow Loamy (SwLy) 15-19” Foothills and Mountains East Precipitation Zone	R043BY362WY	Shallow Loamy
Shallow Sandy (SwSy) 15-19” Foothills and Mountains East Precipitation Zone	R043BY366WY	Shallow Sandy

Similar Sites:

Site Name	Site ID	Site Narrative
Loamy (Ly) 10-14" East Precipitation Zone	R032XY322WY	Loamy 10-14” Foothills and Basins East P.Z., has lower production.

State Correlation:

This site has been correlated with the following states:
WY

Inventory Data References:
Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range trained personnel were also used. Those involved in developing this site include: Chris Krassin, Range Management Specialist, James Haverkamp, Range Management Specialist, Steven Gullion, Range Management Specialist, James Mischke, District Conservationist, and Everet Bainter, State Range Management Specialist. Other sources used as references include USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, and USDA NRCS Soil Surveys from various counties.

Type Locality:

Relationship to Other Established Classifications:

Other References:

Site Description Approval:

Author	Date	Approval	Date
J. Haverkamp	2/22/2006	E. Bainter	5/1/2008

Reference Sheet

Author(s)/participant(s): Ray Gullion, E. Bainter

Contact for lead author:ray.gullion@wy.usda.gov 307-347-2456

Date:5/1/2008 **MLRA:**043B **Ecological Site:**Loamy (Ly) 15-19” Foothills and Mountains East Precipitation ZoneR043BY322WY This *must* be verified based on soils and climate (see Ecological Site Description). Current plant community cannot be used to identify the ecological site.

Composition (indicators 10 and 12) based on: XAnnual Production, Foliar Cover, Biomass

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Indicators. For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years for **each** community and natural disturbance regimes within the reference state, when appropriate and (3) cite data. Continue descriptions on separate sheet.

1. **Number and extent of rills:** Rare to nonexistent. Where present, short and widely spaced.
2. **Presence of water flow patterns:** Barely observable.
3. **Number and height of erosional pedestals or terracettes:** Rare to nonexistent.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, standing dead, lichen, moss, plant canopy are not bare ground):** Bare ground can range from 0-20%.

5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present.

6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent.

7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous and large woody litter not expected to move.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil Stability Index ratings range from 3 (interspaces) to 6 (under plant canopy), but average values should be 4.0 or greater.

9. **Soil surface structure and SOM content (include type and strength of structure, and A-horizon color and thickness):** Soil data is limited for this site. Described A-horizons vary from 6-23 inches (15-58 cm) with OM of 2 to 5%.

10. **Effect on plant community composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Plant community consists of 70-80% grasses, 15% forbs, and 5-15% shrubs. Evenly distributed plant canopy (60-95%) and litter plus moderate infiltration rates result in minimal runoff. Basal cover is typically 5-15% for this site and does affect runoff on this site.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None.

12. **Functional/Structural Groups (list in order of descending dominance by above-ground weight using symbols: >>, >, = to indicate much greater than, greater than, and equal to) with dominants and sub-dominants and "others" on separate lines:**
    Dominant: Mid-size, cool season bunchgrasses>> perennial shrubs=perennial forbs>tall, cool season bunchgrasses>cool season rhizomatous grasses=short cool season bunchgrasses
    Sub-dominant:
    Other:
    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal decadence, typically associated with shrub component.

14. **Average percent litter cover (50 - 90 %) and depth (.2 - .6 inches):** Litter ranges from 5-40% of total canopy measurement with total litter (including beneath the plant canopy) from 50-90% expected. Herbaceous litter depth typically ranges from 5-15mm. Woody litter can be up to a couple inches (4-6 cm).

15. **Expected annual production (this is TOTAL above-ground production, not just forage**

production): English: 1100-1600 lb/ac (1350 lb/ac average); Metric 1232-1792 kg/ha (1512 kg/ha average).

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16. **Potential invasive (including noxious) species (native and non-native). List Species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicator, we are describing what in NOT expected in the reference state for the ecological site:** Bare ground greater than 30% is the most common indicator of a threshold being crossed. Big sagebrush, rubber rabbitbrush, and bluegrasses are common increasers. Kentucky bluegrass, common dandelion, thistles, and annual weeds such as kochia and mustards are common invasive species in disturbed sites.

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17. **Perennial plant reproductive capability:** All species are capable of reproducing, except in extreme drought years.

Reference Sheet Approval:

Approval	Date
E. Bainter	5/1/2008

Appendix E

2010 Upland Range Site Inventory

Kirby Creek Watershed Study, Hot Springs County, Wyoming

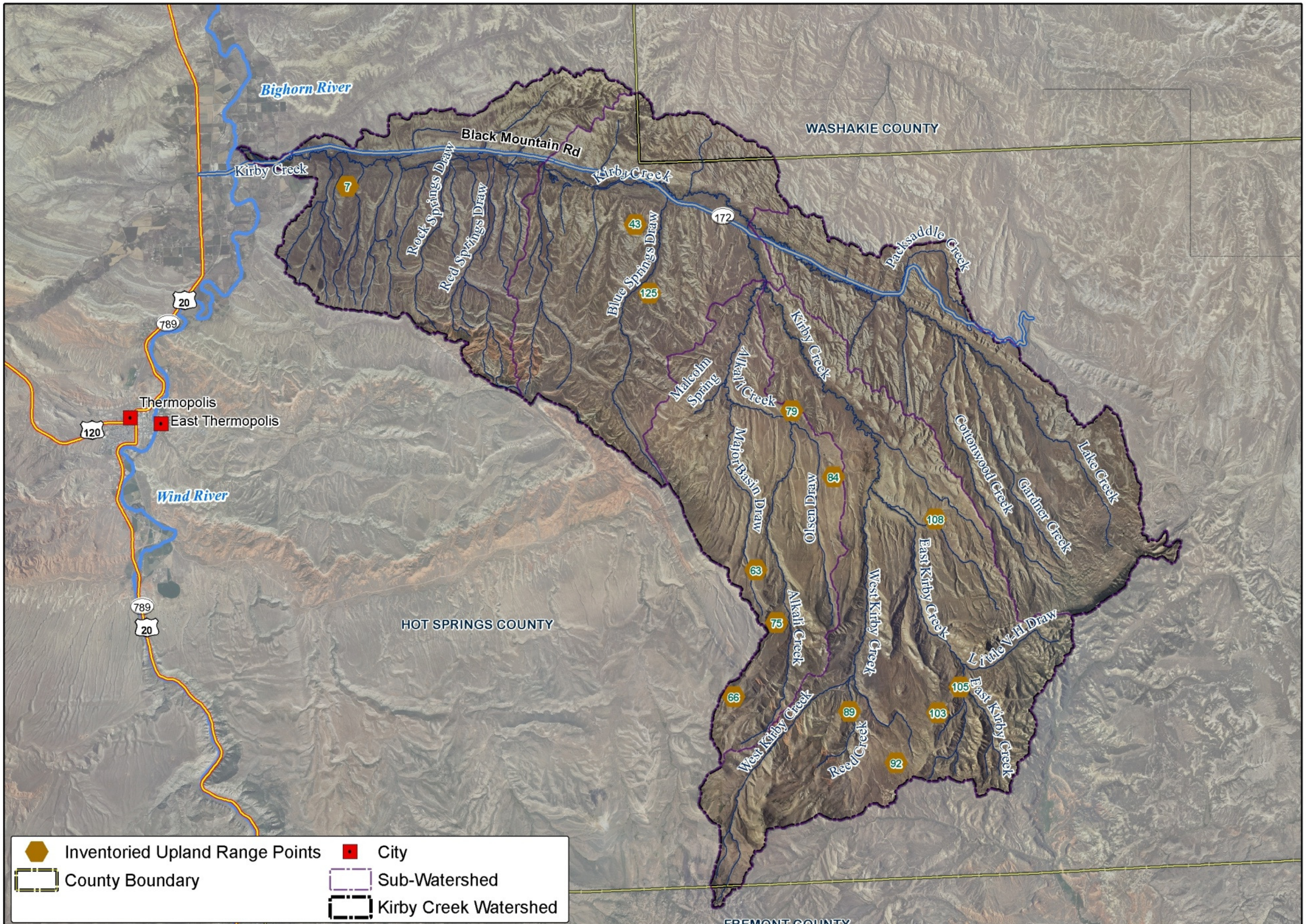


FIGURE E-1

PROJECT NAME: Kirby Creek Watershed Study

FIGURE TITLE: Locations of Inventoried Upland Range Points

N

0 1.5 3 6 Miles

PROJ NO: *100008648* | PLOTTED: *07-15-2010* | LOCATION: *HOT SPRINGS COUNTY, WY* | PROJECT MGR: *MR*

S:\Water Resources\projects\100008648 Kirby Creek Watershed Study\GIS\mxds\Final Figures\WDEQ Stream Classifications.mxd

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

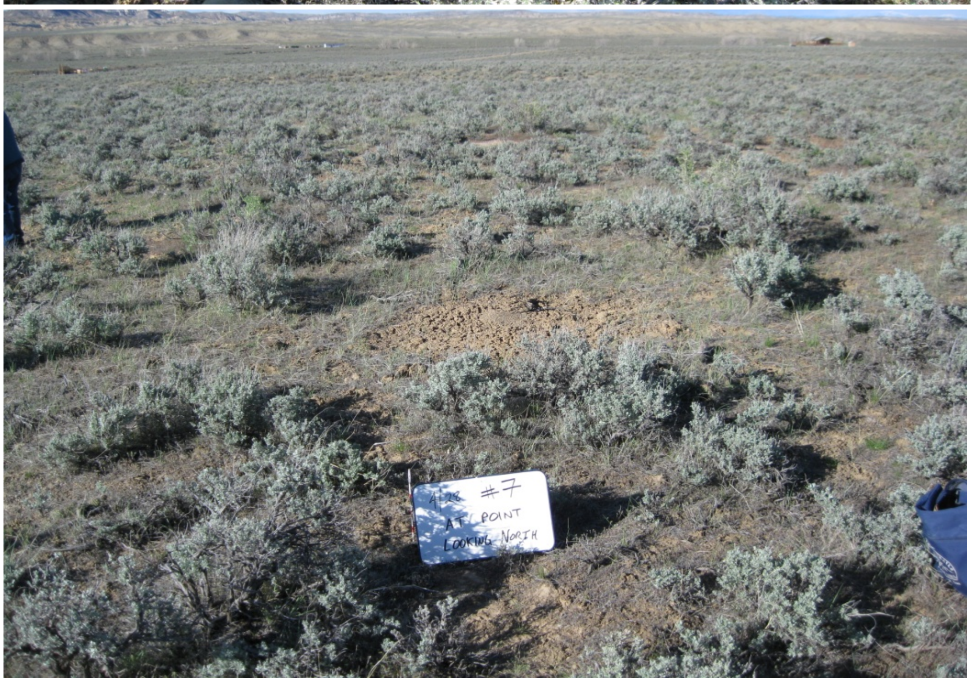
DATE - 4/28/10 **LOCATION - #7**

SITE - Loamy/Clayey site **PZ - 10 - 14"**

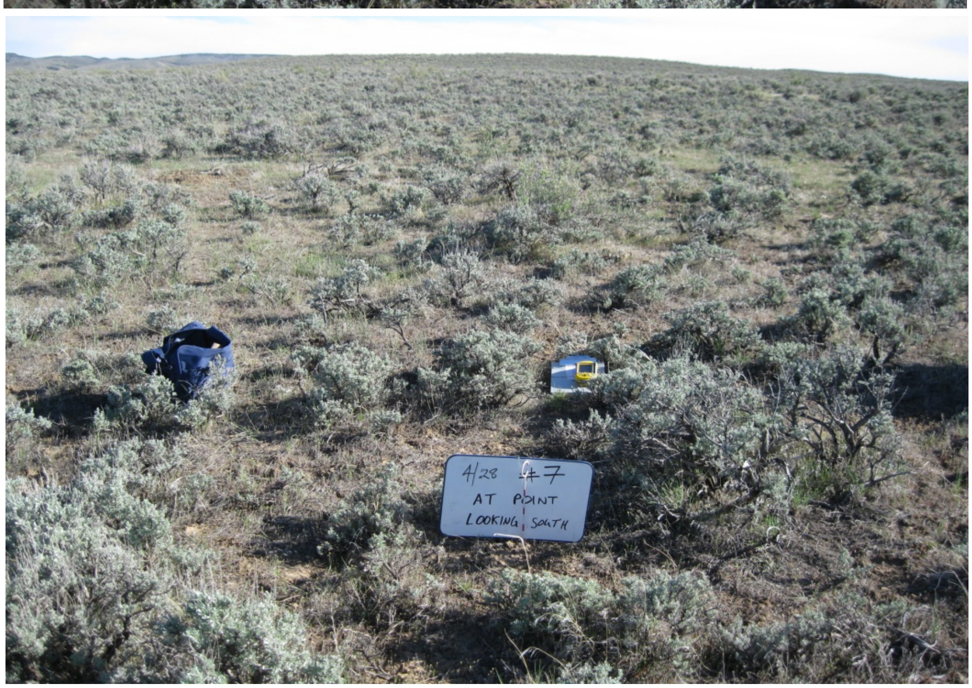
Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Cheatgrass brome		10				X				
Western wheatgrass		18	18	X						
Needleandthread		14	5		X					
Prairie junegrass		10	5	X						
Sandberg bluegrass		10	5	X						
FORBS:										
Hood phlox		3	3		X					
Lichen		1			X					
Paintbrush		2	2	X						
Sego lilly		T		X						
Onion		1	1	X						
Biscuitroot		1	1	X						
Fanweed		1	1		X					
Filaree		1				X				
Tansy mustard		1	1		X					
SHRUBS:										
Wyoming big sagebrush		22	22		X					
Pricklypear cactus		3			X					
Greasewood		2	2		X					
	TOTALS	100	66				30	5		

Site is close to HCPC based on species composition and amounts. Continued grazing management practices will sustain the ecological status of the plant community.

Kirby Creek
4/28/10
Site #7
Loamy/Clayey
Before Grazing



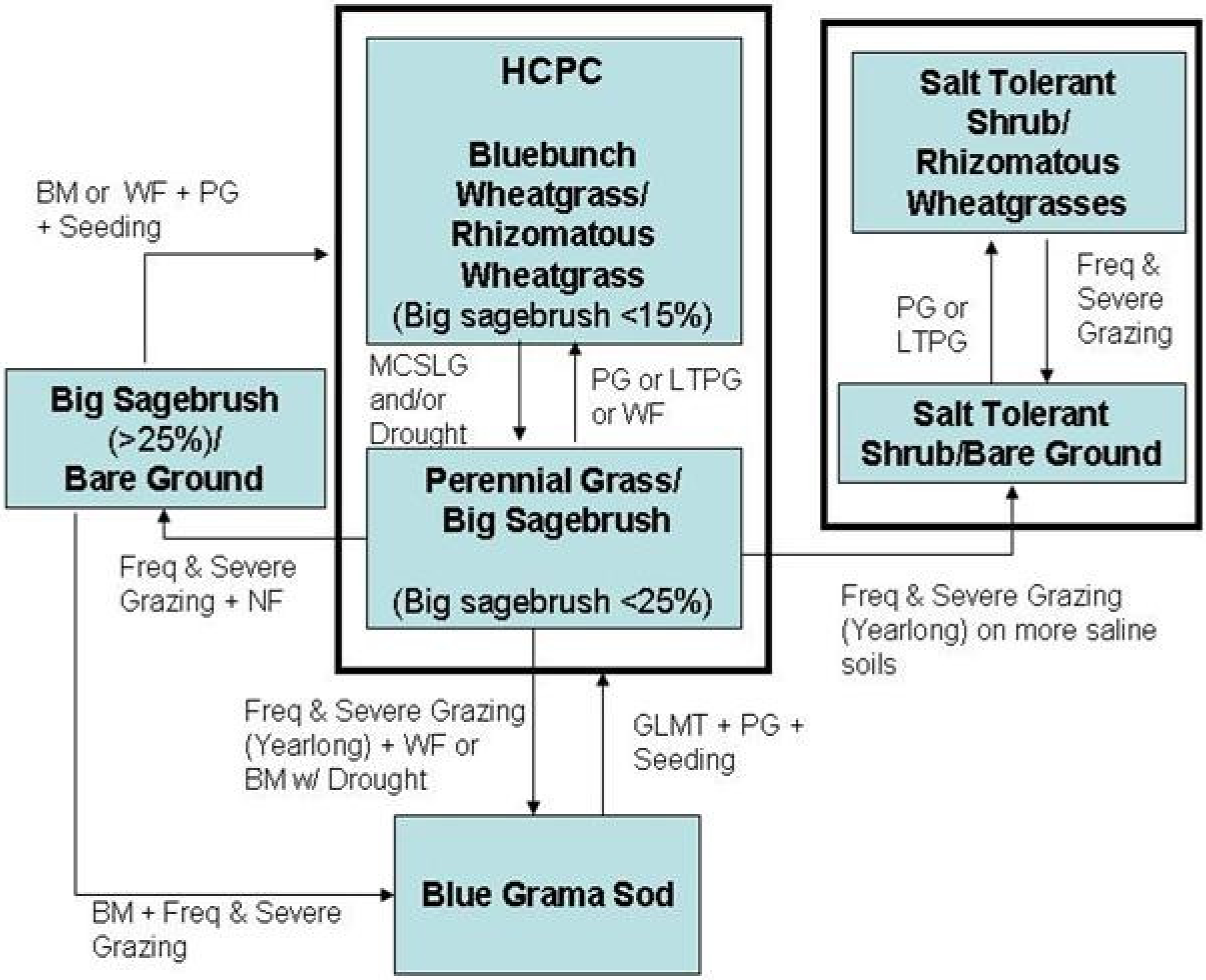
Kirby Creek
4/28/10
Site #7
Loamy/Clayey
Looking North



Kirby Creek
4/28/10
Site #7
Loamy/Clayey
Looking South

Site Type: Rangeland
MLRA: 32 – Northern Intermountain Desertic Basins

Loamy 10-14" E
032XY322WY



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-term 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)
WF - Wildfire (Natural or Human Caused)

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 4/28/10 **LOCATION - #43**

SITE - Clayey site **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Western wheatgrass		10	10	X						
Cheatgrass brome		20				X				
Bottlebrush squirreltail		3	3	X						
Prairie junegrass		11	5		X					
Sandberg bluegrass		10	5		X					
Needleandthread		10	5	X						
FORBS:										
Hood phlox		3	3		X					
Tansy		10	5		X					
Filaree		3				X				
SHRUBS:										
Pricklypear cactus		5				X				
Wyoming big sagebrush		15	10		X					
	TOTALS	100	46				50	10		

The plant community indicates a departure from HCPC. Water development is necessary to distribute livestock more evenly and to facilitate planned grazing as a method to improve Range Condition.

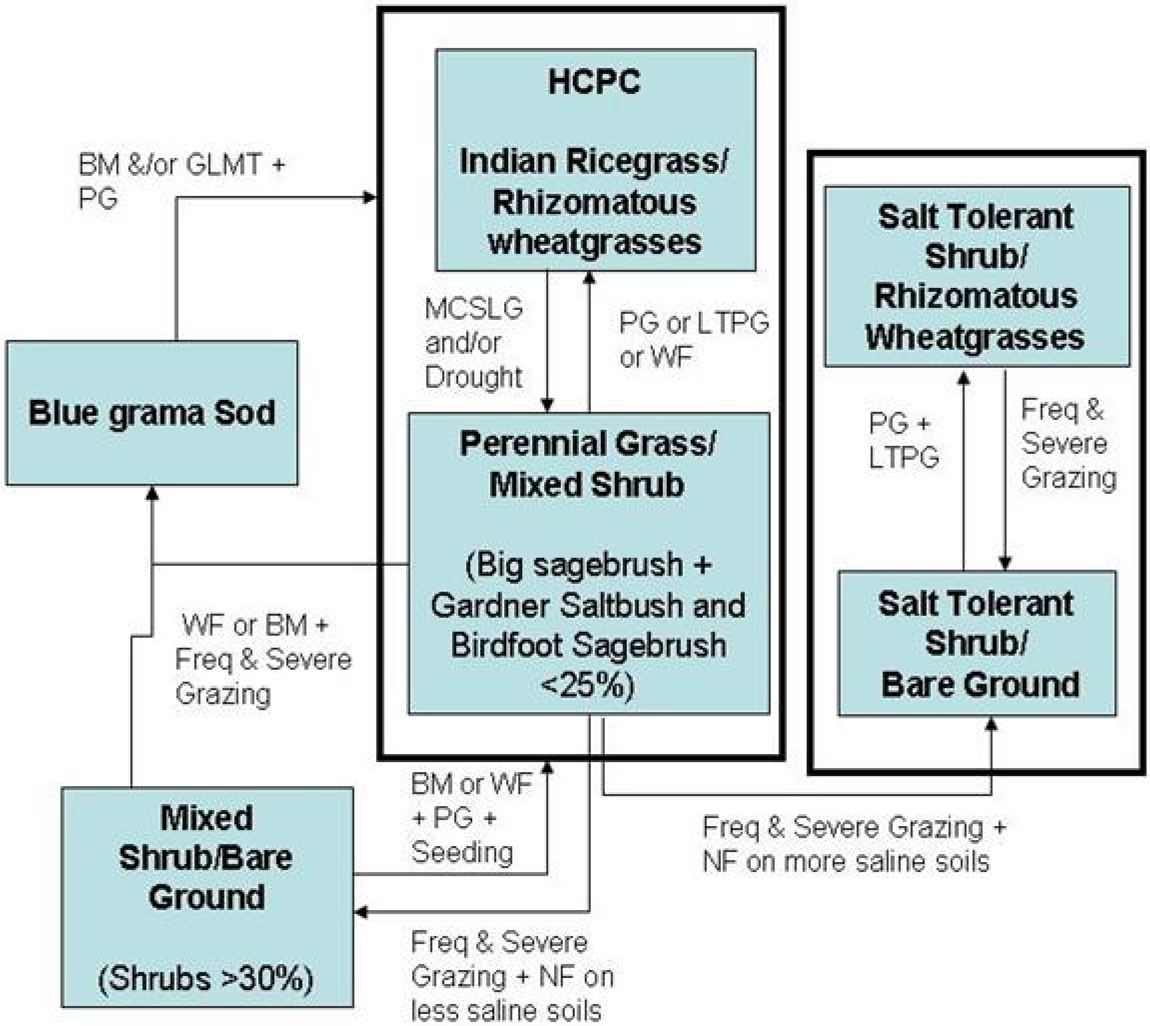
Kirby Creek
4/28/10
Site #43 - Clayey
Before Grazing

Kirby Creek
4/28/10
Site #43 - Clayey
Looking North

Kirby Creek
4/28/10
Site #43 - Clayey
Looking South

Site Type: Rangeland
MLRA: 32 – Northern Intermountain Desertic Basins

Clayey 10-14" E
032XY304WY



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-term 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)
WF - Wildfire (Natural or Human Caused)

Technical Guide
Section IIE

USDA-NRCS
Rev. 11-01-05

RANGE SITE AND CONDITION GUIDE

INVENTORY WORKSHEET

DATE - 6/25/10 **LOCATION - #63**

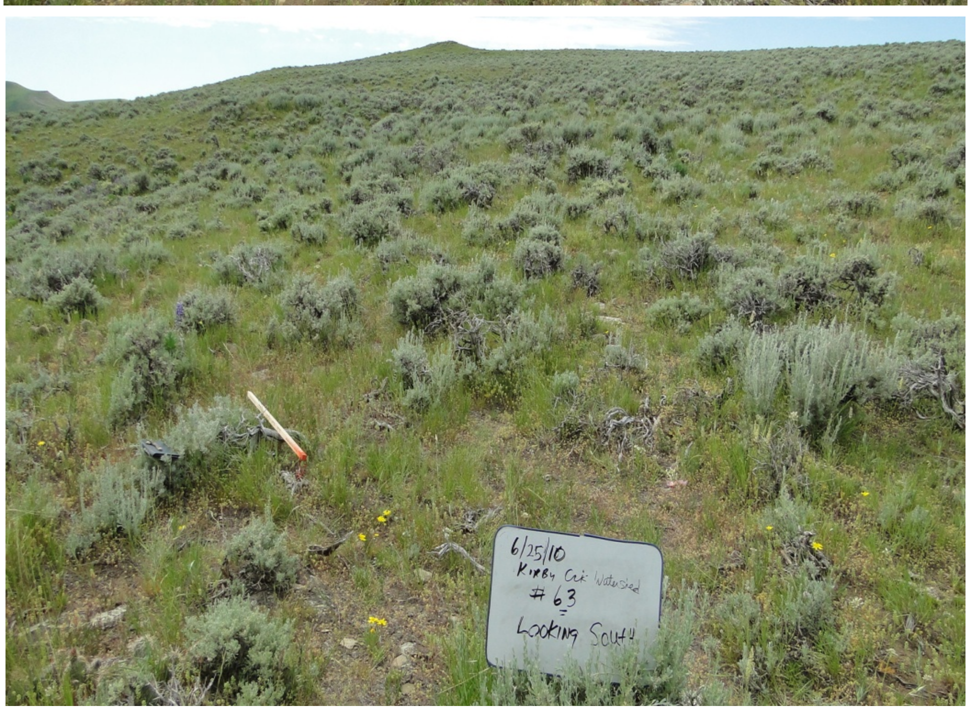
SITE - Shallow Loamy site **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Prairie junegrass		8	5		X					
Bluebunch wheatgrass		15	15	X						
Canby bluegrass		9	5	X						
Threadleaf sedge		6	5		X					
Needleandthread		11	10		X					
FORBS:										
Hood phlox		3	3		X					
Lupine		2	2		X					
Fanweed		4	2		X					
Bitterroot		2	2	X						
Cutleaf balsamroot		2	2	X						
Vetch		2	2	X						
Sunflower		1	1		X					
SHRUBS:										
Wyoming big sagebrush		30	10		X					
Rubber rabbitbrush		5	5		X					
	TOTALS	100	69				20	10	10	

The plant community indicates a moderate departure from Historic Climax plant community (HCPC).
Deferred and or rest during sensitive stages of plant growth would enhance the sustainability of the site.
Upland water development should aid in livestock distribution.

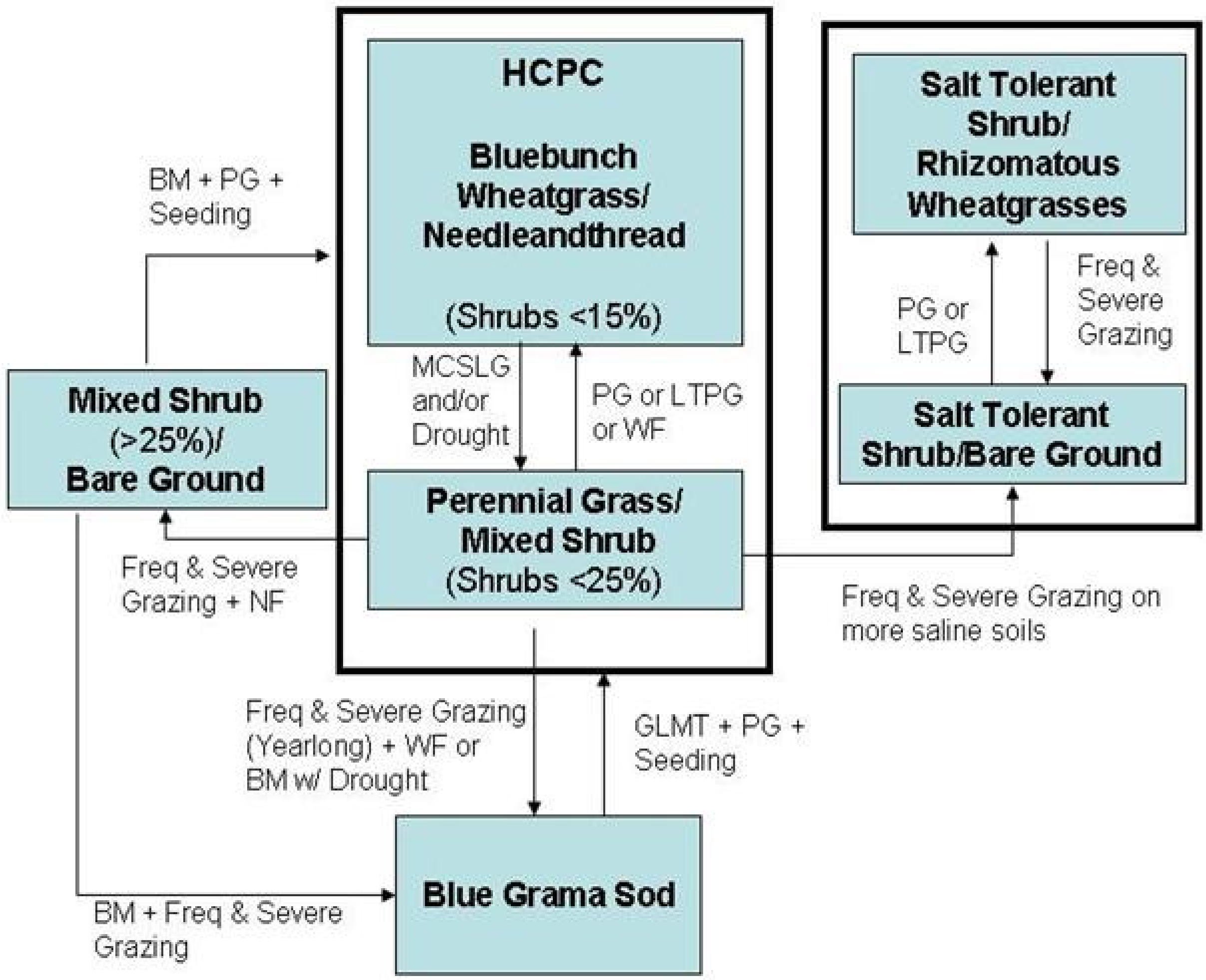
Kirby Creek
6/25/10
Site #63
Shallow Loamy
Before Grazing

Kirby Creek
6/25/10
Site #63
Shallow Loamy
Looking North



Kirby Creek
6/25/10
Site #63
Shallow Loamy
Looking South

Site Type: Rangeland **Shallow Loamy 10-14" E**
MLRA: 32 – Northern Intermountain Desertic Basins **032XY362WY**



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-term 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)
WF - Wildfire (Natural or Human Caused)

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 4/27/10 **LOCATION - #66**

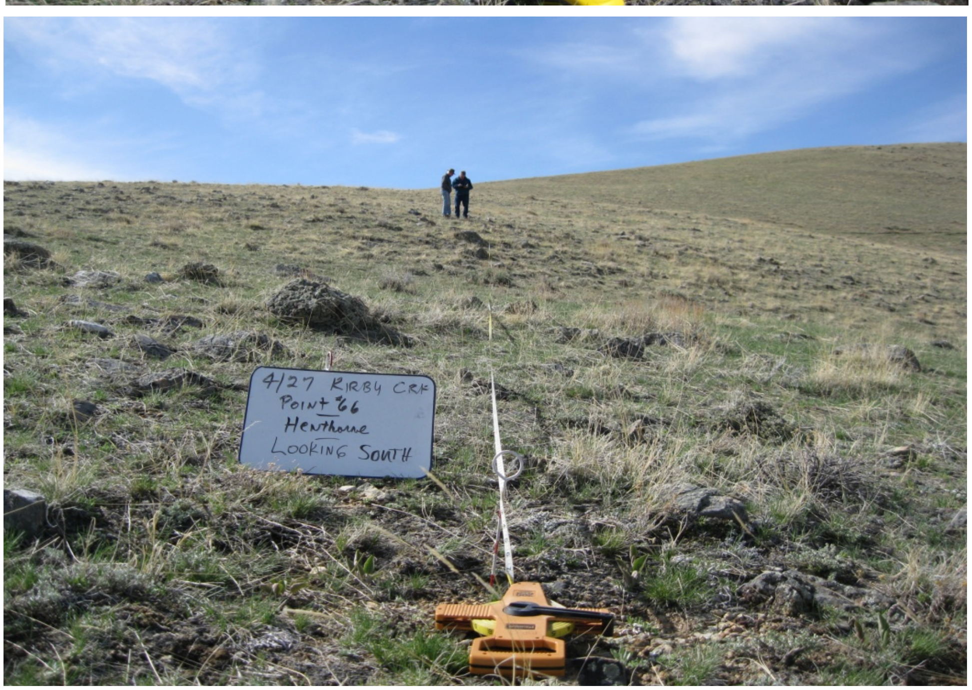
SITE - Shallow Loamy / Gravely site **PZ - 15 - 19"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Bluebunch wheatgrass		15	15	X						
Sandberg bluegrass		15	5		X					
Prairie junegrass		10	5		X					
Idaho fescue		10	10		X					
Thickspike wheatgrass		5	5	X						
Needleandthread		5	5		X					
FORBS:										
Clubmoss		T			X					
Lupine		5	3		X					
Buckwheat		5	5	X						
Hood phlox		10	5		X					
Onion		1	1	X						
Violet		1	1		X					
SHRUBS:										
Wyoming big sagebrush		15	10		X					
Rubber rabbitbrush		3	3		X					
	TOTALS	100	73				6	7		

The plant community indicates a Historic Climax Plant Community status. Continued sustainable grazing management is recommended.

Kirby Creek
4/27/10
Site #66 - Shallow Loamy
Before Grazing

Kirby Creek
4/27/10
Site #66 - Shallow Loamy
Looking North

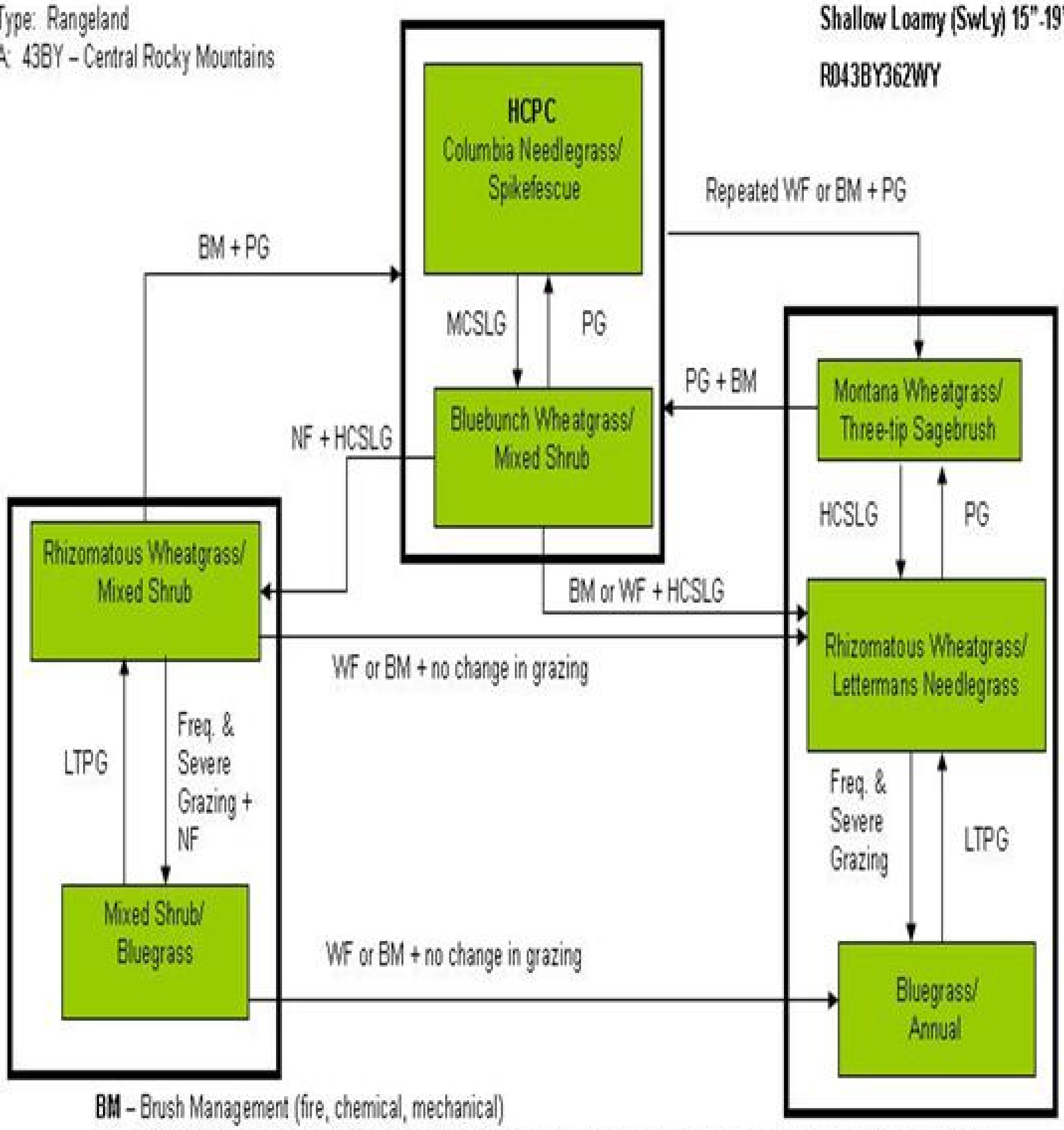


Kirby Creek
4/27/10
Site #66 - Shallow Loamy
Looking South

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Shallow Loamy (SwLy) 15"-19" East P.Z.

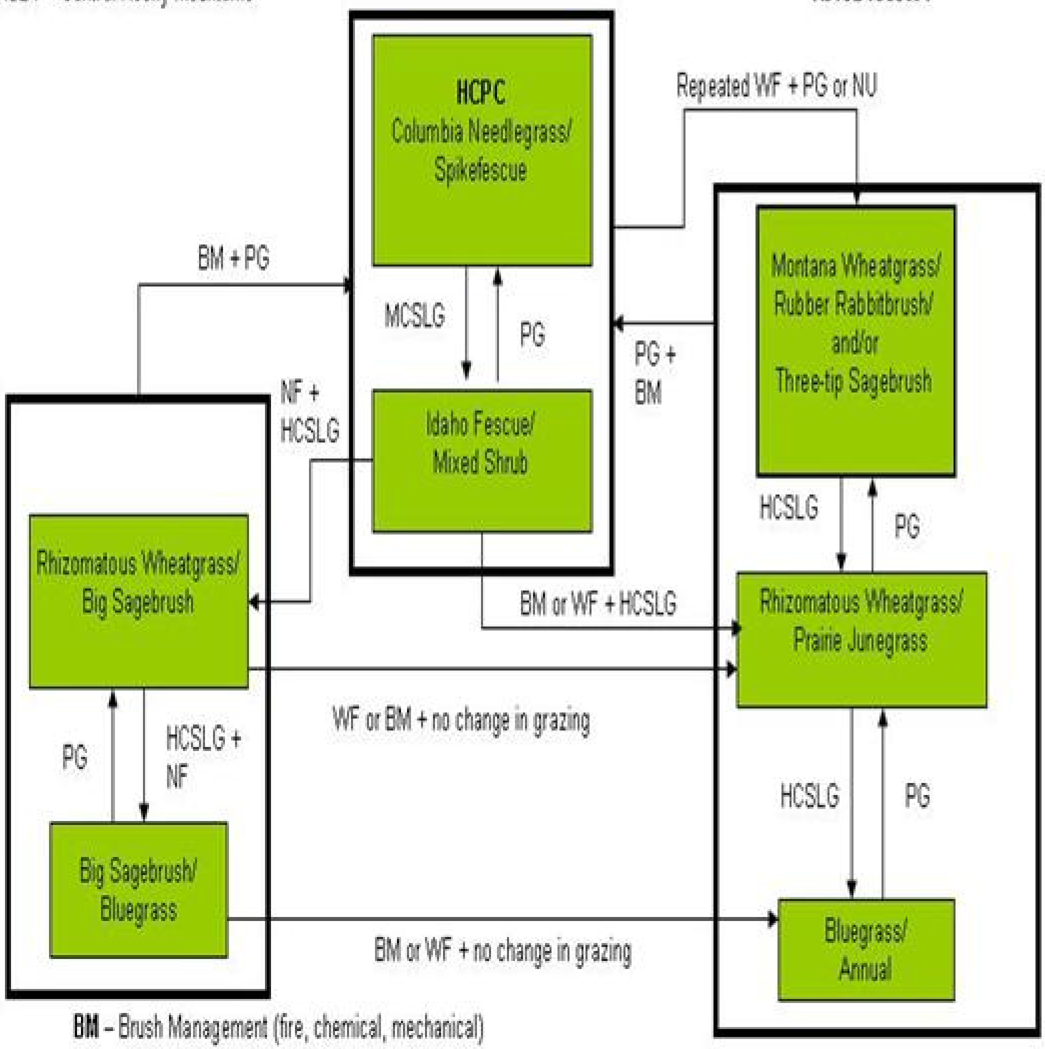
R043BY362WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF – Wildfire

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Coarse Upland (CU) 15"-19" East P.Z.
R043BY308WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF - Wildfire

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

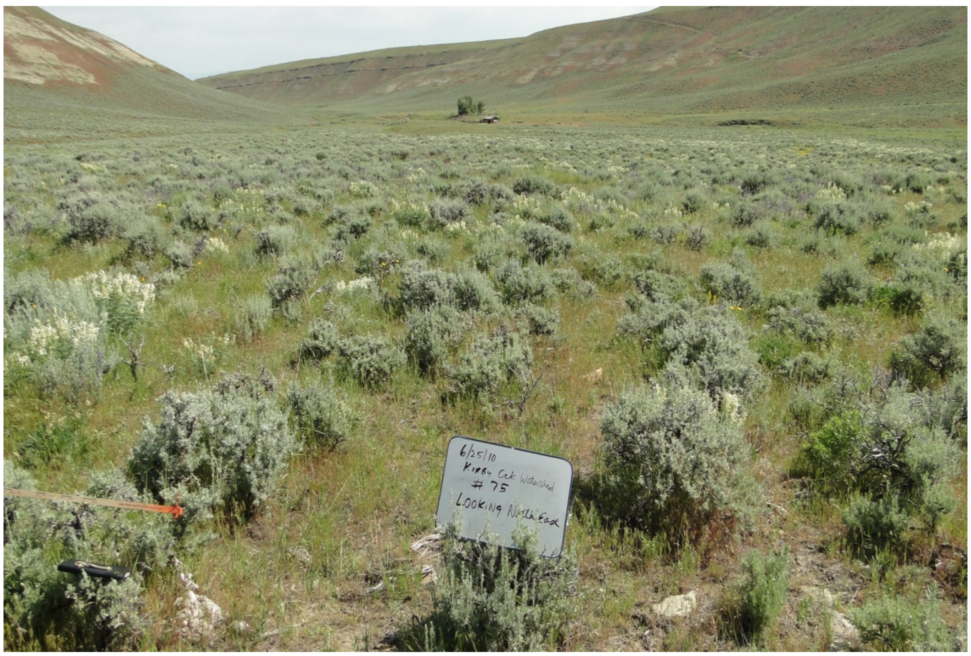
DATE - 6/25/10 **LOCATION - #75**

SITE - Loamy site **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Cheatgrass		39				X				
Thickspike wheatgrass		10	10	X						
Sandberg bluegrass		4	4	X						
Prairie junegrass		T		X						
Green needlegrass		3	3	X						
FORBS:										
Pale agoseris		1	1		X					
Lupine		2	2		X					
Milkvetch		1	1		X					
Gromwell		1	1		X					
SHRUBS:										
Wyoming big sagebrush		38	15		X					
Rubber rabbitbrush		1			X					
	TOTALS	100	37				6	3		

Departure from HCPC because of Sagebrush dominance. Suggested management Alternatives - Brush management, Controlled burn, planned grazing systems, improved water distribution and water developments.

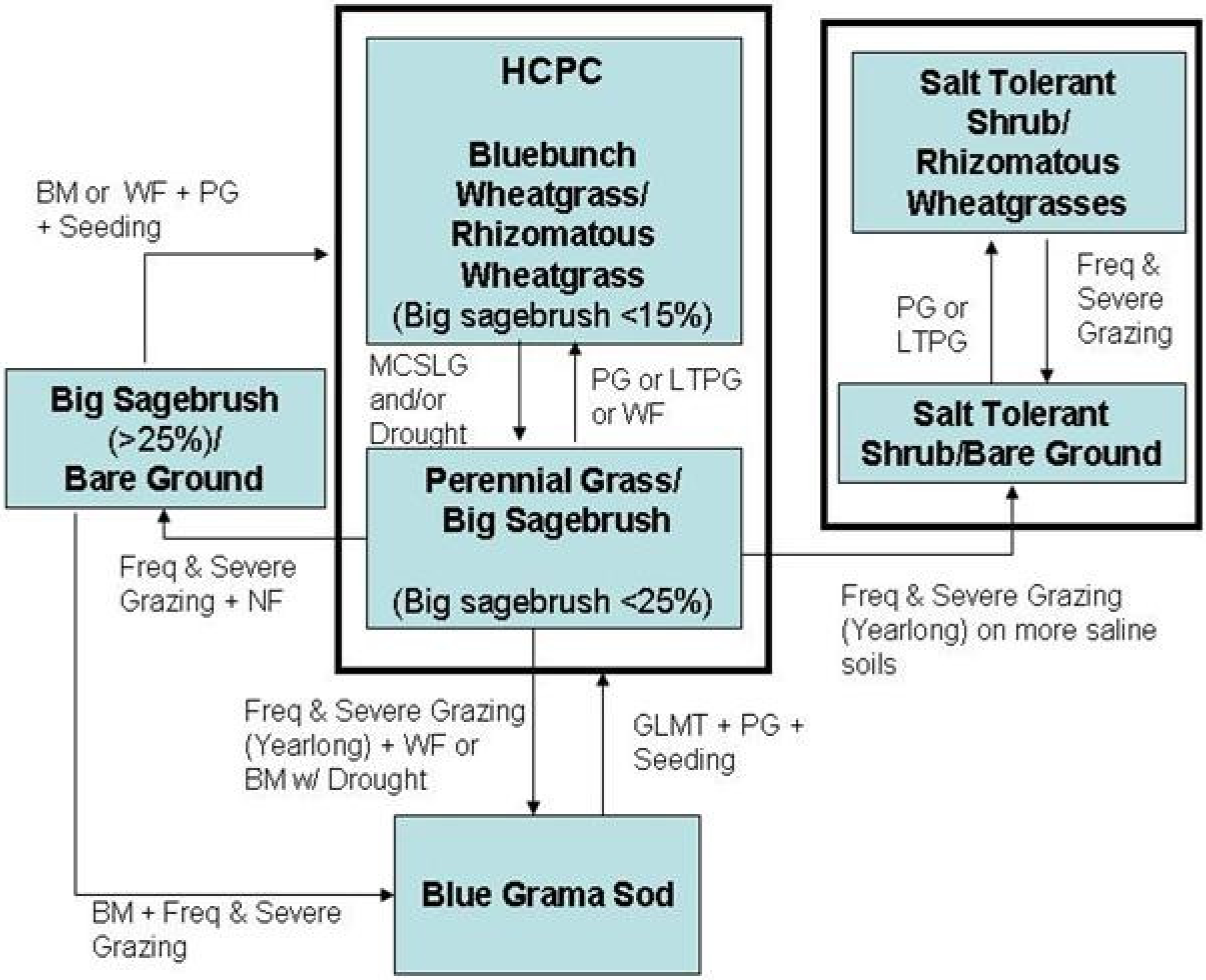
Kirby Creek
6/25/10
Site #75
Loamy
Before Grazing



Kirby Creek
6/25/10
Site #75
Loamy
Looking North

Kirby Creek
6/25/10
Site #75
Loamy
Looking Southwest

Site Type: Rangeland **Loamy 10-14" E**
MLRA: 32 – Northern Intermountain Desertic Basins **032XY322WY**



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-term 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)
WF - Wildfire (Natural or Human Caused)

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 4/28/10 **LOCATION - #79**

SITE - Loamy site **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Sandberg bluegrass		15	5	X						
Prairie junegrass		10	5	X						
Cheatgrass		10				X				
Bluegramma		15	5		X					
Threadleaf sedge		6	5		X					
Western wheatgrass		6	6	X						
FORBS:										
Wild onion		1	1	X						
Biscuitroot		1	1		X					
Violet		1	1	X						
Hood phlox		1	1		X					
Salsify		1				X				
Paintbrush		1	1		X					
Lupine		1	1		X					
Vetch		1	1	X						
SHRUBS:										
Pricklypear cactus		5			X					
Wyoming big sagebrush		20	20		X					
Rubber rabbitbrush		5	5		X					
	TOTALS	100	58				50	T		

The plant community composition represents a slight departure from Historic Plant Community Condition (HCPC). Continued range improvement practices will be beneficial such as grazing rotations that include rest from grazing during the critical growing season periods.

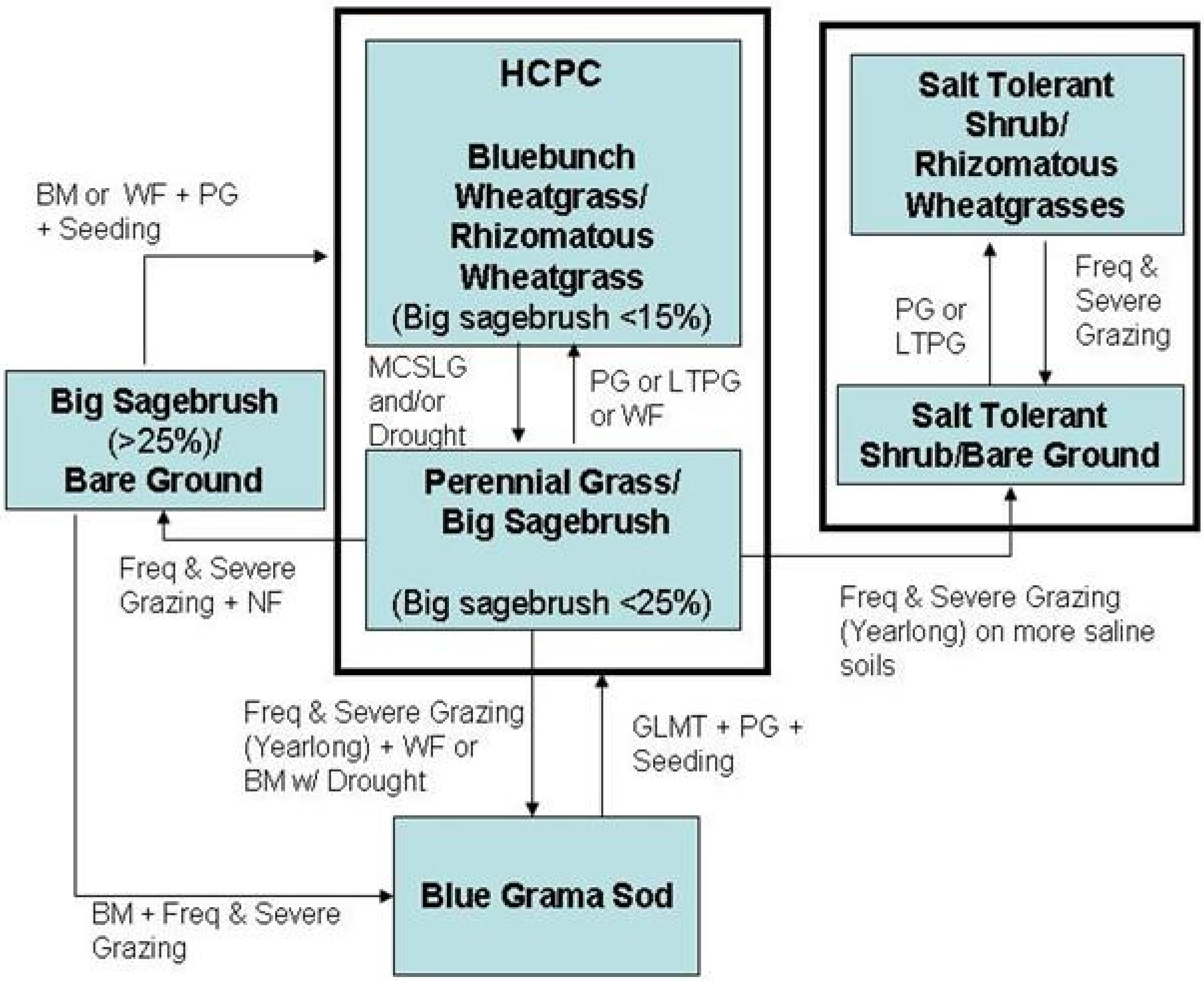
Kirby Creek
4/28/10
Site #79 - Loamy
Before Grazing

Kirby Creek
4/28/10
Site #79 - Loamy
Looking North

Kirby Creek
4/28/10
Site #79 - Loamy
Looking South

Site Type: Rangeland
MLRA: 32 – Northern Intermountain Desertic Basins

Loamy 10-14" E
032XY322WY



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-term 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)
WF - Wildfire (Natural or Human Caused)

RANGE SITE AND CONDITION GUIDE

INVENTORY WORKSHEET

DATE - 4/28/10 **LOCATION - #84**

SITE - Loamy **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Western wheatgrass		30	25	X						
Sandberg bluegrass		15	5		X					
Cheatgrass		2				X				
Blue gramma		5	5		X					
Prairie junegrass		10	5		X					
Indian ricegrass		1	1	X						
Needleandthread		5	5		X					
Threadleaf sedge		4	4	X						
FORBS:		15								
Western yarrow			2		X					
Paintbrush			1		X					
Violet			1		X					
Hood plox			2		X					
Biscuitroot			1		X					
Buckwheat			1	X						
SHRUBS:										
Pricklypear cactus		1			X					
Wyoming big sagebrush		10	10		X					
Rubber rabbitbrush		2	2		X					
	TOTALS	100	70				40	2		

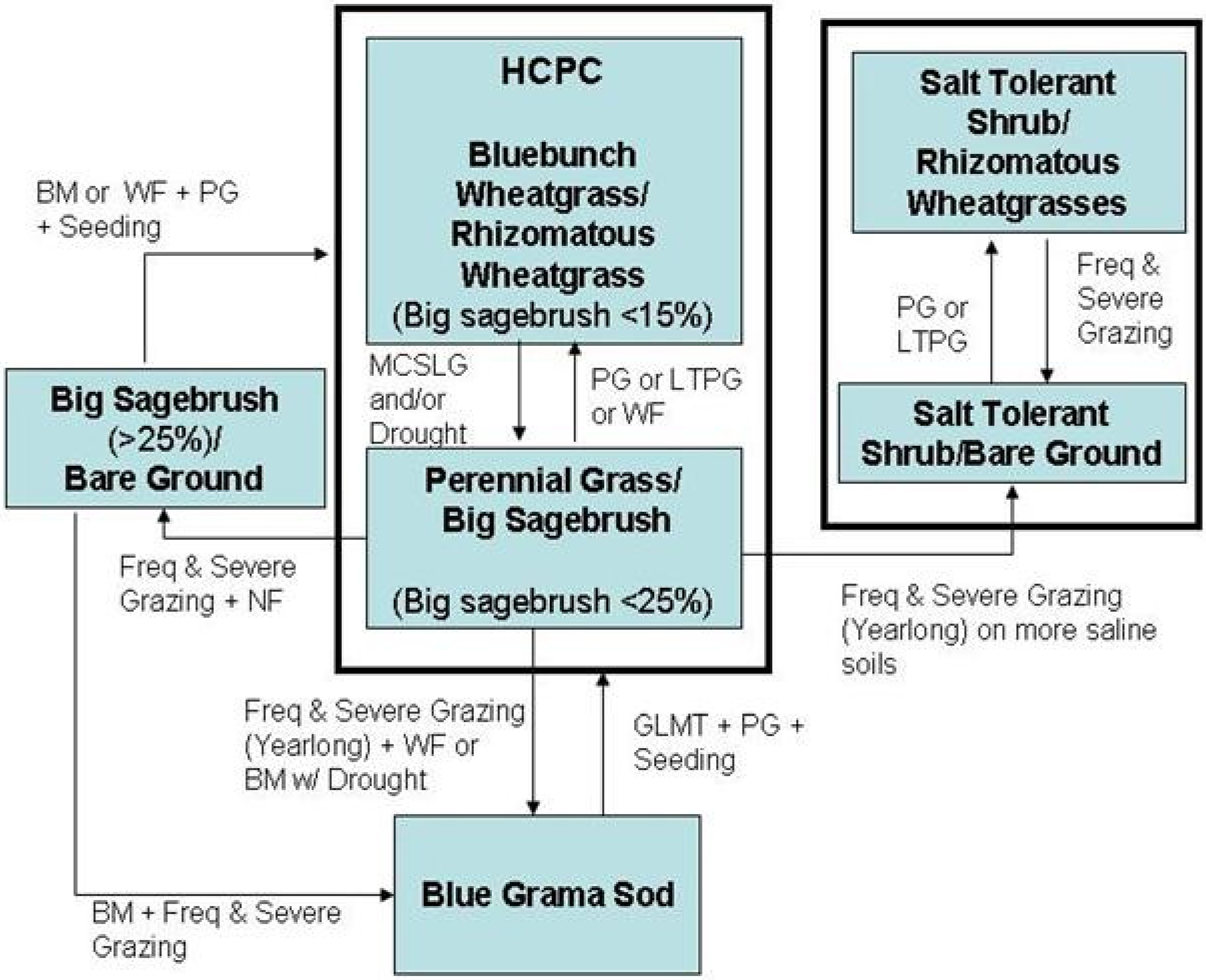
This site is on the borderline of meeting HCPC requirements. Continued planned grazing practice that recognizes plant needs during the growing season (April- May) are essential in the maintaining sustainability

Kirby Creek
4/28/10
Site #84 - Loamy
Before Grazing

Kirby Creek
4/28/10
Site #84 - Loamy
Looking North

Kirby Creek
4/28/10
Site #84 - Loamy
Looking South

Site Type: Rangeland **Loamy 10-14" E**
MLRA: 32 – Northern Intermountain Desertic Basins **032XY322WY**



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-term 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)
WF - Wildfire (Natural or Human Caused)

RANGE SITE AND CONDITION GUIDE

INVENTORY WORKSHEET

DATE - 6/25/10 **LOCATION - #89**

SITE - Loamy site **PZ - 15 - 19"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Bluebunch wheatgrass		2	2	X						
Sandberg bluegrass		3	3	X						
Thickspike wheatgrass		25	25	X						
Cheatgrass		12				X				
FORBS:										
Arrowleaf balsamroot		1	1		X					
Hood phlox		1	1		X					
Violet		2	2	X						
Lupine		2	2		X					
Fringed sagewort		1	1		X					
Dandelion		2				X				
Buckwheat		1	1	X						
SHRUBS:										
Wyoming big sagebrush		35	15		X					
Rubber rabbitbrush		5	5		X					
Snowberry		3	3	X						
Greenleaf rabbitbrush		5			X					
	TOTALS	100	61							

Departure from HCPC because of Sagebrush dominance. Suggested management Alternatives - Brush management, Controlled burn, planned grazing systems, improved water distribution and water developments.

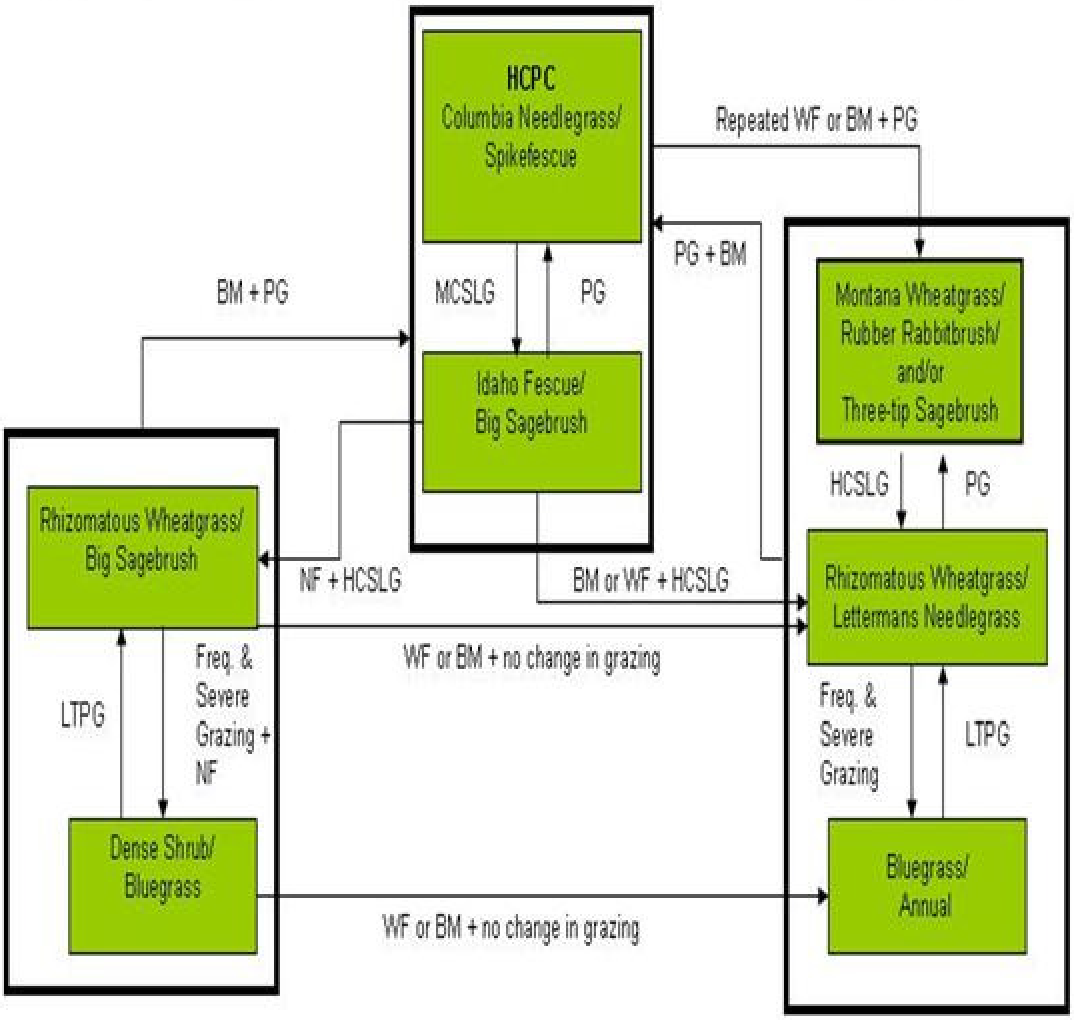
Kirby Creek
6/25/10
Site #89
Loamy
Before Grazing

Kirby Creek
6/25/10
Site #89
Loamy
Looking North

Kirby Creek
6/25/10
Site #89
Loamy
Looking South

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Loamy (Ly) 15"-19" East P.Z.
R043BY322WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF – Wildfire

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 4/27/10 **LOCATION - #92**

SITE - Shallow Loamy site **PZ - 15 - 19"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Western wheatgrass		25	20	X						
Sandberg bluegrass		20	5		X					
Cheatgrass		5				X				
Blue gramma		1	1		X					
Prairie junegrass		5	3		X					
Idaho fescue		1	1		X					
Green needlegrass		5	5	X						
FORBS:										
Western yarrow		8	2		X					
Dandelion		2	1			X				
Violet		2	2		X					
Hood plox		1	1		X					
Lupine		4	2		X					
Mustard		1	1		X					
SHRUBS:										
Pricklypear cactus					X					
Wyoming big sagebrush		20	10		X					
	TOTALS	100	54				10	10		

The plant community indicates a moderate departure from Historic Climax plant community (HCPC). Deferment and or rest during sensitive stages of plant growth would enhance the sustainability of the site. Improvement in range condition would be apparent in a few years. Upland water development should assist with livestock distribution.

Kirby Creek
4/27/10
Site #92 - Shallow Loamy
Before Grazing

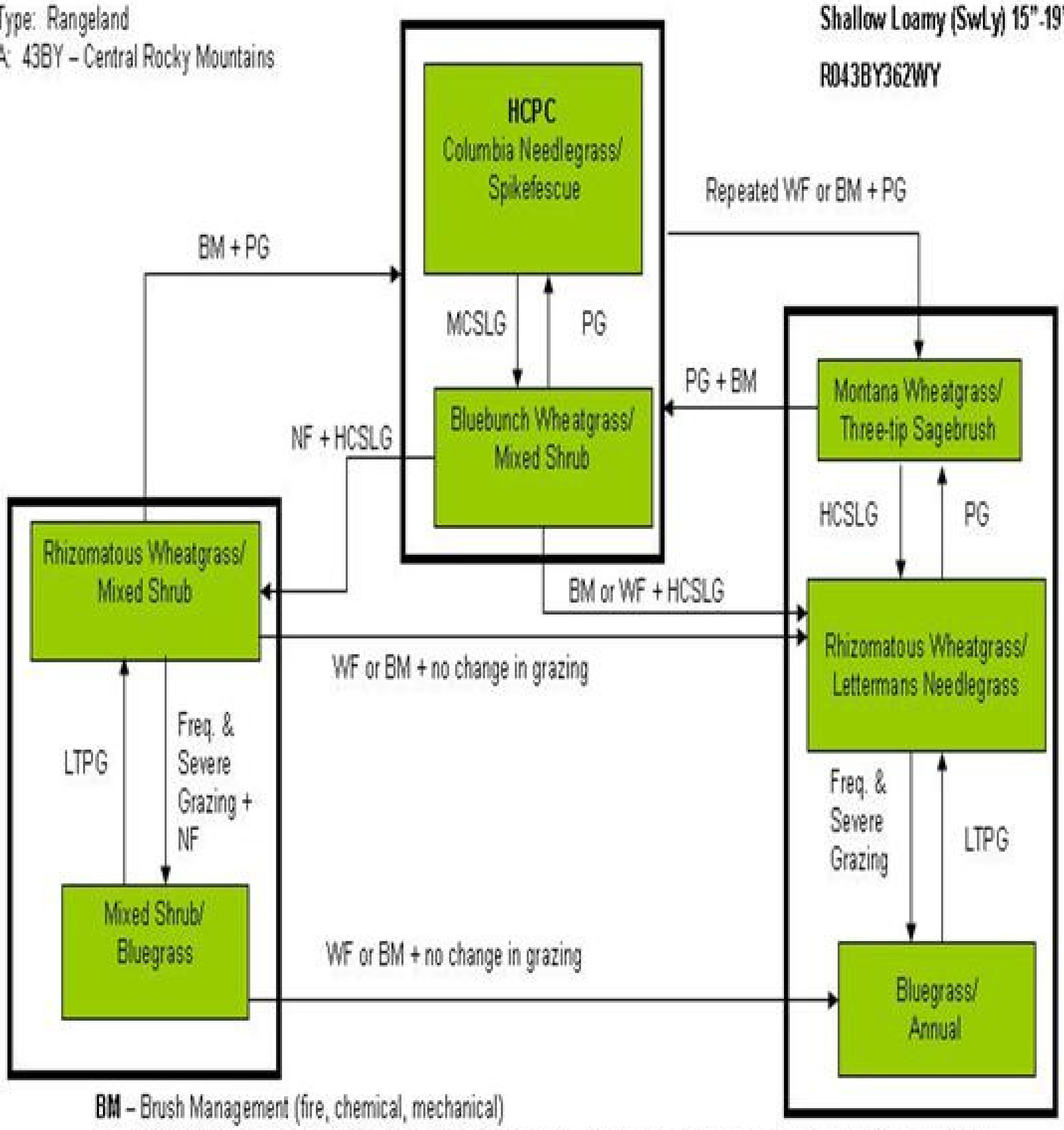
Kirby Creek
4/27/10
Site #92 - Shallow Loamy
Looking North

Kirby Creek
4/27/10
Site #92 - Shallow Loamy
Looking South

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Shallow Loamy (SwLy) 15"-19" East P.Z.

R043BY362WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF – Wildfire

RANGE SITE AND CONDITION GUIDE

INVENTORY WORKSHEET

DATE - 4/27/10 **LOCATION - #103**

SITE - Loamy site **PZ - 15 - 19"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Western wheatgrass		25	20	X						
Sandberg bluegrass		15	10		X					
Cheatgrass		T				X				
Bluebunch wheatgrass		10	10	X						
Needleandthread		8	5		X					
FORBS:										
Knotweed						X				
Hood phlox		2	2		X					
Violet		1	1	X						
Lupine		2	2		X					
Mullen		1	1		X					
Fringed sagewort		2	2		X					
Buttercup		2	2	X						
SHRUBS:										
Pricklypear cactus		1			X					
Wyoming big sagebrush		13	5		X					
Three tip sagebrush		3	3		X					
Rubber rabbitbrush		10	5		X					
	TOTALS	95	68				5	10		

Plant community and Range Condition indicates a slight departure from Historic Climax plant community (HCPC).
Continued grazing as done in the past will sustain the integrity of the site.
Additional water development is always beneficial in promoting livestock distribution.

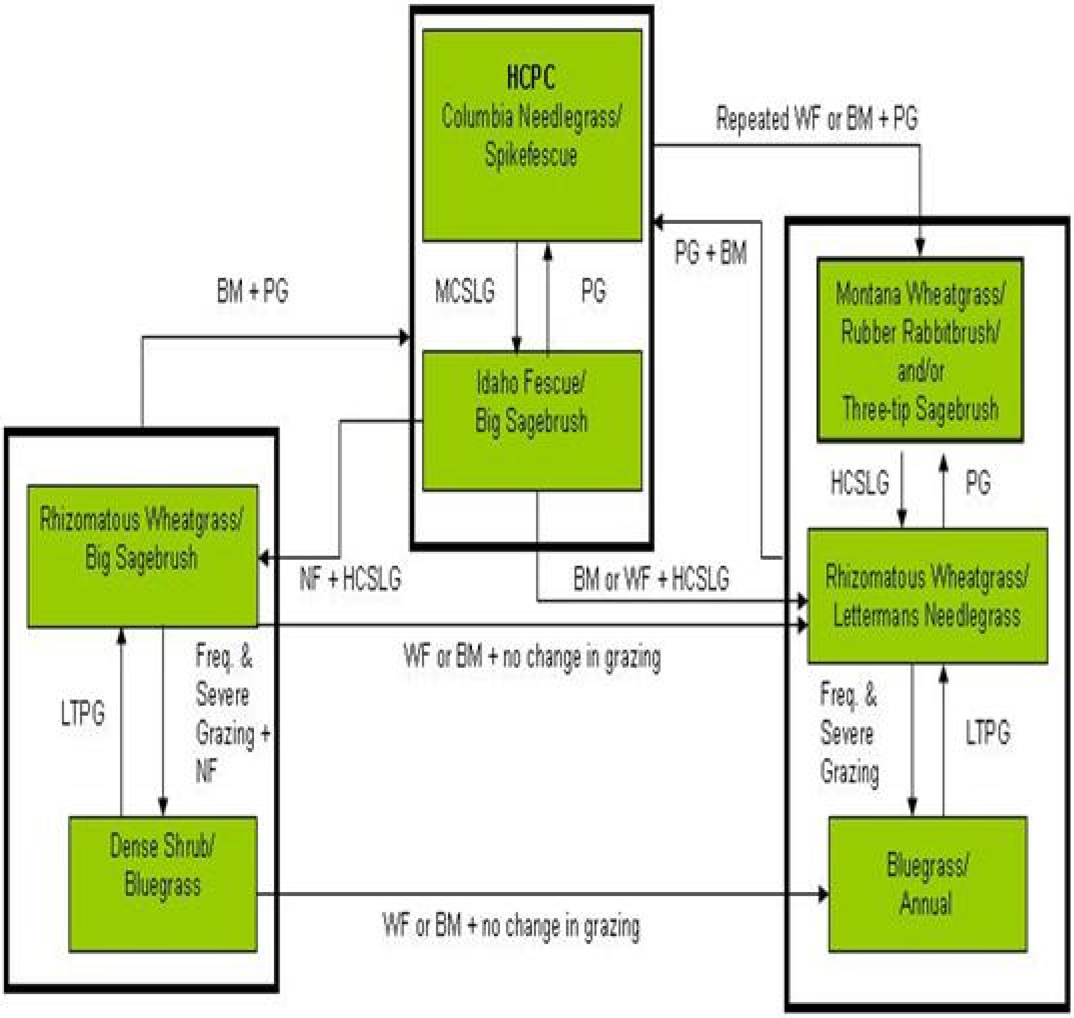
Kirby Creek
4/27/10
Site #103 - Loamy
Before Grazing

Kirby Creek
4/27/10
Site #103 - Loamy
Looking North

Kirby Creek
4/27/10
Site #103 - Loamy
Looking South

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Loamy (Ly) 15"-19" East P.Z.
R043BY322WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF – Wildfire

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 4/28/10 **LOCATION - #105**

SITE - Shallow Loamy **PZ - 15 - 19"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Bluebunch wheatgrass		15	15	X						
Green needlegrass		5	5	X						
Cheatgrass		5				X				
Sandberg bluegrass		15	5		X					
Prairie junegrass		10	5		X					
Thickspike wheatgrass		15	10	X						
FORBS:										
Hood phlox		6	2		X					
Bluebell		1	1		X					
Biscuitroot		1	1		X					
Western yarrow		1	1		X					
Violet		1	1		X					
Paintbrush		1	1		X					
Scurfpea		1	1	X						
Lupine		1	1		X					
Low larkspur		1	1		X					
SHRUBS:										
Green rabbitbrush		4	2		X					
Wyoming big sagebrush		17	15		X					
	TOTALS	100	67				5	15		

This site is within the HCPC status. Continued planned grazing measures (periodic rest and deferment May and June) will sustain the site plant community. Additional water development may be useful.

Kirby Creek
4/28/10
Site #105 - Shallow Loamy
Before Grazing

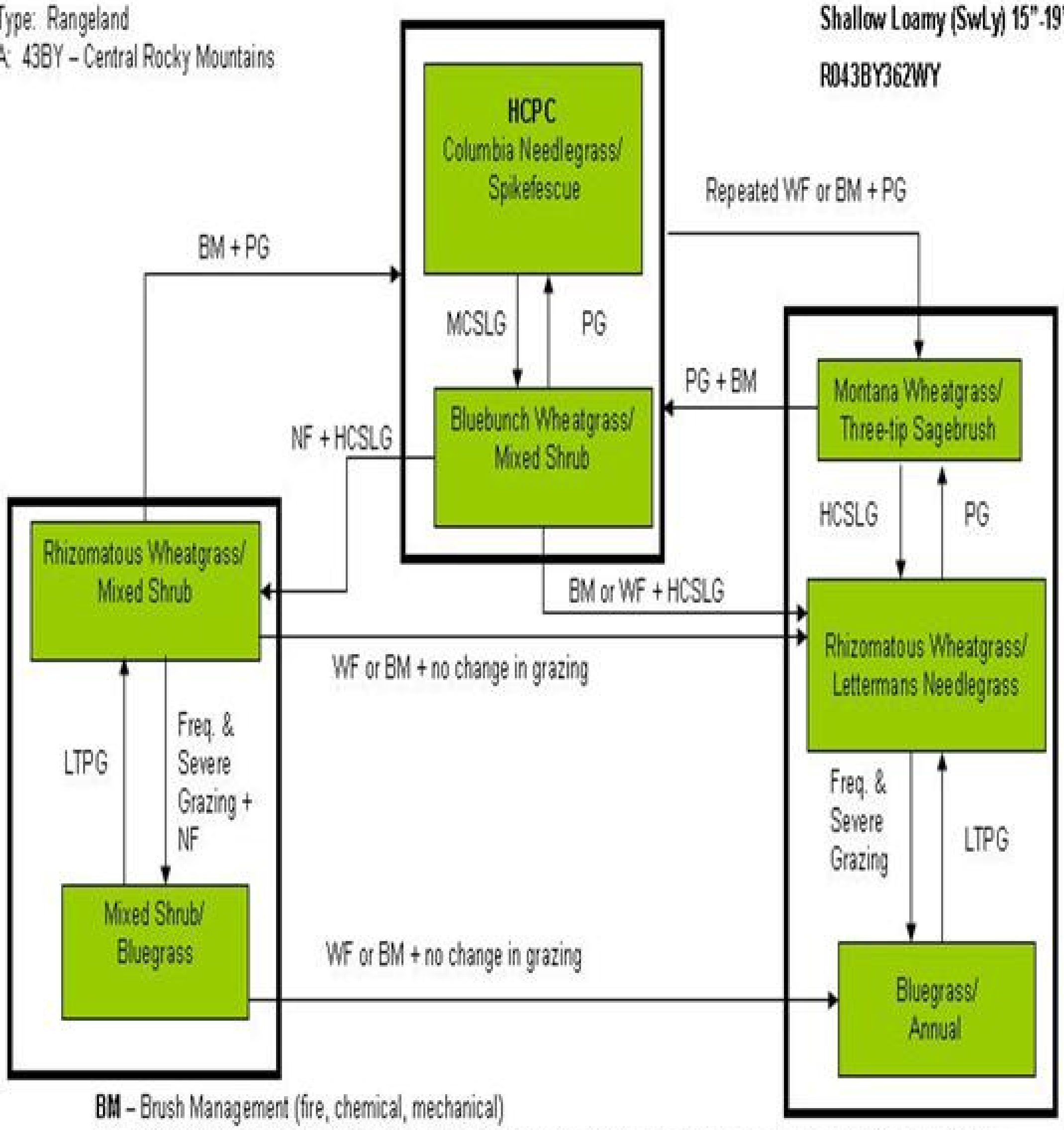
Kirby Creek
4/28/10
Site #105 - Shallow Loamy
Looking North

Kirby Creek
4/28/10
Site #105 - Shallow Loamy
Looking South

Site Type: Rangeland
MLRA: 43BY – Central Rocky Mountains

Shallow Loamy (SwLy) 15"-19" East P.Z.

R043BY362WY



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-term Prescribed Grazing
MCSLG – Moderate, Continuous Season-long Grazing
HCSLG – Heavy, 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 – Moderate Sodium in Soil
WF – Wildfire

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 4/28/10 **LOCATION - #108**

SITE - Clayey/Saline upland **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Western wheatgrass		23	23	X						
Cheatgrass brome		10				X				
Sandberg bluegrass		20	5		X					
Prairie junegrass		5	5		X					
FORBS:										
Knot weed		2	2		X					
Violet					X					
Hood phlox		1	1		X					
Mustard		2	2		X					
Mullen		2			X					
Lichen		T			X					
SHRUBS:										
Wyoming big sagebrush		25	10		X					
Greasewood		10	5		X					
	TOTALS	100	53				3	10		

This site is a mixture of Clayey and Saline Upland soils. It is difficult to determine a dominant site, however, either way the plant community indicates a slight departure from Historic Climax Plant Community. This site and area could require rest deferred grazing through a planned Grazing System.
Water development to enhance better distribution would be Beneficial. The site will improve over time.

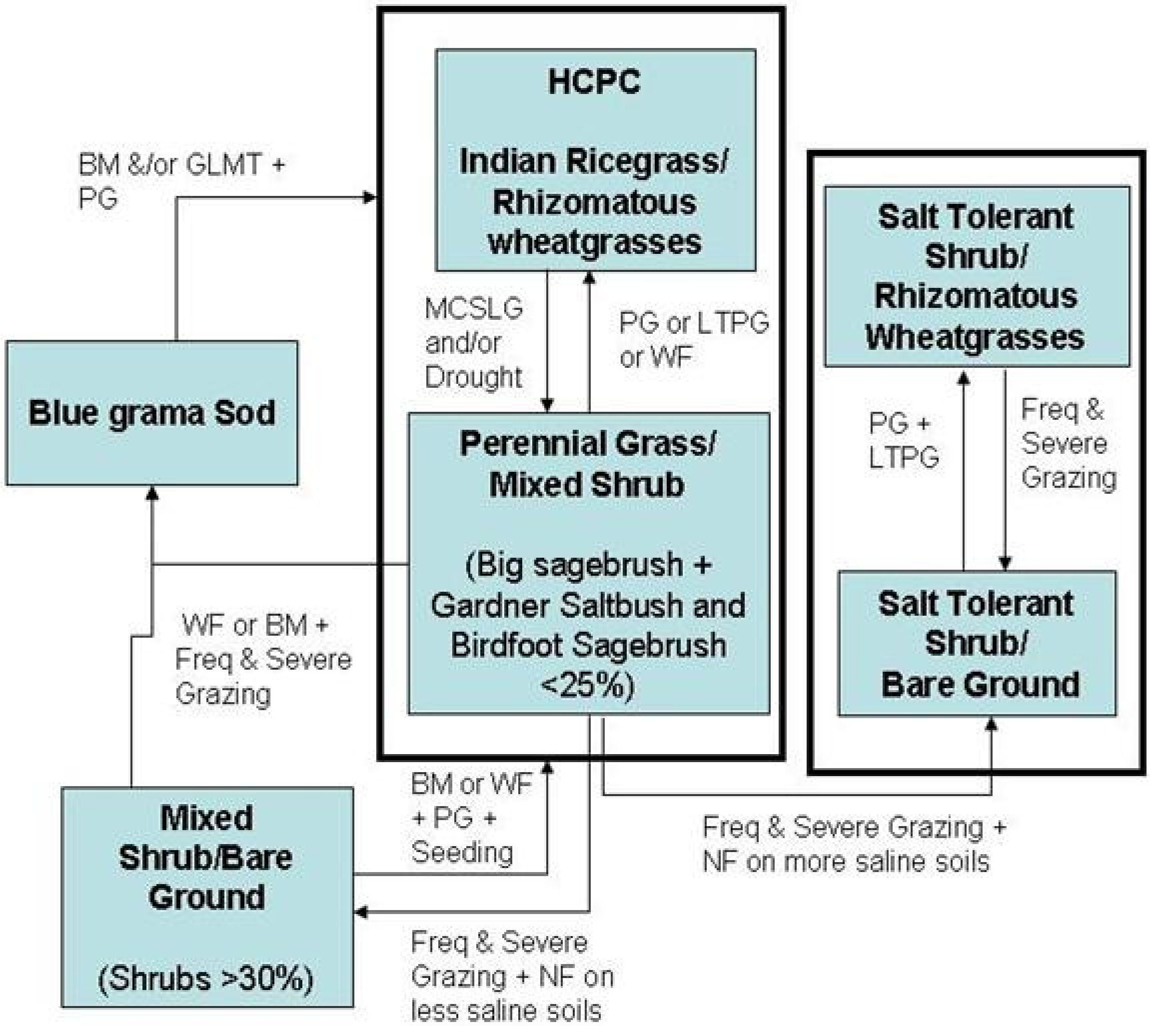
Kirby Creek
4/28/10
Site #108
Clayey-Saline Upland
Before Grazing

Kirby Creek
4/28/10
Site #108
Clayey-Saline Upland
Looking North

Kirby Creek
4/28/10
Site #108
Clayey-Saline Upland
Looking South

Site Type: Rangeland
MLRA: 32 – Northern Intermountain Desertic Basins

Clayey 10-14" E
032XY304WY



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-term 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)
WF - Wildfire (Natural or Human Caused)

Technical Guide
Section IIE

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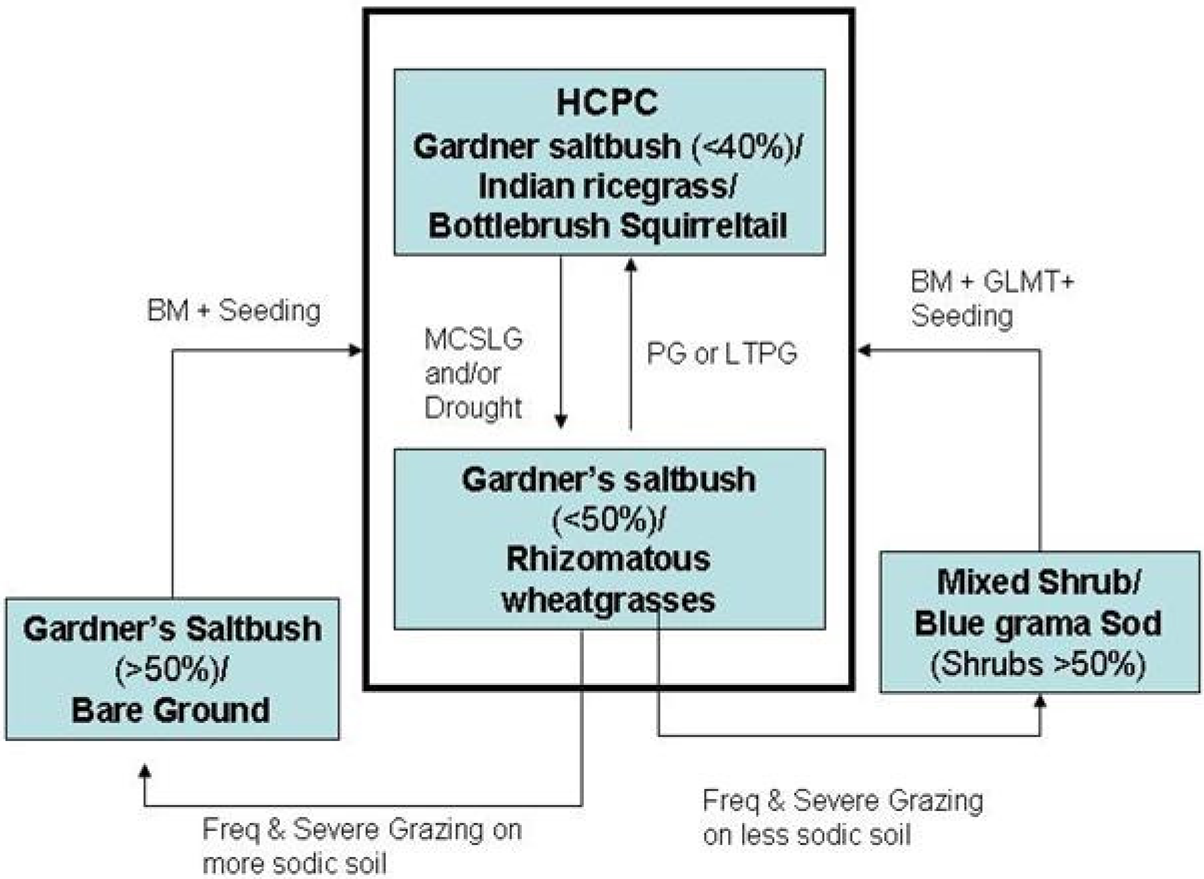
Rev. 11-01-05

Site Type: Rangeland
MLRA: 32 – Northern Intermountain Desertic Basins

Saline Upland 10-14” E
032XY344WY



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-term 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)
WF – Wildfire

RANGE SITE AND CONDITION GUIDE
INVENTORY WORKSHEET

DATE - 6/25/10 **LOCATION - #125**

SITE - Clayey **PZ - 10 - 14"**

Transect #1 PLANT COMPOSITION	% PRESENT	EST. POTENTIAL %	% TOWARD CONDITION	APPARENT RESPONSE TO GRAZING DEC	INC	INV	% BARE GROUND	% LITTER	% ROCK	VIGOR & TREND
GRASSES:										
Cheatgrass		50				X				
Western wheatgrass		5	5	X						
Sandberg bluegrass		2	2	X						
FORBS:										
Fanweed		5	5		X					
Sego lilly		1	1		X					
Woolly plantain		5	5		X					
Scarlet globemallow		1	1		X					
SHRUBS:										
Wyoming big sagebrush		30	10		X					
Pricklypear cactus		1			X					
	TOTALS	100	29							

This site location is to close to water to be representative of the area. Water has caused the concentration of grazing over many years. This site should be relocated to a more representative location (at least a half mile from water).

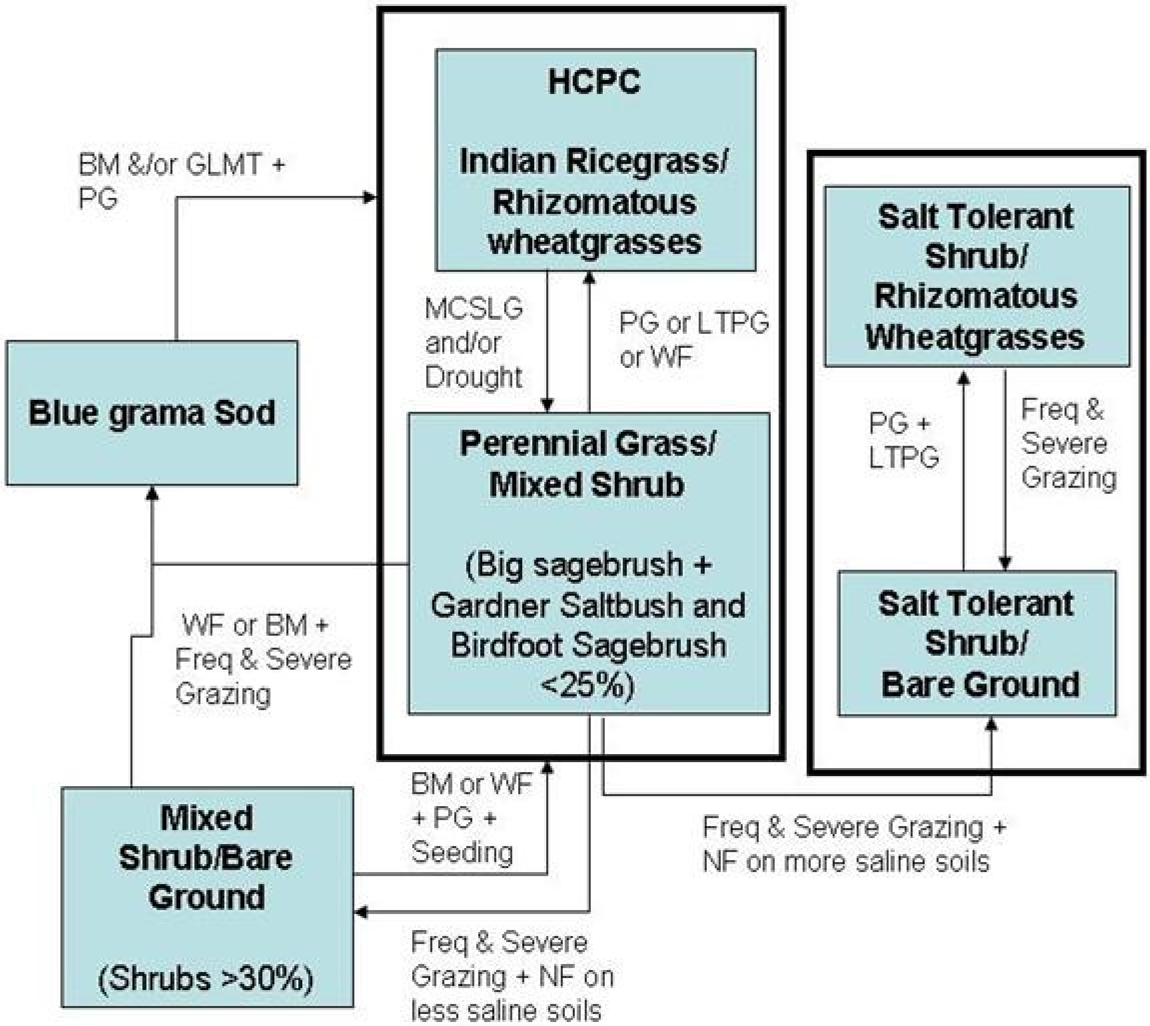
Kirby Creek
6/25/10
Site #125
Clayey
Before Grazing

Kirby Creek
6/25/10
Site #125
Clayey
Looking North

Kirby Creek
6/25/10
Site #125
Clayey
Looking West

Site Type: Rangeland
MLRA: 32 – Northern Intermountain Desertic Basins

Clayey 10-14" E
032XY304WY



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-term 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)
WF - Wildfire (Natural or Human Caused)

Appendix F

ROSGEN STREAM CLASSIFICATION SYSTEM

Kirby Creek Watershed Study, Hot Springs County, Wyoming

Figure 1. Rosgen Stream Classification Levels.

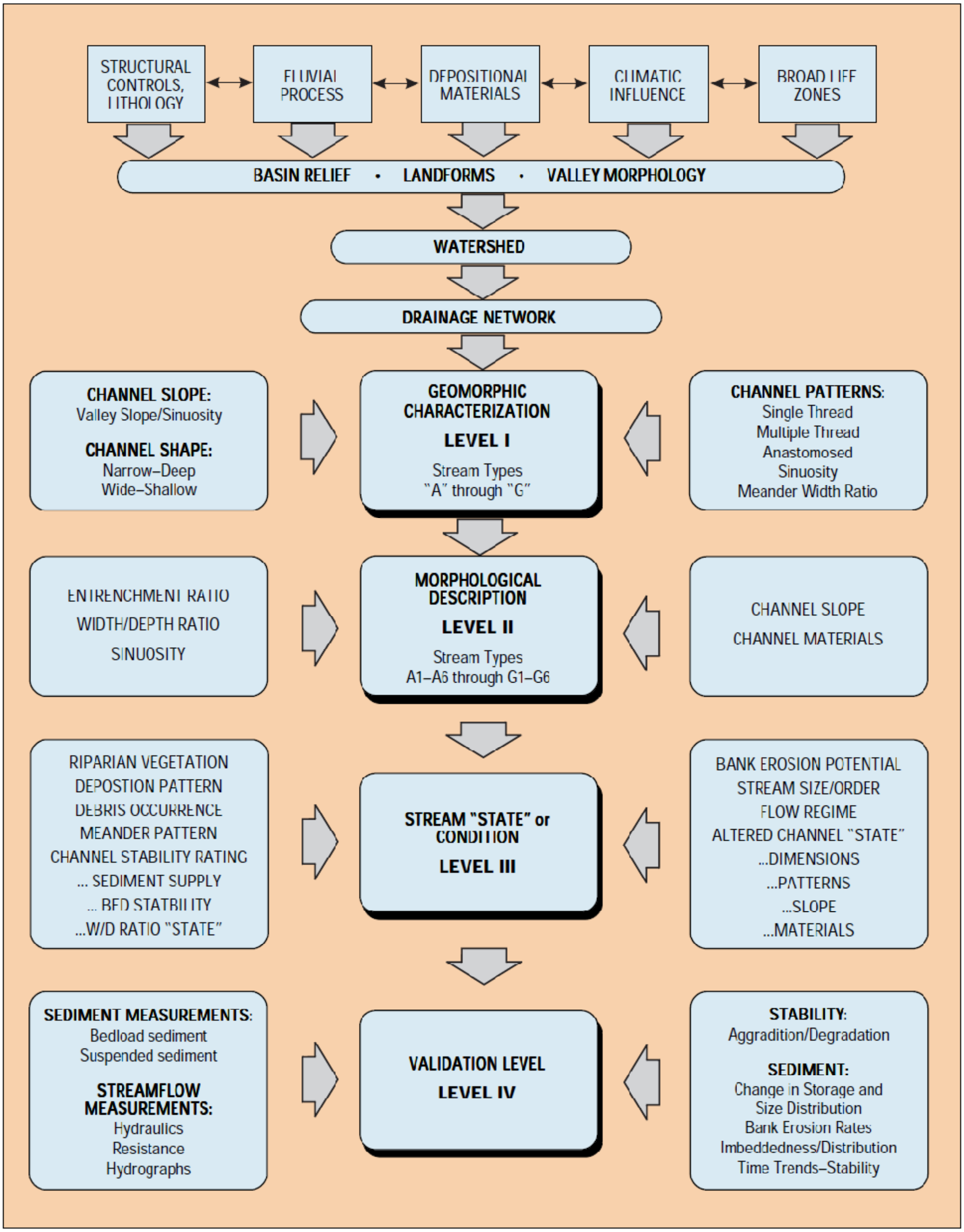


Figure courtesy of North Carolina Stream Restoration Institute, North Carolina State Cooperative Extension Service.

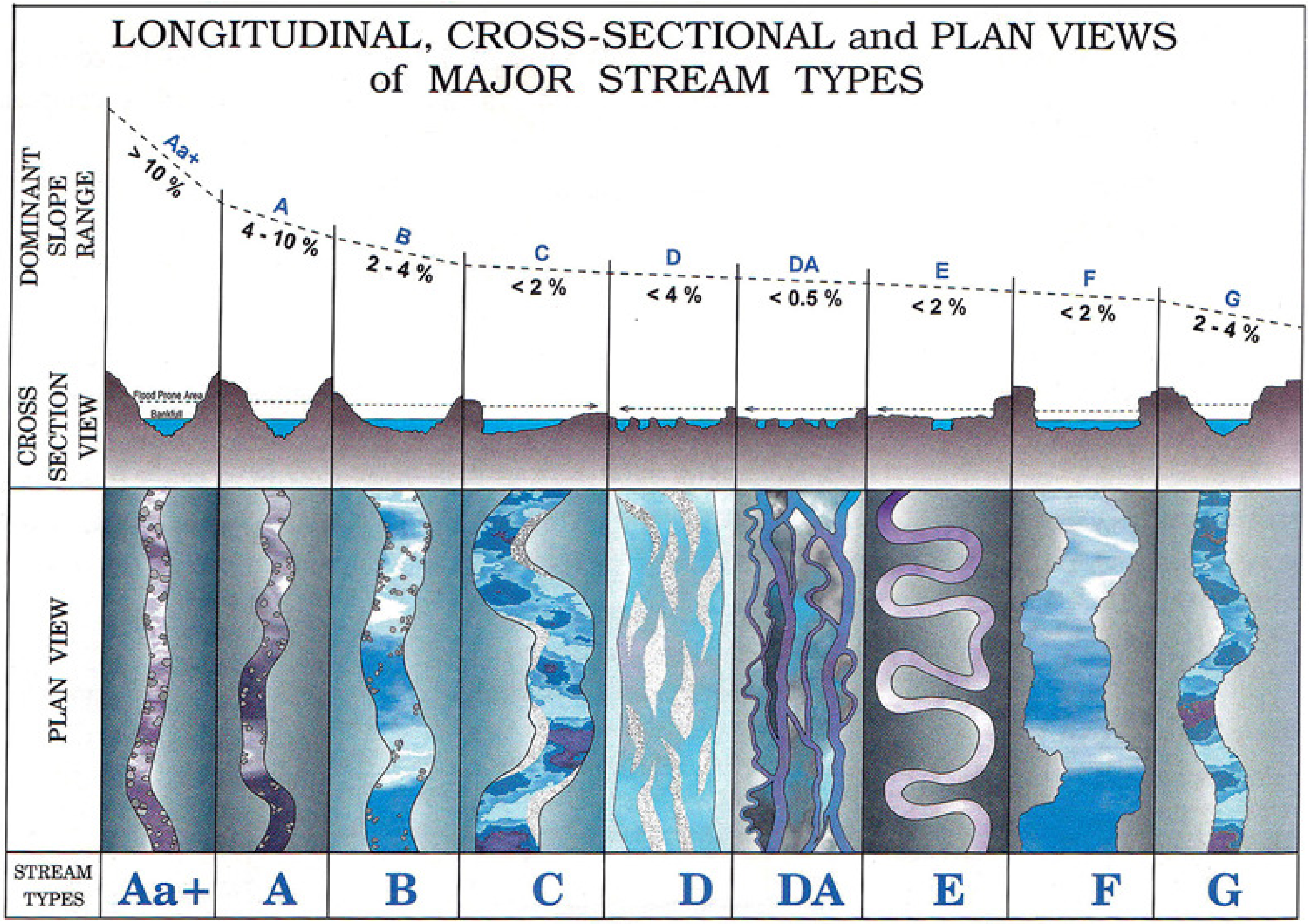


Figure courtesy of North Carolina Stream Restoration Institute, North Carolina State Cooperative Extension Service.

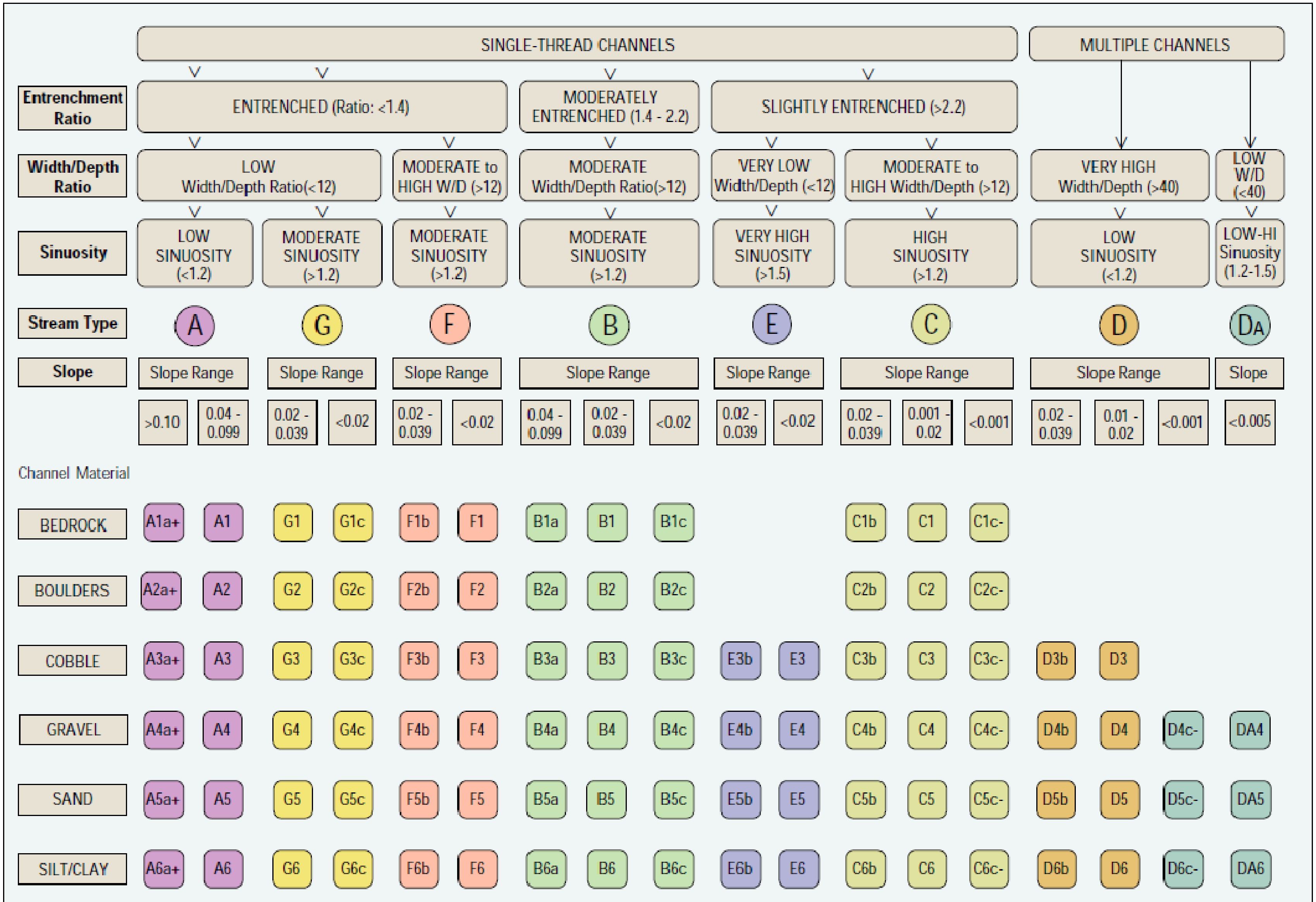


Figure 3. Key to the Rosgen Classification of Natural Rivers. As a function of the "continuum of physical variables" within stream reaches, values of *entrenchment* and *sinuosity* ratios can vary by +/– 0.2 units; while values for width/depth ratios can vary by +/– 2.0 units.

Figure courtesy of North Carolina Stream Restoration Institute, North Carolina State Cooperative Extension Service.

Appendix G

WATER SUPPLY IMPROVEMENT OPTIONS

Kirby Creek Watershed Study, Hot Springs County, Wyoming

APPENDIX G: WATER SUPPLY IMPROVEMENT OPTIONS

A variety of options exists for water resource development on the Kirby Creek Watershed. The influencing factor is cost and benefit. Before developing a potential water source, a thorough investigation of the resources and environment must be done to ensure a cost effective project that will provide water during the intended season of use. These options include:

- Spring developments,
- New wells,
- Existing wells, using wind and/or solar power,
- Pipeline/tank systems, and
- Stock ponds.

G.1 Spring Development

Springs can often provide a reliable source of water for wildlife and grazing opportunities and when designed properly with favorable conditions, springs can be an economic way to increase wildlife and grazing production. When compared to new wells or ponds, spring development costs are relatively cheap. The primary costs will include: digging with a backhoe, gravel material, pipe, a spring box, and any necessary permits. However, several factors must be identified before considering developing a spring. The water source must be reliable to ensure that once it's developed, the spring can maintain a useful flow rate for the intended season of use. The water source must be free of contamination or harmful natural constituents. The geology of the Kirby Creek watershed has the potential to carry harmful elements and compounds that may arise from the geologic material holding the water. The potential for burial or erosion must also be considered. During flood years, the spring must be isolated or protected from high flows or depositional conditions. Lastly, the spring must be fairly accessible for operational maintenance and repair. Several private and government agencies endorse spring development and have prepared a plethora of resources on the following websites:

www.nrcs.usda.gov

www.epa.gov

www.lifewater.org

The following are some typical spring development configurations obtained from various sources:

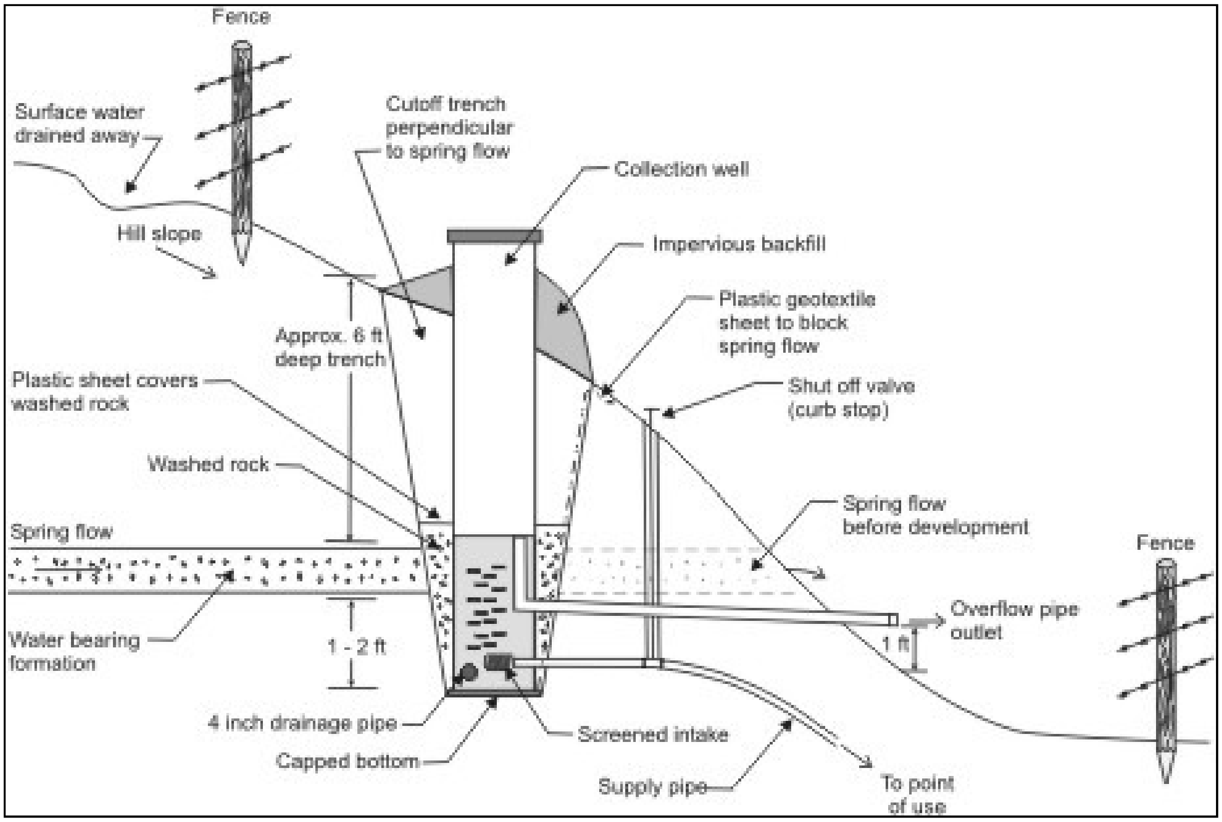


Figure G.1. Typical hillside spring box (Prairie Water News 2002).

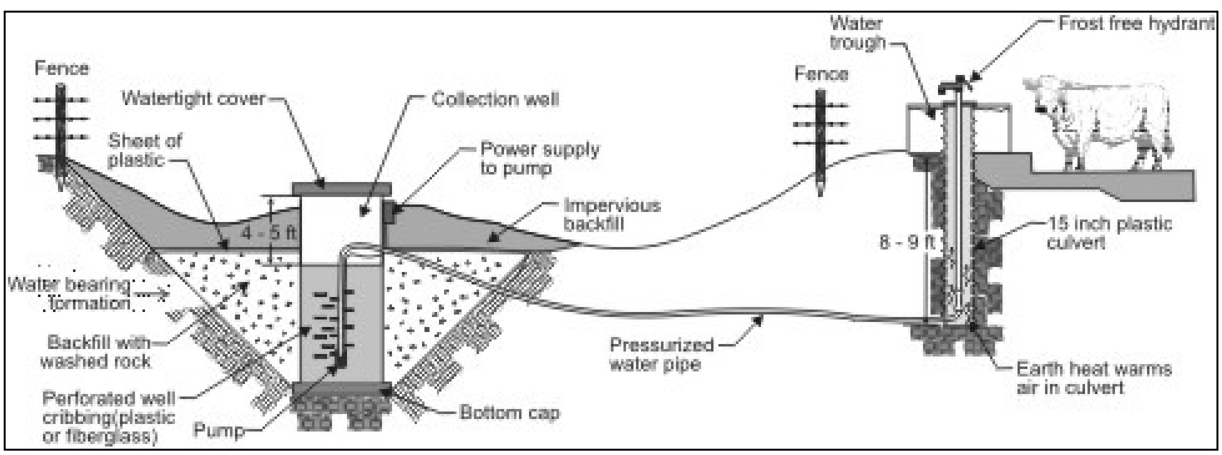


Figure G.2. Typical spring box with permeable bottom for spring water on level ground (Prairie Water News 2002).

G.2 Wells

Wells can provide the highest level of reliability for a water source throughout the entire grazing season. However, the installation of a new well is costly and the benefits may be uncertain. For this reason, new wells are only installed when the hydrogeology of an area is well known and all other water improvement options have been deemed unfeasible. Another option is reactivating old wells. There is an abundance of existing wells in the Kirby Creek Watershed and it may be feasible to reactivate those wells. Investigation of why the well is no longer producing may reveal an easy solution. In other instances, certain processes can be done to the well to promote water development. A borrowed technology from oil and gas efforts, hydraulic fracturing of the aquifer may be successful to reactivate abandoned water wells. In this process, a hydraulic fracture is formed by pumping the fracturing fluid into the well bore at to increase the pressure to a point higher than the native pressure of the formation. The pressure causes the formation to crack, and further pressure causes fractures to expand. Sand is generally mixed into the fluid and essentially “props” the fractures open to allow more transmissivity and permeability of the formation to increase the yield of the well. There are several abandoned oil wells within the Kirby Creek Watershed. The possibility exists for an abandoned oil well to be reactivated to produce adequate amounts of water for wildlife or grazing opportunities. Care must be taken to ensure no contamination from organics in the produced water. Typically, certain areas of the abandoned oil well may need to be blocked, or the well must be drilled deeper, all of which have their associated costs. A very detailed cost estimate and benefit analysis should be conducted and compare to the cost of drilling a new well because reactivation costs may be comparable to new well installation. Depending on the underlain geology, some wells are artesian and freely flow to the surface however, most aquifers do not support these conditions and pumping is required. Several options are available to provide pumping power.

G.3 Power Supply

Wells typically require pumping. If the well is located within a mile of a power line, it may be cost effective to install new power line to the well. This is the most reliable and maintenance free source of power. However, due to the costs of up to $10,000 per mile associated with installing new power lines over rough, remote terrain, other means of generating power remotely have been used. In the past, windmills have been employed in remote areas further than a mile from a power line. Windmills have proven to be fairly reliable in the West, due to frequent winds with enough velocity to pump adequate water from the well. These systems are typically mechanical, with piston pumping, however in some cases, the windmills turn a turbine to power an electrical pump. In both cases, the high degree of mechanical action requires constant maintenance and repair. Windmills have had a significant place throughout American farming and ranching lifestyle but there time may be closing. Unfortunately, the average age of ranchers is increasing and without young ranchers to provide assistance, climbing up windmills to perform repairs is becoming less desirable. Generally in Wyoming, the wind blows the least in August when the water is most needed. Also, windmill parts and repair services are becoming less abundant and costs are increasing. For this reason, several farmers and ranchers have been turning to solar as means to power pumps. Several manufacturers are developing solar pumps for both well and overland pumping needs. Solar pumps have been available for at least 20 years, however recent advances in technology has made solar cheaper, with a higher degree of efficiency and durability. Solar wells are becoming more popular around ranches in Wyoming due to the decreasing costs and the lack of maintenance needed. They have fewer moving parts than windmills and new installation costs are on the order of windmill replacement. They can accommodate cloudy days with the use of storage tanks. In Wyoming, sunny days outnumber cloudy days, so when the sun is shining, extra water not used by wildlife or livestock is pumped to a storage tank to be used when it's overcast. Pronghorn Pump and Repair from Glenrock, WY has been installing new solar pump systems around Wyoming, Montana, and Idaho for 14 years. They have had increasing amount of business replacing failing windmills and new well installation. Cost of new installation typically ranges from $4,500 to $10,000. Pronghorn Pump's website showcases several success projects:

www.pronghornpump.com

They primarily use Grunfos pumps, a company which emerged 9 years ago and has grown to be the industry standard by producing durable, long lasting pumps. They also have made system design easy with online software on their website:

www.grunfos.com

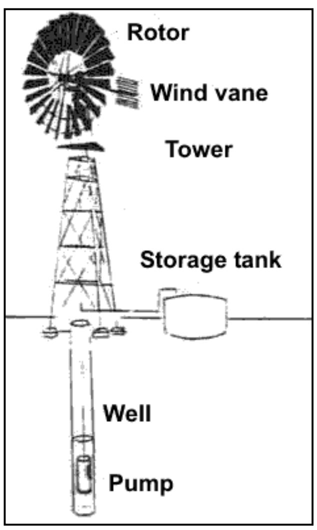


Figure G.3. A typical windmill configuration for pumping water (WOT 2010).

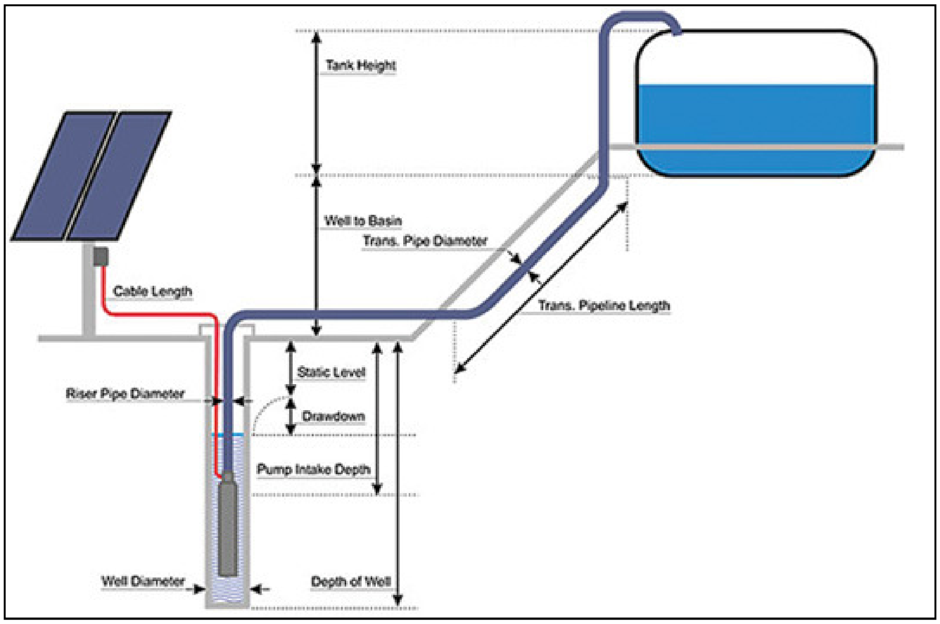


Figure G.4. A typical solar submersible pump configuration (Solar Group 2009).

Figure G.5. Typical solar pump with storage tank configuration (Observant 2010).

G.4 Pipelines

Pipelines can provide the most reliable source of water because the water can be delivered anywhere on the landscape. An ideal scenario is a pipeline delivering water from a high elevation to lower elevations using gravity head alone. With HDPE pipes, the friction losses are low and gravity is often sufficient to provide enough flow with enough head to fill stock tanks throughout the lower elevations. For piping systems, the water may come from any source available whether a well or a reservoir. The flexibility piping systems make them an attractive option for water development projects. When coupled with pumps, pipes can deliver water to a multitude of locations in a variety of configurations that can be optimized to distribute water efficiently and effectively on the landscape. If storage tanks are used with solar pumps to fill several stock tanks distributed across the landscape, a low cost system that is highly effective can be developed.

G.5 Stock Ponds

Stock ponds have been used throughout grazing history and have proven to be a reliable method of delivering water to wildlife and livestock. Typically, stock reservoirs are constructed with an earthen dam and an overflow spillway in line with an ephemeral stream. This allows for storage and full utilization of the water resource. The size of the pond determines the regulatory processes involved with design, permitting, and construction of the pond. If the dam height is less than 20 feet, and the maximum storage is 20 acre-feet, the permitting requirements are less encroaching. NRCS Agricultural Handbook 590 has provided resources for design and construction of stock ponds at:

http://www.in.nrcs.usda.gov/pdf%20files/PONDS.PDF

This document has summarized the planning, design, and construction for stock ponds, with features that are well suited to Wyoming. Below are figures from various sources that illustrate components of stock ponds.

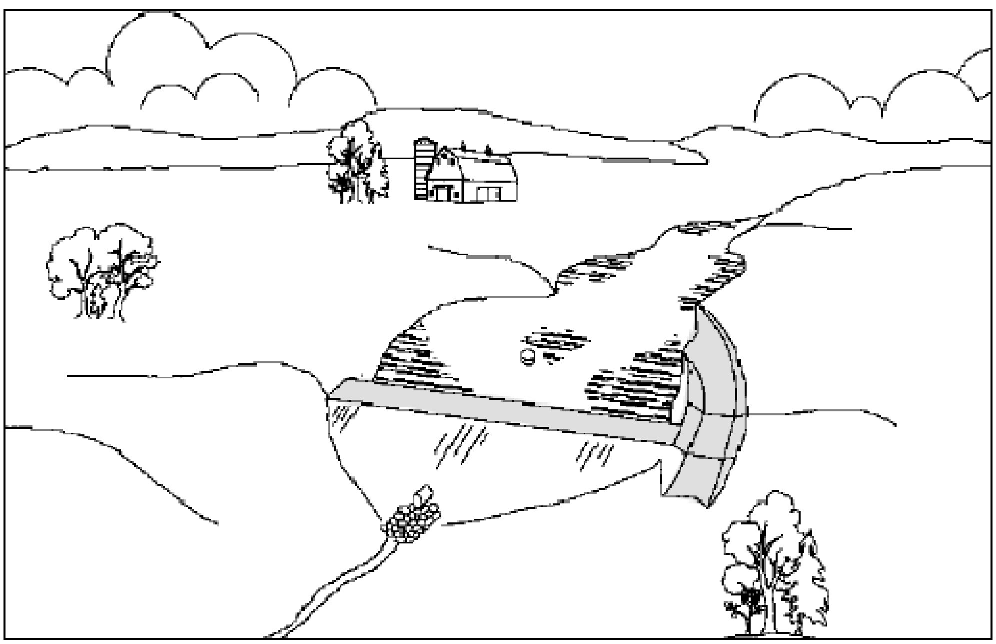


Figure G.6. A schematic illustrating an embankment type pond (ACES 1998).

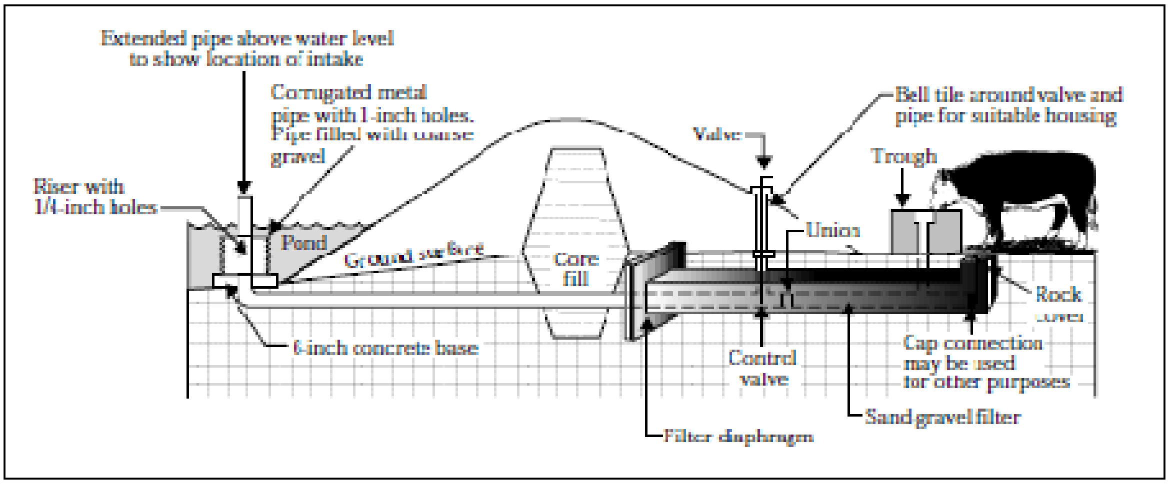


Figure G.7. Delivery schematic from an embankment type pond to a stock water trough (NRCS 1997).

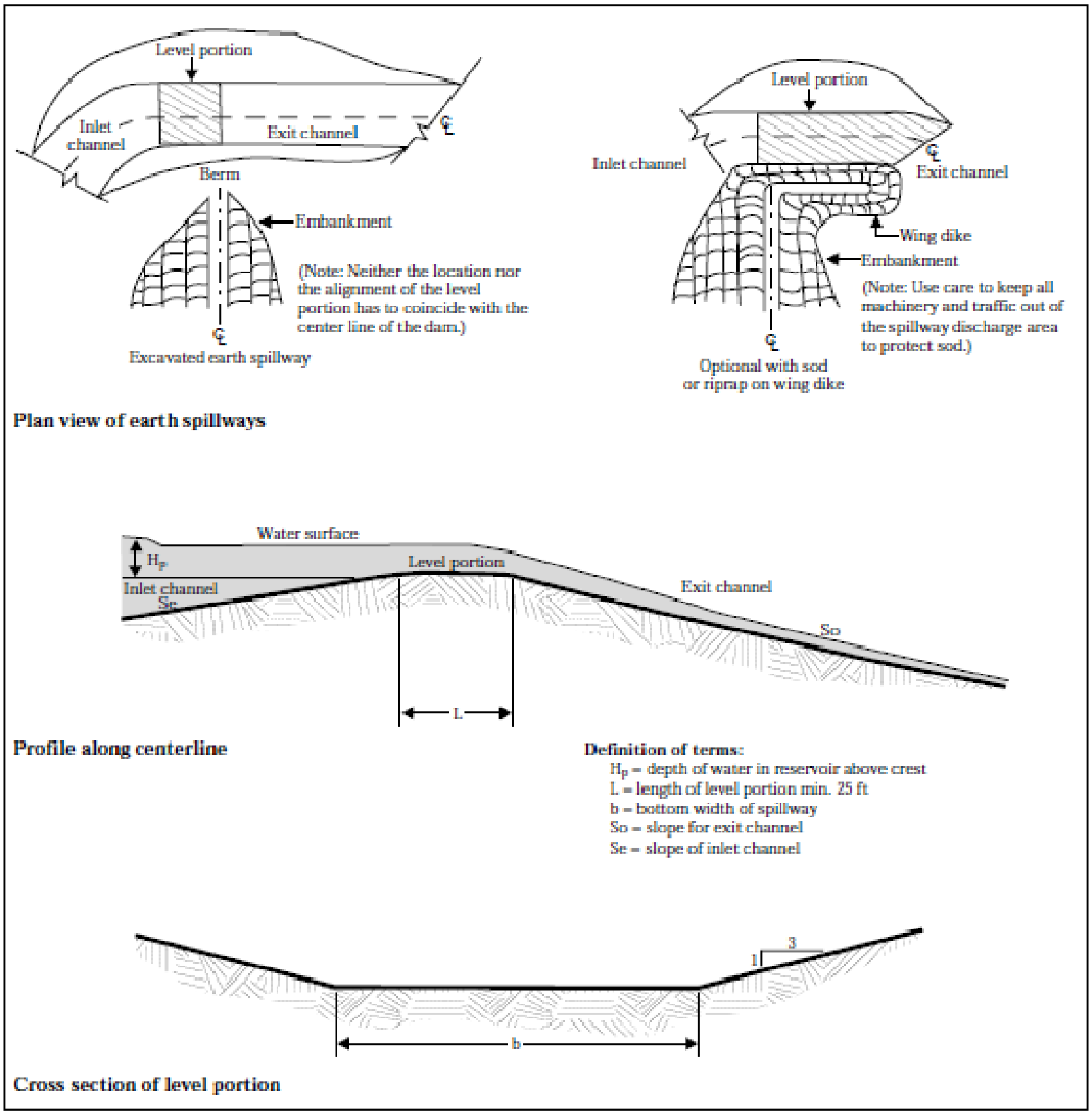


Figure G.8. Earthen dam spillway configuration (NRCS 1997).

REFERENCES

Agricultural Handbook 590 (1997)
*www.in.nrcs.usda.gov/.../Small%20Farms%20**Spring**%20**Development**%20(IN)-web.pdf –*

spring development:

http://www.prairiewaternews.ca/water/vol13no1/story4.html

windmill:
http://www.wot.utwente.nl/information/tour/waterpumping.html

solar submersible:
http://www.solar-eng.com/SolarWaterPump.aspx

solar picture:
http://observant.com.au/case-studies/robert-ingram/

embankment stockwater trough:
http://www.in.nrcs.usda.gov/pdf%20files/PONDS.PDF

embankment pond schematic:
http://www.aces.edu/pubs/docs/A/ANR-1114/ANR-1114.pdf