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FINAL REPORT
LOWER LARAMIE RIVER
WATERSHED LEVEL I STUDY

Prepared for:
Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002

Prepared by:

Anderson Consulting Engineers, Inc.
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Fort Collins, CO 80525
(ACE Project No. WYWDC40)

Anderson Consulting Engineers, Inc.
Civil • Water Resources • Environmental

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Professional Engineer (Civil)
Bradley Alan Anderson
5150
Date 11/16/19
WYOMING

November 16, 2019

Disclaimer:

It is important to note that all project recommendations presented in this report are conceptual only and are intended to provide sufficient information to initiate projects, assess design/site constraints, understand costs, and to apply for funding through various funding mechanisms; implementation may require further engineering analysis and design. Also, there are no requirements that these projects be ultimately implemented; participation is totally voluntary. Furthermore, the Platte County Resource District has no obligation to participate as sponsor of projects for potential funding. Decisions to sponsor a project will be made by the PCRD board on a case by case basis.

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I. INTRODUCTION AND OVERVIEW

1.1 Introduction

In 2017 the Platte County Resource District (PCRD) requested funding from the Wyoming Water Development Commission (WWDC) for the completion of a watershed management plan for the Lower Laramie River watershed. The intent of the funding request was to have a comprehensive watershed inventory completed, which identified issues related to land use and water resources, and to then develop a plan addressing those issues. The WWDC approved funding for the study and Anderson Consulting Engineers, Inc. (ACE) was ultimately contracted in June 2018 to complete the project.

1.2 Project Overview

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

1.2.1 Study Area

The project study area is located in southeastern Wyoming; primarily in Platte and Albany Counties, Wyoming (Figure 1.2-1). Lower Laramie River is defined by the United States Geologic Survey (USGS) as the fourth order basin: Lower Laramie River (Hydrologic Unit Code 10180011). The study area begins where the Upper Laramie River watershed ends at Wheatland No. 2 Reservoir and extends downstream to the river's confluence with the North Platte River. Primary tributaries include Bluegrass Creek, Chugwater Creek, Duck Creek, Hunton Creek, Luman Creek, Sybille Creek, Richeau Creek, and Ricker Creek. The principal water storage facilities in the area include Grayrocks Reservoir and Wheatland Reservoir No. 1. Elevations within the watershed range from about 4,200 feet above mean sea level at the North Platte River to over 10,000 feet in the Laramie Mountains.

The study area covers approximately 1,492,969 acres (2,333 sq. mi.) in southeast Wyoming. The watershed is mostly contained in Platte and Albany counties, with a small portion in Laramie and Goshen counties. The towns of Wheatland and Chugwater lie within the watershed boundary. The majority of the area's residents live in the Town of Wheatland and its vicinity. The remainder of the study area is relatively sparsely populated and consists primarily of open range lands and irrigated fields.

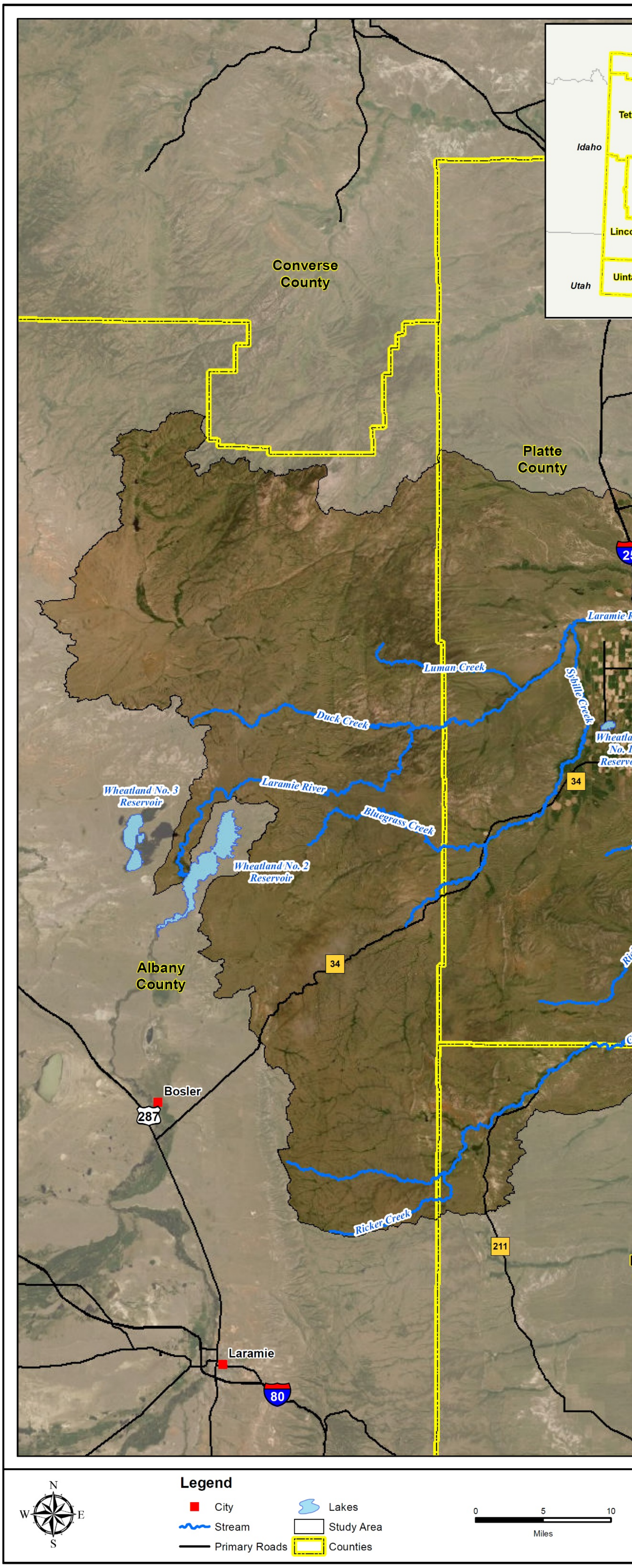


Figure 1.2-1 Lower Laramie River Watershed: Location Map

1.2.2 What is a Watershed Study?

The Operating Criteria of the Wyoming Water Development Program (Wyoming Water Development Commission, 2015) describes Level I watershed studies as such:

> *"These studies provide a detailed evaluation of an individual watershed. The studies may identify water development and system rehabilitation projects as well as address erosion control, flood control or other non-water development related environmental issues. Watershed improvement studies are an integral part of the Small Water Project Program, which has its own specific criteria. The studies may identify projects that may be eligible for the New Development, Rehabilitation, or Dam and Reservoir Programs."*

While the WWDC's definition summarizes a watershed study in terms of their operating criteria, the general philosophy of a watershed study may perhaps be best explained in an article entitled "Conservation and Watershed Studies. What's the Connection?" which appeared in the WWDC's *Water Planning News* Fall 2009 newsletter (Wyoming Water Development Commission, 2009). In this article, a watershed study is described as follows:

> *"Today, conservation by watershed is an old concept with new horizons. Watersheds have long been recognized in the western United States for their significant natural resources and the interrelationships found contained in land areas connected by stream systems. These relationships were recognized by John Wesley Powell from his early expeditions of the west and resulted in proposed conservation, low density open grazing, irrigation systems and state boundaries based on watershed areas.*
>
> *The conservation concept developed over time to coalesce in the early 1930's with the formation of special districts whose boundaries were often based on watersheds. At that time the relationship between stream systems and landscape function was recognized. This relationship was broadened to embrace watershed condition and quality and its response to human influences. This further provided some understanding of the historic land use effect on watershed condition and how management and restoration needs to be based on local landscape characteristics.*
>
> *Today, these relationships are embraced by the Wyoming Water Development Commission and Office through a watershed study program. On behalf of a local community sponsor, a watershed study can provide a comprehensive evaluation, analysis and description of the resources associated with a watershed and the watershed's water development opportunities. It is best stated that information related to the physical sciences is incorporated into a biological system.*
>
> *There are three prominent issues that are important considerations in a watershed information review and study. The first is surface water storage. Surface water storage is often of significant interest to a watershed community in order to address seasonal and/or annual shortages of water supply, augment late season stream flow to benefit riparian habitat, fisheries and wildlife, address*

flood impacts, enhance recreation opportunities, improve water quality and steam channel stability.

Second is the evaluation of irrigation infrastructure and development of information necessary to guide its rehabilitation and conservation. Of interest to local water users are ways to improve water delivery and on-farm irrigation efficiencies often timed to address annual or seasonal shortages of water supply or irrigation water delivery issues.

Third is the enhancement of upland water resources and distribution for livestock and wildlife that allows grazing management adjustments for range resource improvement. Benefits to the watershed, through plant community invigoration, reduction of erosion and stream channel stabilization, can be achieved from water development projects being strategically implemented over the watershed. Other issues and opportunities such as making beneficial use of produced water and removal of high water demand invasive species can also be important.

A watershed study, providing management and rehabilitation plans for water storage, irrigation systems and upland water development, can help empower a community to proactively enhance their watershed. Conservation by watershed can be an effective holistic approach to embracing the natural resource challenges and opportunities facing a community. A watershed study can provide the information to meet those challenges."

1.2.3 The Small Water Project Program (SWPP)

One of the purposes of this Level I watershed study is to provide the basis upon which the WWDC can make future decisions pertaining to state funding of water development projects. Potential projects identified in this study may be eligible for funding through the WWDC's Small Water Project Program, or SWPP. According to the operating criteria of the SWPP:

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

Applicants can receive up to $35,000 towards the cost of constructing eligible projects. Individuals apply for funding through the PCRD which serves as the applicant's sponsor. Application deadlines are December 31st of each year.

In addition, projects that have completed the permitting requirements, certified designs, agency notifications, land procurement and finalized other financial agreements (in other words, "shovel ready" projects) may be considered a funding priority at the discretion of the WWDC. The SWPP and its operating criteria are discussed in greater detail in Chapter 8: Economic Analysis.

1.3 Project Purpose and Objectives

The purpose of this Level I watershed study was to combine the available data and information with the study-generated inventory data to develop a comprehensive watershed management and rehabilitation plan that outlines proposed and potential water-development opportunities. To accomplish this effort, the following objectives were completed:

- *Facilitate consensus building among the conservation district, landowners and the Wyoming Water Development Commission.*
- *Facilitate public participation through public meetings, open houses/workshops, PCRD contacts, and advertisements.*
- *Conduct an evaluation and description of the Lower Laramie River watershed, including quantity and quality of surface water resources, and riparian/upland conditions.*
- *Inventory and describe irrigation systems, water storage, and flood control needs present within the watershed.*
- *Conduct a geomorphic assessment of the primary channels within the watershed and identify potential mitigation measures to improve impaired channel reaches.*
- *Conduct an irrigation system inventory and develop a rehabilitation plan for those ditches expressing an interest in participating.*
- *Conduct an evaluation of water storage needs and opportunities to augment water available for livestock and wildlife.*
- *Develop a watershed management plan which identifies water resource related issues within the watershed and proposes practical economic solutions.*
- *Identify permits, easements, and clearances necessary for plan implementation.*
- *Develop cost estimates for improvements.*
- *Complete an economic analysis and evaluate alternative sources of funding.*

The study culminates in the delivery of a Watershed Management and Rehabilitation Plan (the Plan). It is the goal and objective of the sponsors and the WWDC to generate a plan that is not only technically sound, but also one that is practical and economically feasible. The plan also includes development of a database to facilitate the planning process and the evaluation/implementation of watershed improvements. To accomplish this task, the PCRD, WWDC, and ACE addressed several key issues, including the following:

- *Utilization of grazing lands*
- *Water availability*
- *Channel stability/riparian restoration/enhancement*

- *Irrigation system assessment (to promote rehabilitation of existing facilities and provide opportunities for water conservation that would support an increase in water availability)*
- *Public participation and acceptance (intent is to focus on solutions, not compliance issues)*

During the completion of this Level I investigation, efforts were made to meet with as many landowners and stakeholders as possible and to help define their individual water projects. These projects are then outlined as components of the Plan. Feasible projects not meeting criteria of the SWPP are included as recommendations in the Plan; they simply exceed the cost limitations of the program or are not project types listed in the WWDC criteria. For these projects, recommendations for future planning/implementation efforts may include recommendation for Level II funding and/or investigation of alternative funding sources.

1.4 Report Utilization

The remainder of this report is organized in a manner that provides the greatest utility to the reader, the WWDC, and the PCRD. The major chapters are presented as follows:

Chapter 2 - Project Meetings: This chapter documents the public meetings, open houses, and Final Results Presentations held in support of the project. In addition, onsite meetings completed with individual landowners to discuss their water resources issues, are documented.

Chapter 3 – Review of Existing Information: This chapter describes the data collection and management methods used in the project, as well as an overview of the project GIS and the Digital Library submitted along with this report.

Chapter 4 - Watershed Description and Inventory: This chapter provides a characterization of the study area and its resources. In this chapter, discussion is provided on the management implications of various watershed attributes and the potential impacts upon watershed improvement recommendations. Source references for data utilized are also provided so the PCRD and WWDC can easily update information as needed during future planning efforts.

While completing this task, we met with numerous stakeholders, including private landowners, state agency representatives, and federal agency representatives to ascertain their specific resource-related concerns, needs and objectives. Our team contacted as many individuals as possible through phone calls, office visits and onsite ranch or farm visits. Potential projects were discussed to help address concerns expressed.

Chapter 5 – Surface Hydrology: This chapter provides a summary of existing hydrology data, mean annual discharge estimations for each sub-watershed, peak flow estimations and flooding information pertinent to the study area, and a description of surface water availability and shortages.

Chapter 6 - Watershed Management Plan: This chapter describes the individual projects which together, comprise the Plan. The projects were, for the most part, conceptualized or documented through the effort discussed under the Watershed Inventory phase (Chapter 4). Projects fall into several broad categories:

- Surface Water Storage Opportunities
- Irrigation System Rehabilitation
- Upland Livestock/Wildlife Water Development
- Grazing Management

In addition, discussions of potential benefits of the various components to the State of Wyoming and its residents are presented.

Chapter 7 - Cost Estimates: In this section, conceptual level cost estimates of the Watershed Management Plan components and the methods and assumptions supporting them are presented. This information can then be used by the PCRD and project sponsors in future planning efforts.

Chapter 8 – Economic Analysis: This valuable portion of the report summarizes numerous funding programs provided by various local, state and federal entities as well as private organizations. This information can be used to determine optimized funding strategies including partnering with multiple funding sources

Chapter 9 – Permits: Most projects included in the Plan will require some sort of permit to be completed. In this section, information is provided to help guide the PCRD through the permitting process along with agency contact information.

Chapter 10 – Conclusions and Recommendations: Here we summarize the Highlights of the Plan all summarized along with concise and feasible recommendations for further action on behalf of the WWDC and the PCRD.

II. TASK 1: PROJECT MEETINGS

2.1 Meetings and Workshops

An integral part of the Lower Laramie River Watershed Study was the public outreach and involvement effort. Meetings were orchestrated by Anderson Consulting Engineers (ACE) and typically included informal presentations conducted by ACE staff and the Wyoming Water Development Office (WWDO). The objectives of the meetings were to:

- Discuss the purpose, existing data, and available information for the watershed study
- Obtain input and opinions from residents and landowners about the study area
- Identify concerns and answer questions about the area's water and land resources
- Request participation in the study effort and coordinate inventory activities
- Present initial results and preliminary findings from the watershed study

At each of the meetings, ACE representatives were available to discuss the project one-on-one with landowners/stakeholders and to initiate development of watershed plan alternatives. The project GIS was demonstrated when appropriate to keep landowners up to date on the information which would ultimately be incorporated within it.

At the Project Workshops/Open Houses, ACE staff were available to discuss the study one-on-one with landowners/stakeholders or the general public. These conversations typically ended with initiation of development of project plans or scheduling future on-site visits.

- August 21, 2018 Project Scoping Meeting
- November 15, 2018 Project Workshop / Open House
- February 6, 2019 Project Workshop / Open House (Cancelled due to storm)
- April 10, 2019 Project Workshop / Open House (Cancelled due to storm)
- April 24, 2019 Project Workshop / Open House
- May 14, 2019 Project Workshop / Open House
- October 22, 2019 Final Draft Report Presentation (Appendix 2A contains Record Materials)

Meetings and workshops were advertised in advance using several methods:

- A mailing list was developed using county assessors data and selecting owners of parcels zoned "agricultural". Letters or cards were then sent two weeks prior to each meeting.
- Radio ads were placed with the local radio station.
- Newspaper ads were placed in the Platte County Record.

2.2 Field Trips and "Tailgate Talks"

Field investigations generally occurred in coordination with scheduled meetings for efficiency. Specific field efforts targeted irrigation inventory, upland livestock/wildlife water opportunities, and observations of stream channel conditions.

Individual meetings with landowners and lease holders were scheduled at their residences and properties where discussions focused on land and water resource concerns and issues specific to the landowner. Usually, the landowner gave a tour of the property. During these property visits, initial planning and conceptual project designs were discussed for upland livestock/wildlife and irrigation water improvements. These informal interviews, often held spontaneously while in the field, have become dubbed "tailgate talks" and provide valuable insight into the overall assessment of the watershed. The project team reached out to approximately 45 contacts. Ultimately, a total of 40 individuals/agencies were interviewed; some on multiple occasions.

Throughout the watershed study, local ranchers, irrigators, and residents who invited the study team to visit their properties and discuss issues and concerns demonstrated extensive knowledge and valuable insight about the watershed. Because of the willingness of landowners to share information, insight, and direction, the study team was able to incorporate this knowledge and experience into the study and provide a more effective evaluation of the watershed.

III. TASK 2: REVIEW OF EXISTING INFORMATION

3.1 Collection of Existing Information

A significant amount of information and pertinent data were available from existing sources at the time this project was initiated. In an effort to collect and incorporate as much of this information as possible, the following sources were either contacted directly or information and documents procured via websites, libraries, or personal contacts:

- U.S. Bureau of Land Management (BLM)
- U.S. Geological Survey (USGS)
- U.S. Department of Agriculture/Natural Resources Conservation Service (NRCS)
- U.S. Department of Agriculture/Farm Service Agency (FSA)
- U.S. Department of Agriculture/Forest Service: Medicine Bow National Forest (USFS)
- U.S. Environmental Protection Agency (EPA)
- U.S. Fish and Wildlife Service (FWS)
- U.S. Department of Interior (DOI)
- U.S. Department of Interior (DOI)/National Park Service Register of Historic Places (NPS)
- Wyoming Water Development Commission (WWDC)
- Wyoming Department of Environmental Quality (WDEQ)
- Wyoming Abandoned Mine Land Program (AML)
- Wyoming Game and Fish Department (WGFD)
- Wyoming State Historic Preservation Office (SHPO)
- Wyoming State Engineer's Office (WSEO)
- Wyoming Oil and Gas Conservation Commission (WOGCC)
- Wyoming State Geological Survey (WSGS)
- Wyoming Geographic Information Science Center (WyGISC)
- Wyoming Natural Diversity Database (WYNDD)
- Wyoming Landscape Conservation Initiative (WLCI)
- Wyoming Wildlife Federation (WWF)
- Water Resources Data System (WRDS)
- Trout Unlimited (TU)

3.2 Previous WWDC-Funded Investigations

Several projects and studies have been completed through the Wyoming Water Development Commission within the study area. Figure 3.2-1 shows a map of these previous studies.

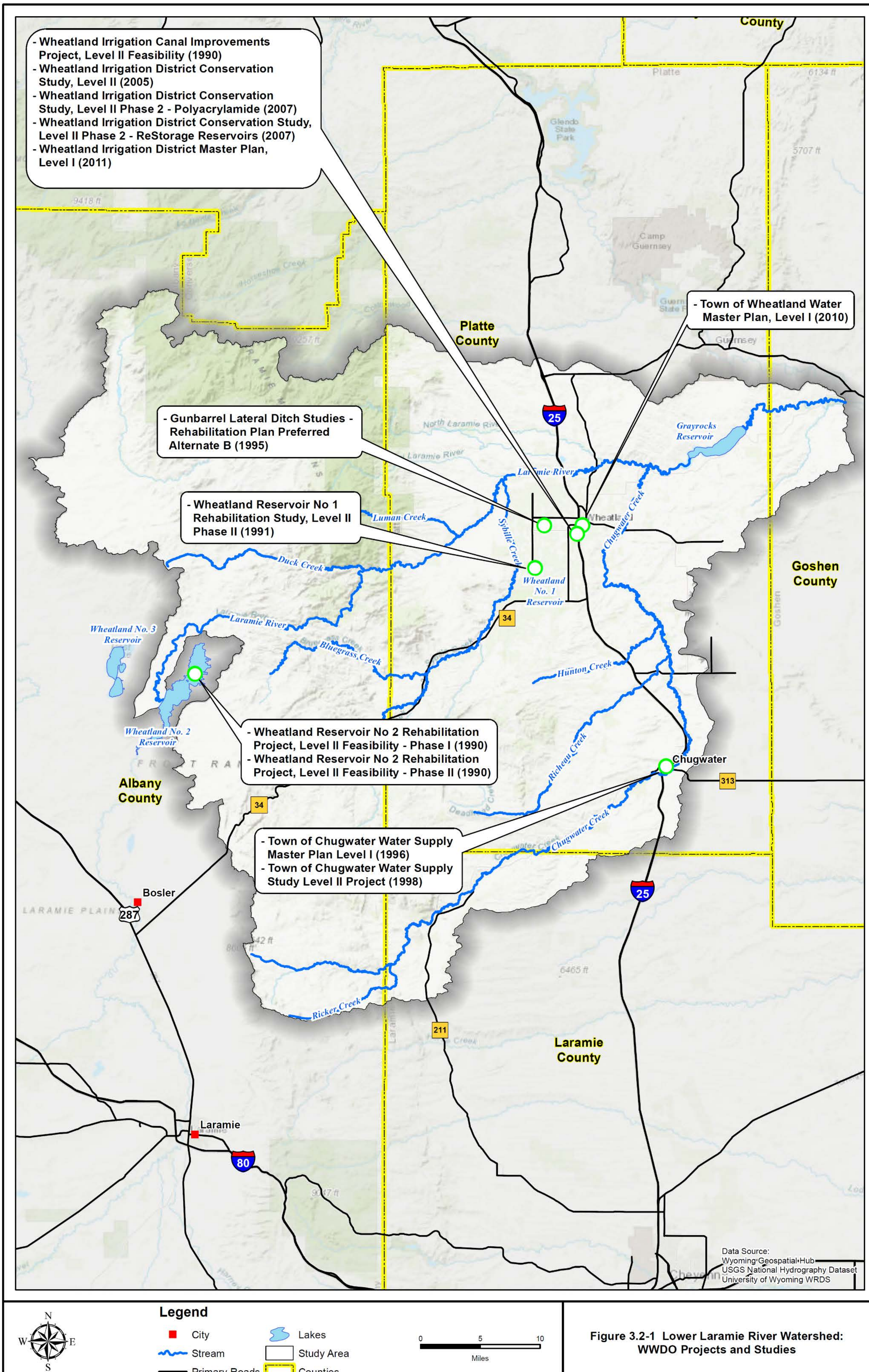


Figure 3.2-1 Lower Laramie River Watershed: WWDO Projects and Studies

3.3 Geographic Information System

A GIS can be thought of as a powerful three-dimensional mapping tool that can be used to evaluate and compare spatial data pertaining to a wide range of topics. Numerous maps can be "stacked" to overlay information; each map, or "theme", incorporates data, or "attributes" pertaining to the theme. For instance, a theme showing the location of stock reservoirs could also include numerical data pertaining to each reservoir's water rights and condition.

The Wyoming Association of Conservation Districts has developed an online tool called SuiteWater. SuiteWater is a web-based interface providing access to a wide range of spatial data, aerial imagery, and other spatial datasets. It provides the user with GIS capabilities without the need for expensive GIS software.

Available GIS data pertaining to the Study Area was collected from a wide range of sources and used to develop the characterization of the watershed presented in Chapters 4 and 5 of this report. SuiteWater was a source for much of the general information. In addition, data was collected from various agencies and incorporated into the project GIS.

The data that is included in the GIS deliverable is data, that throughout the course of the project, was generated through analysis and watershed plan development. This data represents "new" or "value added" data that does not currently exist in Suitewater and is not available from any other source. "New" data would include items such as: Rosgen stream classification results, identification of upland water sources, WWDC potential project locations, etc. "Value Added" data are datasets that already exist (i.e. through SuiteWater for example) but have been modified or have had attributes added due to an analysis conducted during this study. For example, the HUC 12 Hydrologic Units are an existing dataset distributed by the USGS and available through SuiteWater. During this study the dataset was used as a basis for hydrologic analyses. Mean annual runoff and peak discharges were computed using various regional methodologies. The results of this effort were incorporated within the HUC12 dataset as new attributes.

The delivered GIS geodatabase was built using a template geodatabase obtained from the Wyoming Water Development Office (WWDO). The geodatabase adheres to the GIS standards detailed in the Bear River Data Model Pilot Project, GIS Standards Technical Memorandum issued January 1, 2018.

It is also important to note that data presented in the project GIS and within this report are subject to change with time as the agencies creating them continually update their databases. The user is encouraged to obtain the most current data available to meet the needs of future endeavors utilizing the project GIS.

3.4 Digital Library

The Digital Library is a collection of 281 documents, plats, maps, figures, spreadsheets, etc., pertaining to the project. Documents reviewed during the completion of this project were scanned and included in the

Digital Library to the extent possible. Copyright protected documents were not included in the Library; however, documents published by public agencies were included where feasible. The Digital Library consists of a spreadsheet listing the available documents and links to each; it can be searched or sorted depending upon the user's needs. Documents included in the Digital Library were obtained from the agencies listed in Table 3.4-1, among many others. The Digital Library table of contents has been included as Appendix 3A.

Table 3.4-1 Selected Sources of Information Included in the Digital Library.

USDI Bureau of Land Management
United States Army Corps of Engineers
United States Environmental Protection Agency
United States Fish and Wildlife Service
United States Forest Service
USDI United States Geological Survey
Natural Resources Conservation Service
Wyoming Department of Environmental Quality
Wyoming Game and Fish Department
University of Wyoming
Wyoming Water Development Commission
Wyoming Department of Environmental Quality
Wyoming Weed and Pest Council
Wyoming State Engineers Office
Wyoming State Geological Survey
United States Forest Service
Miscellaneous

IV. TASK 3: WATERSHED DESCRIPTION AND INVENTORY

4.1 Introduction and Purpose

The primary objective of the watershed description and inventory phase of this project was to accomplish the following:

1. collect, review, and compile existing pertinent information regarding the study area;
2. collate the data in a single database; and
3. assess the data to characterize the watershed and facilitate identification of existing issues and development of improvements to the watershed.

Within this chapter, an overview of existing conditions of natural resources found within the study area is provided. The discussion of various watershed attributes is divided into the following sections:

- Physical Systems,
- Biological Systems, and
- Anthropogenic Systems.

Included are summaries of numerous individual disciplines: vegetation, soils, wildlife, hydrology, ecological site descriptions, etc. For each discipline, individual maps delineating the character and extent of that watershed attribute were generated within the project GIS. The Wyoming Association of Conservation Districts in collaboration with the University of Wyoming has developed an online GIS system called Suitewater. Suitewater was used for initial review and evaluation of numerous datasets. Maps presented within this document were then created using Esri ArcGIS. In conjunction with many of the map figures, summary tables have been prepared which tabulate various attributes of the pertinent watershed characteristics.

4.2 Physical Systems

4.2.1 Overview

Specific topics discussed in the following sections include the following:

- Climate
- Geology
- Groundwater Hydrology
- Surface Water Hydrology
- Geomorphology

4.2.2 Climate

Climate of the study area would be considered a semi-arid continental climate with some variation due to topography. Historic climate data for five NOAA Cooperative Weather Stations in the watershed was obtained through the Western Regional Climate Center website (*http://www.wrcc.dri.edu/*). Table 4.2-1 presents the average temperature range and average total precipitation while Figures 4.2-1 displays the data graphically as bar charts. As indicated in the bar charts, summers are warm with July high temperatures averaging around 88 °F (31.1 °C) in Chugwater and Wheatland. The Double Four Ranch, Lookout, and Sybille Research Unit stations are higher in elevation, where the July high average is about 82 °F (27.8 °C). Summer nights throughout the watershed are characterized by a rapid cool down; with mean summer lows averaging 45°F. Winters are cold, but variable with periods of sometimes extreme cold interspersed between generally mild periods. Chinook winds can provide unusually warm temperatures in some locations.

Figure 4.2-2 displays the mean annual precipitation throughout the watershed. The data used to generate this figure were obtained from the Wyoming Geographic Information Science Center (WyGISC). These data represent the results of PRISM spatial climate data generated at the Oregon Climate Center, Oregon State University. As indicated in this figure, the mean annual precipitation varies from a minimum of about 12-13 inches near Grayrocks reservoir, located at the lower end of the watershed, to 27 inches in the Laramie Mountains. The majority of the watershed receives less than 18 inches annually. Extreme fluctuations in temperatures from day to day and in annual precipitation from year to year are common. These climatic variations have strong effects on vegetation and in determining land capabilities and use.

Annual rainfall cannot be used alone to quantify stream flow and groundwater recharge. Depending on the temperature, soil moisture content, vegetation, as well as timing, location, and intensity of precipitation, rainfall is translated into either streamflow or groundwater recharge. The Palmer Drought Severity Index (PDSI) (Palmer, 1965) is a climactic measure used by the National Oceanic and Atmospheric Administration (NOAA) to characterize drought conditions. According to the Horse Creek Groundwater / Surface Water Connection Investigation (Hinckley Consulting, 2011),

> *"The PDSI reflects current and precedent precipitation and temperature conditions, and regional constants such as water-holding capacity of soils. It is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. Negative values of the PDSI reflect drier-than-normal conditions and positive values reflect wetter-than-normal conditions. A value of -2.0 or lower is considered moderate drought, -3.0 or lower is considered severe drought, and values lower than -4.0 are considered extreme drought."*

The Lower Laramie River watershed is entirely located in Wyoming Climate Division 8 – Lower Platte. The monthly Palmer Drought Severity Indices were downloaded from NOAA for 1985-2019 from the following website: https://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#

Since the 12-month period prior to the typical occurrence of maximum storage volume in irrigation reservoirs is May 1 of the previous year to April 30 of the listed year (Hinckley Consulting, 2011), the monthly PDSIs were averaged over this period in Figure 4.2-3.

Table 4.2-1 Summary of Monthly Climatic Data: Lower Laramie Watershed.

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Chugwater, Wyoming 481730: 11/01/1900 to 06/06/2016													
Average Max. Temperature (F)	39.9	42.2	48.7	58.4	67.7	78.4	86.6	85.2	76.5	63.9	49.8	41.1	61.5
Average Min. Temperature (F)	15.3	16.5	21.3	28.7	37.3	45.6	51.5	49.7	40.0	30.2	22.1	16.1	31.2
Average Total Precipitation (in.)	0.52	0.62	1.03	1.89	2.71	2.25	1.72	1.34	1.23	1.08	0.65	0.68	15.73
Sybille Research Unit, Wyoming 488808: 05/01/1964 to 06/10/2016													
Average Max. Temperature (F)	36.1	38.4	46.8	55.9	65.6	76.6	84.3	82.4	73.2	61.0	45.4	36.4	58.5
Average Min. Temperature (F)	16.1	17.3	22.9	29.8	38.0	46.6	53.8	52.0	42.9	33.1	23.7	16.5	32.7
Average Total Precipitation (in.)	0.56	0.62	1.04	1.93	2.52	2.15	1.61	1.29	1.27	1.23	0.85	0.65	15.72
Lookout 14 NE, Wyoming 485720: 02/01/1933 to 07/31/1965													
Average Max. Temperature (F)	28.7	32.1	37.8	50.5	61.4	72.1	80.6	79.0	69.6	58.0	41.5	33.2	53.7
Average Min. Temperature (F)	6.0	8.9	15.5	25.2	34.5	43.3	49.8	48.0	38.7	28.7	16.2	11.0	27.2
Average Total Precipitation (in.)	0.68	0.76	0.98	1.55	1.81	1.47	1.57	0.96	0.91	0.69	0.53	0.47	12.38
Wheatland 4 N, Wyoming 489615: 01/01/1893 to 06/10/2016													
Average Max. Temperature (F)	41.0	43.3	50.7	61.2	70.6	81.1	89.3	87.8	78.0	65.5	51.2	42.5	63.5
Average Min. Temperature (F)	17.3	18.6	23.9	32.1	41.3	49.8	56.0	54.0	44.4	34.4	25.4	19.1	34.7
Average Total Precipitation (in.)	0.32	0.38	0.74	1.62	2.47	2.04	1.50	1.06	1.19	0.94	0.45	0.43	13.15
Double Four Ranch, Wyoming 482680: 08/01/1942 to 12/31/2005													
Average Max. Temperature (F)	34.7	38.1	44.5	54.4	64.0	74.4	82.5	81.0	71.8	59.8	44.2	36.1	57.1
Average Min. Temperature (F)	13.9	16.1	20.2	27.0	35.3	42.1	47.8	45.9	37.3	29.2	21.7	15.6	29.3
Average Total Precipitation (in.)	0.40	0.47	0.95	1.82	2.72	2.36	1.71	1.17	1.18	0.80	0.74	0.51	14.82

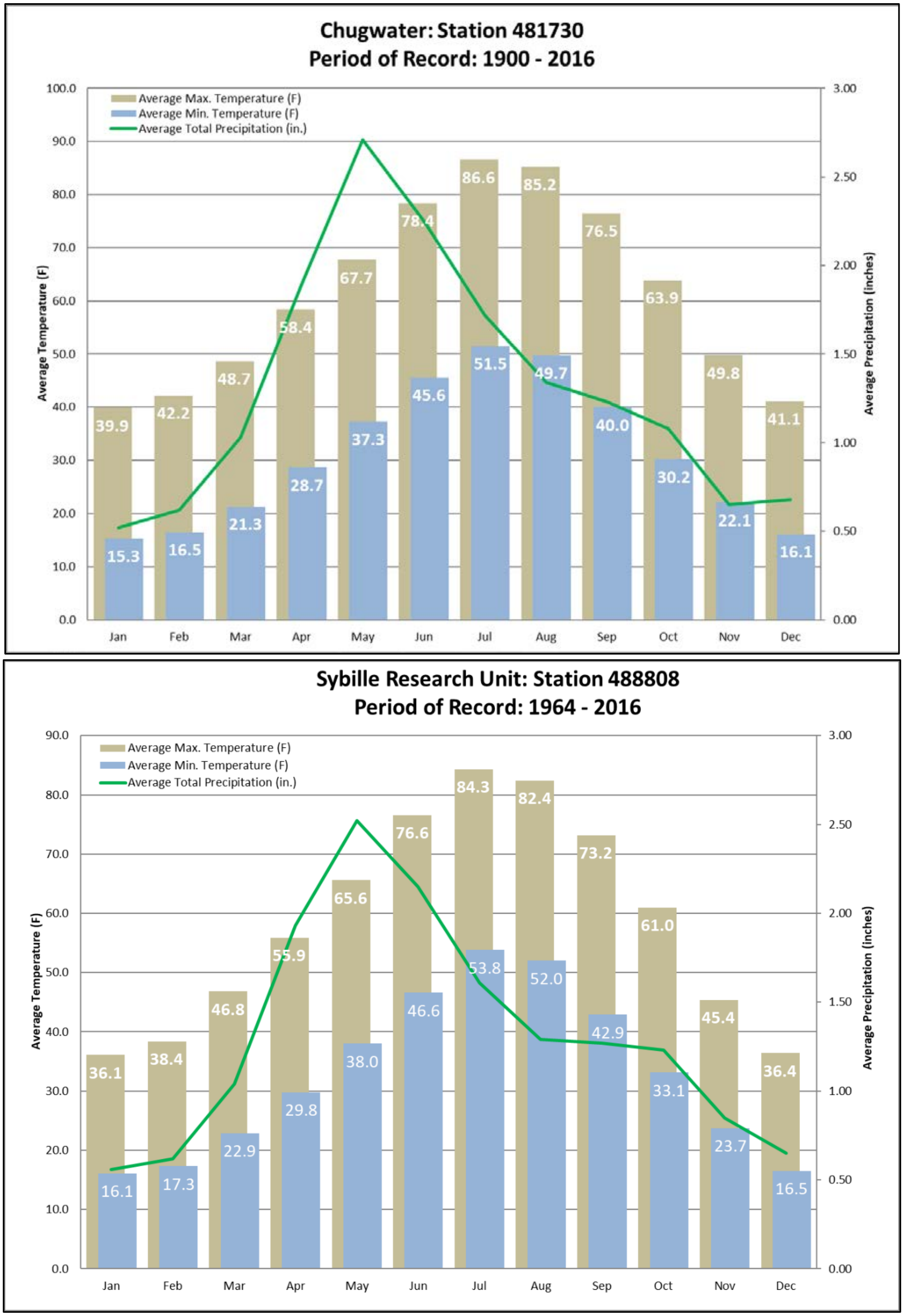
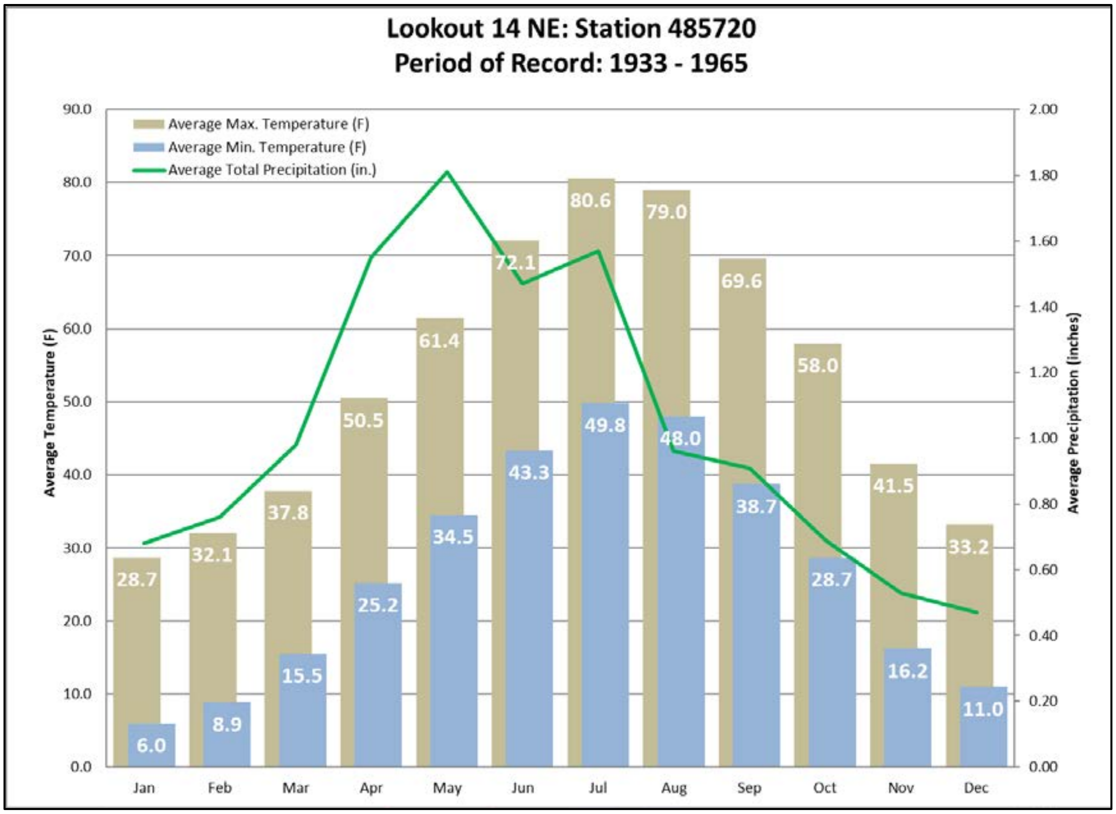


Figure 4.2-1 Mean Monthly Climatic Factors for Lower Laramie Watershed.



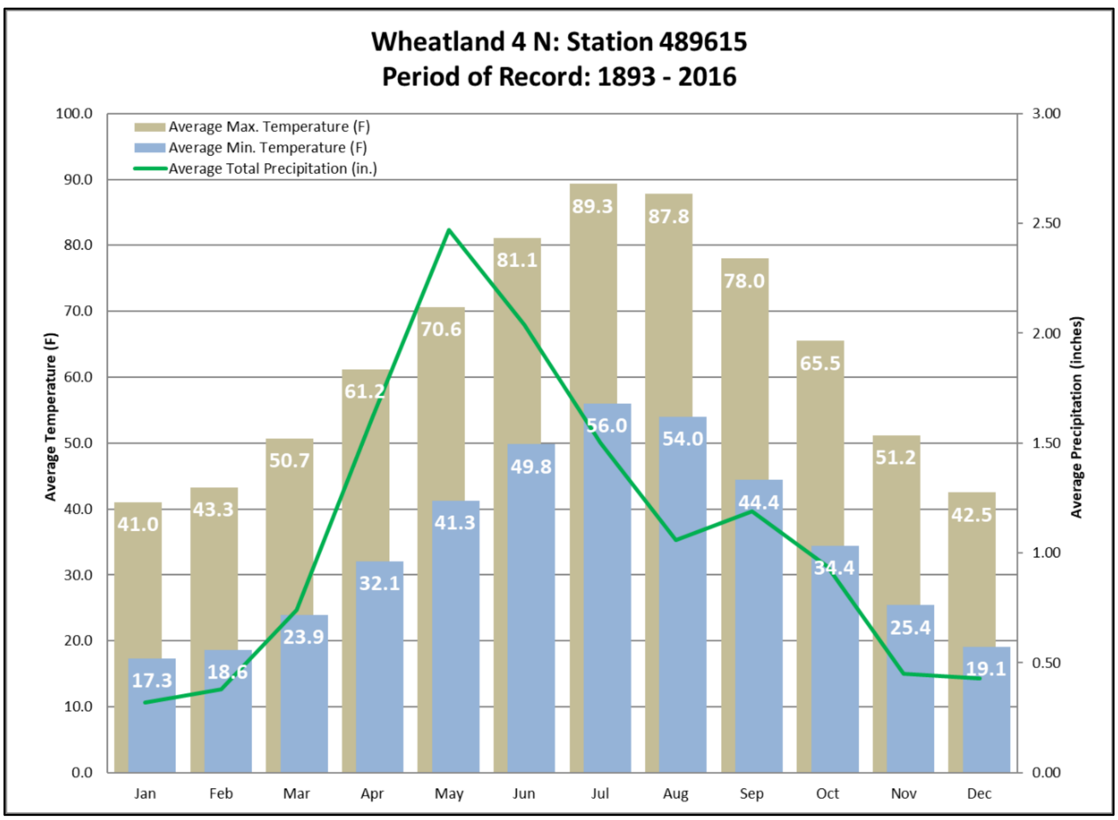


Figure 4.2-1 Mean Monthly Climatic Factors for Lower Laramie Watershed (continued).

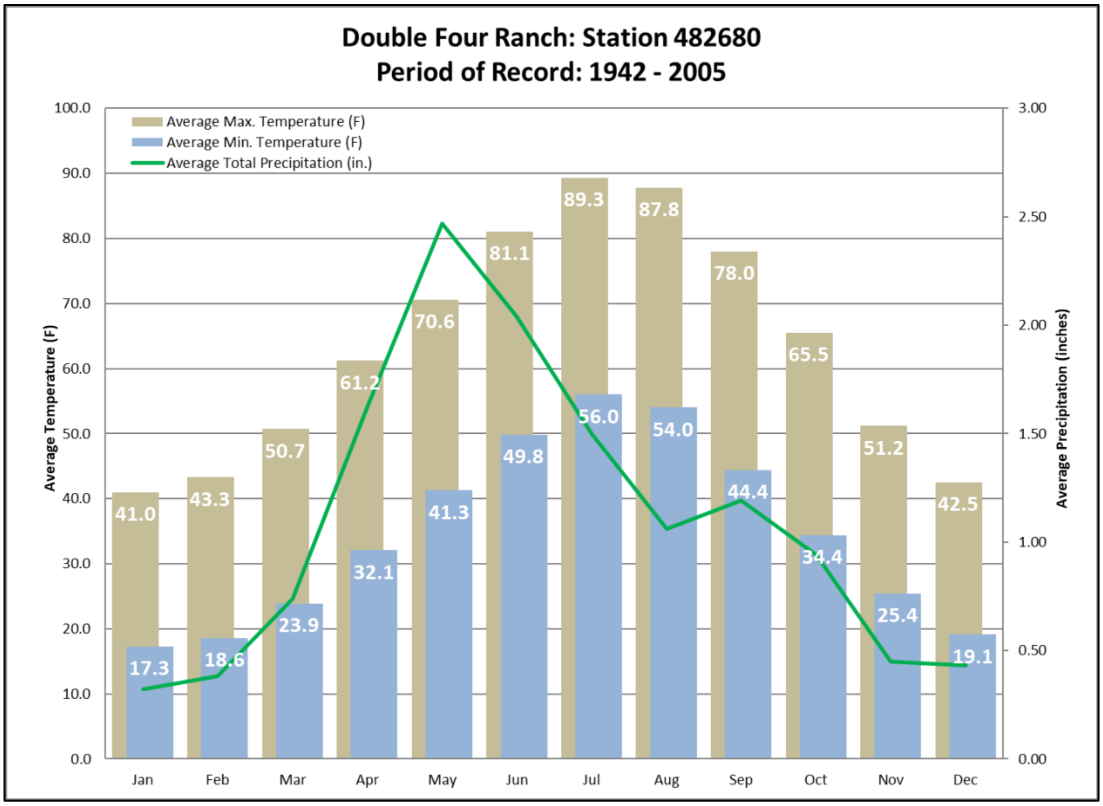


Figure 4.2-1 Mean Monthly Climatic Factors for Lower Laramie Watershed (continued).

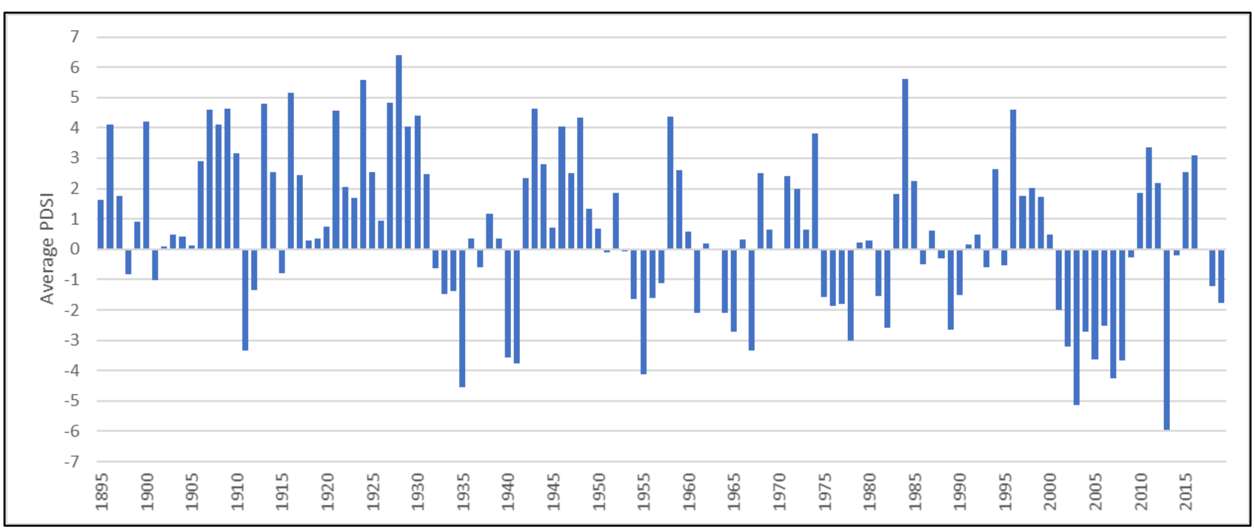


Figure 4.2-3 Palmer Drought Severity Index (PDSI) for Wyoming Climate Division 8.

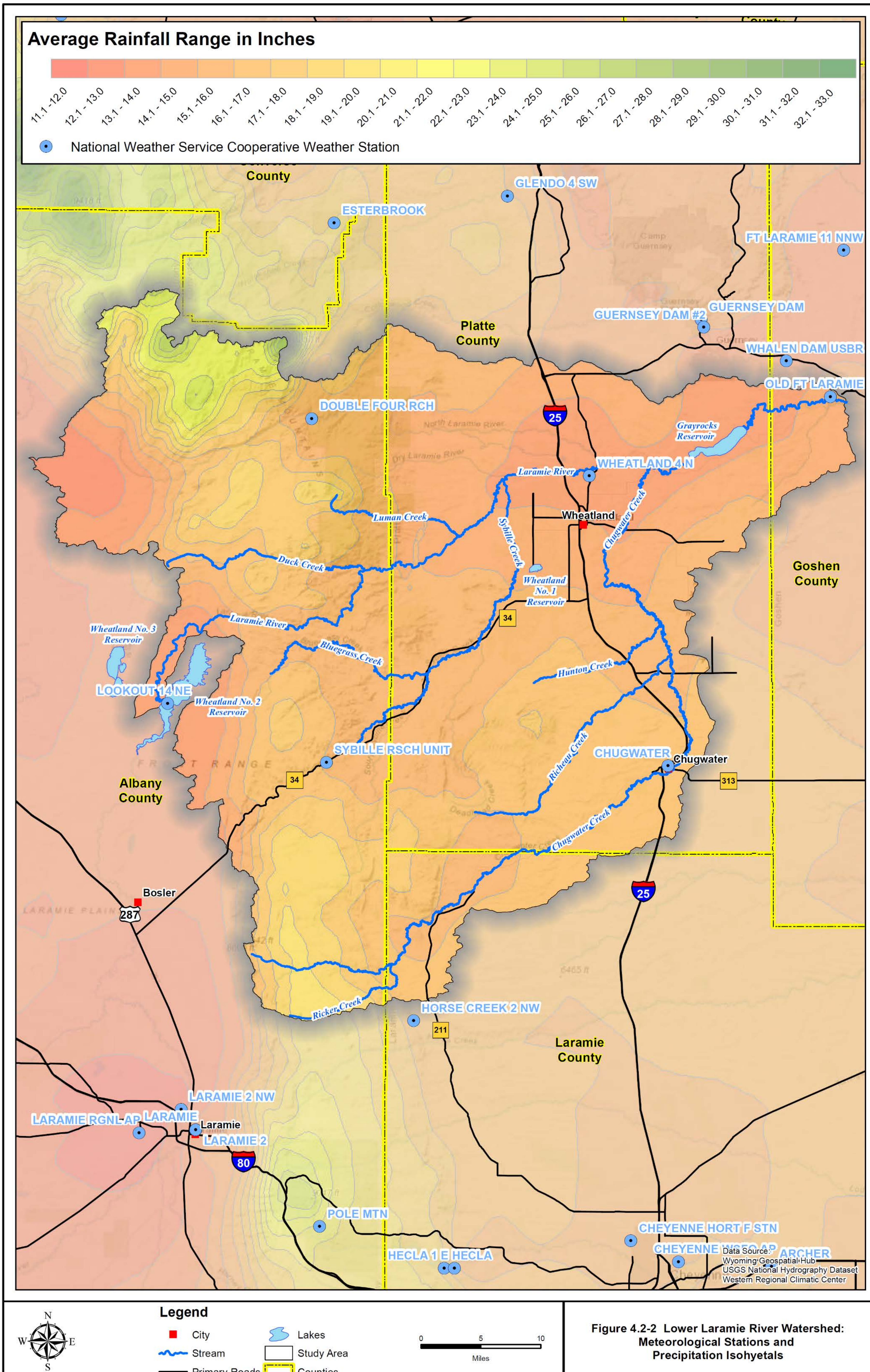


Figure 4.2-2 Lower Laramie River Watershed: Meteorological Stations and Precipitation Isohyetals

The average “frost free period” can be used to approximate the growing season, as described by the NRCS below:

> *“The growing season is defined as that part of the year when soil temperatures at 50 cm (20 inches) below the soil surface are higher than biologic zero (5 degrees C, 41 degrees F). As this quantitative determination requires in-ground instrumentation which is not usually available, growing season can be estimated by approximating the number of frost free days. The growing season can be approximated as the period of time between the average date of the last killing frost in the spring to the average date of the first killing frost in the fall. This represents a temperature threshold of 28 degrees F or lower at a frequency of 5 years in 10.”*

The average (50% probability) frost free period, spring last freeze dates, and fall first freeze dates at the NOAA Cooperative Weather Stations are shown in Table 4.2-2. The freeze-free periods are also shown graphically in Figure 4.2-4 for two threshold temperatures (28^{o}F and 32^{o}F). Temperatures between 32 and 28 degrees are considered a “light freeze” where tender plants are killed with little destructive effect on other vegetation, whereas temperatures below 28 degrees have a widely destructive effect on most vegetation.

Table 4.2-2 Average Frost-Free Periods at NOAA Cooperative Weather Stations.

Station	Period of Record	Threshold Temperature	Average Spring Last Freeze Date	Average Fall First Freeze Date	Average "Freeze Free" Period (days)
Chugwater	1900-2016	28^{o}F	14-May	22-Sep	133
		32^{o}F	2-Jun	14-Sep	104
Sybille Research Unit	1964-2016	28^{o}F	11-May	25-Sep	141
		32^{o}F	27-May	18-Sep	114
Lookout 14 NE	1933-1965	28^{o}F	21-May	21-Sep	123
		32^{o}F	4-Jun	9-Sep	98
Wheatland 4 N	1893-2016	28^{o}F	2-May	4-Oct	154
		32^{o}F	13-May	22-Sep	132
Double Four Ranch	1942-2005	28^{o}F	21-May	18-Sep	119
		32^{o}F	10-Jun	6-Sep	92

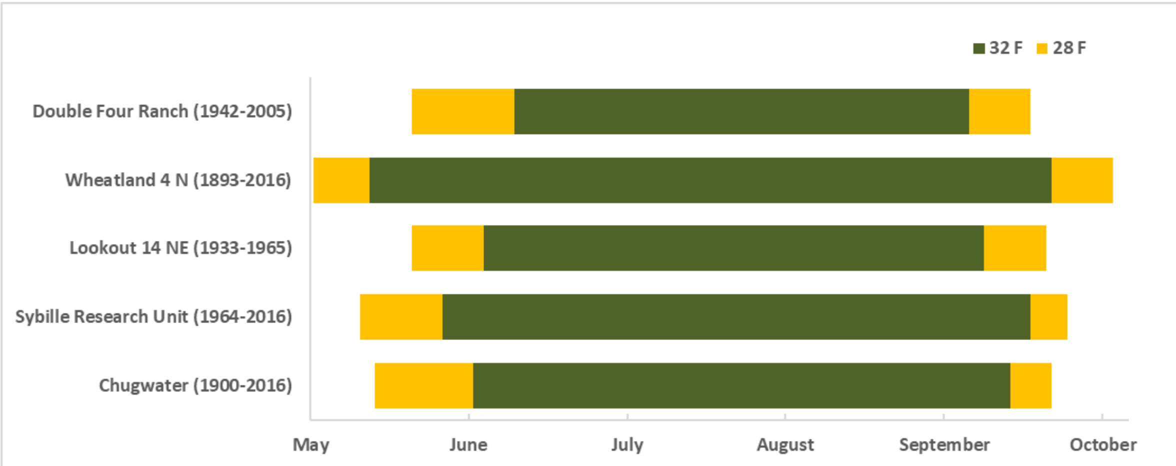


Figure 4.2-4 Average Frost-Free Periods at NOAA Cooperative Weather Stations.

This information must be viewed in light of the fact that climate variability is occurring and will likely continue to occur into the future. Causal relationships are open to debate, however, according to a recent publication of the University of Wyoming (Gray, S., C. Anderson, 2009):

> *"There is mounting evidence that the earth is experiencing a warming trend. Climate change has resulted in a 1° F increase in average global temperature in the past century, largely in the past 30 years (IPCC, 2007). The concern now is that climate change may increase the impact of droughts, just as population growth and other factors have greatly increased the West's vulnerability to water shortages. The impacts of these global changes on Wyoming's weather and river systems include altered precipitation patterns and changes to the timing of snowmelt and river flows, which together will significantly alter Wyoming's water supply."*

Management Implications:

Climatic variability will present unpredictable challenges for land managers; impacts of long-term climatic changes cannot be predicted at this time. Numerous guidance documents are available which provide guidance for conducting climate change vulnerability assessments, or CCVA's. The USEPA provides guidance documents worthy of review by land managers that target vulnerability assessment and planning to offset potential impacts. Many of these documents have been incorporated within the project Digital Library.

Data Sources:

Western Regional Climate Center: http://www.wrcc.dri.edu/
Oregon Climate Center, Oregon State University PRISM dataset

4.2.3 Geology

The foundation of the Lower Laramie watershed is, of course, the geology. The relative resistance to erosion of the geologic strata exposed at the surface defines every detail of the natural topography, with hard granitic rocks creating the high-elevation core of the Laramie Range, e.g. Laramie Peak, at 10,272 ft. elevation. In contrast, the valley of the Laramie River below Grayrocks (and adjacent Goshen Hole), at elevations below 4,400 ft. are eroded into the soft mudstones of the White River Formation.

In concert with climatic conditions, the geology also controls the texture, chemistry, and overall character of the soils formed across the watershed. Finally, geologic conditions govern the accumulation of mineral deposits and the availability and quality of groundwater.

This section begins with brief a discussion of the surficial geology, the materials found at the surface, intermediate between their bedrock source and their soil progeny. The bedrock geology is then presented in terms of “stratigraphy” - the character and distribution of the materials making up the subsurface strata - and “structure” - the geometry of how those initially flat-lying strata have been tilted (or not) and broken up over time.

4.2.3.1 Surficial Geology

The surficial deposits mapped within the Lower Laramie watershed are presented on Figure 4.2-5 (compiled from Case et al, 1998). For the most part, the distinction between surficial and bedrock geology is that the former is the unconsolidated, weathered product of the latter. Each of these deposits will produce soils and vegetation as a function of its physical and chemical composition, slope, slope aspect, local precipitation and other climatic factors, age, etc., all of which vary across the study area.

The detailed mapping behind Figure 4.2-5 includes 50 individual units. These have been grouped into 12 broader categories for presentation here. (The boundary lines within the major units on the map key reflect finer subdivisions: see the cited references for details.)

The largest fraction of the Lower Laramie watershed has been mapped as “exposed bedrock”, “grus”, and “residuum” (37% total). These are areas in which there has been little accumulation of weathering products, leaving the bedrock material exposed at the surface, or where there is a thin mantle of the direct breakdown products of the underlying rock. (“Grus” is the thin, coarse gravel-like material produced during the local weathering of granitic rocks.) Much of this area is in the highlands of the Laramie Range. With respect to water resources, these areas may be expected to produce rapid runoff of precipitation and snowmelt.

Second to exposed bedrock in areal coverage is “colluvium” (including the tiny percentage of “landslide deposits” (36% total) . This is simply material formed from the weathering of the underlying bedrock, that has moved downhill to some extent under the pull of gravity. (Figure 4.2-6 identifies the specific bedrock formations.) Such movement may be slow, e.g. “soil creep”, or dramatic, e.g. landslides. Soluble components of bedrock have been partially removed by surface water and groundwater. The remaining, insoluble portions of the rock experience mechanical weathering from freeze-thaw and rain-drop impact. Colluvium deposits within the study area may occur over any geologic substrate. Reflecting the ongoing weathering and erosion of underlying materials, these deposits are relatively thin compared to other surficial deposits. With respect to water resources, they are mostly too superficial to represent potential aquifer material, but may have implications for erosion.

Next most common are "terrace", "alluvial" and "bench" deposits (20%). These are composed of the material deposited by present and past stream systems. They are essentially flood deposits - sand, gravel, and clay - left across broad areas when the original stream found a new course in the case of terrace and bench deposits, and along the channels of active streams in the case of alluvial deposits. In the former case, the development of a "new" stream course may have left the deposits without a ready source of recharge. In the latter case, the adjacent stream typically provides abundant local recharge to aquifer materials. In either case, where saturated, these materials can produce attractive groundwater development opportunities and commonly produce relatively gentle slopes suitable for irrigated agriculture.

Other mapped surficial geology deposits mapped on Figure 4.2-5 include:

> "Alluvial Fan Deposits" - as streams carry eroded material out of highland areas, material is commonly deposited where stream gradients are lower at the toe of the slope, creating a fan-like deposit. Although slopes are typically relatively steep, such deposits may be sufficiently thick to host useful groundwater supplies recharged from upstream areas.
>
> "Eolian deposits" - wind-blown materials, i.e. sand dunes.

The surficial geology is primarily of importance with respect to the soils that form on those materials and as an indication of the stability of the landscape (e.g. landslides). With respect to water supply, the surficial geology plays little role, with the exception of immediately along perennial streams, where streamflow may keep surficial deposits saturated, providing a natural filter for wells that are basically stream diversions. Surficial geology may also impact groundwater recharge rates, as precipitation will readily infiltrate an area of sandy deposits and may run off with minimal infiltration where bedrock is exposed at the surface.

4.2.3.2 Bedrock Geology

The following paragraphs outline the basic geology of the Lower Laramie watershed in terms of the geologic formations present (the "stratigraphy") and the geometry of how those formations are oriented, folded, and faulted (the "structure"). For the purposes of this planning investigation, the watershed geology is presented with respect to its general relevance to the development of useful water projects. A detailed description of the complexities of the study area geology is beyond the scope of this investigation.

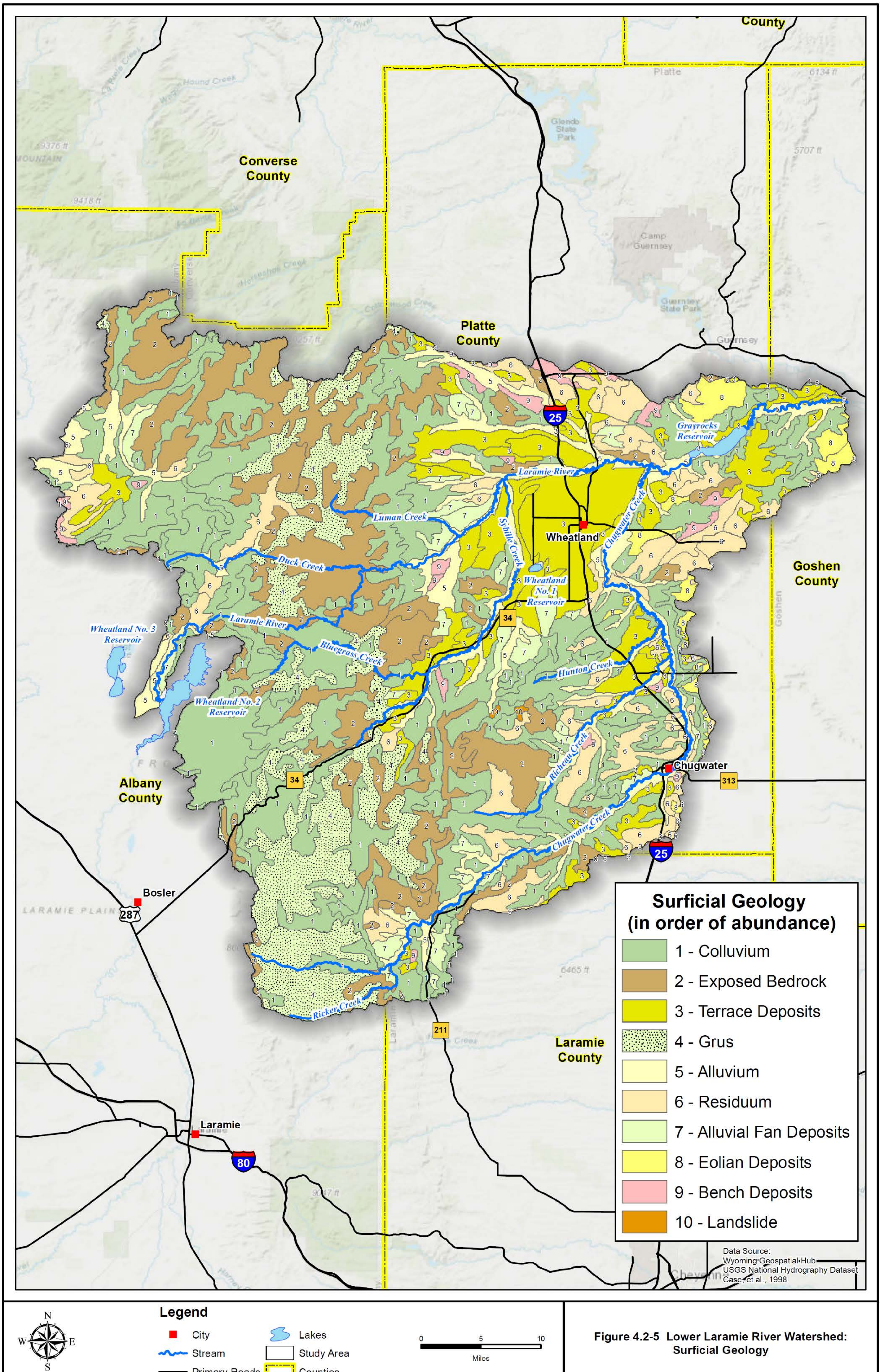


Figure 4.2-5 Lower Laramie River Watershed: Surficial Geology

A multitude of sources exist which provide additional details, site-specific geologic descriptions and mapping (e.g. see Taucher et al., 2013 for copious discussion and bibliography.) A comprehensive, although dated, discussion of groundwater resources through much of the study area is Morris and Babcock (1960), "Geology and Ground-Water Resources of Platte County, Wyoming".

The geologic materials present at the surface and in the near subsurface have an obvious bearing on potentially relevant issues of slope stability, structural integrity (dams, buildings), and infiltration rates and are the foundation for the types and quality of soils present.

The character of geologic materials in the deeper subsurface is primarily of importance to this study with respect to groundwater development opportunities, i.e. the potential quantity and quality of groundwater available at various locations and depths across the watershed.

Figure 4.2-6 provides a bedrock geologic map of the study area developed from standard mapping by the US Geological Survey (USGS) at 1:500,000 scale (Love and Christiansen, 1985) and mapping compiled by the Wyoming State Geological Survery (WSGS) at 1:100,000 scale (McLaughlin and Harris, 2005; VerPloeg and Boyd, 2007). Linear discontinuities between the various sections of Figure 4.2-6 are a function of the mapping scale rather than of any change in geology. Only the map units with significant coverage are labeled. Appendix 4A expands on the figure key and provides basic descriptions of all geologic units mapped in the study area, as well as formations present in the subsurface that may not outcrop within the Lower Laramie watershed. (The formations of the watershed are listed top-down from youngest to oldest on the Figure 4.2-6 key.)

Stratigraphy

The geologic formations that underlie the study area range in age from Precambrian (>600 million years old) to the alluvial deposits currently being laid down by the action of the Laramie River and its tributaries. Bedrock units exposed at the surface are primarily the Precambrian-age rocks making up the Laramie Range, the uplift of which laid the basic foundation for the river basin, and the Tertiary-age rocks that subsequently filled the basins between Wyoming mountain ranges.

Basically, the uplift of the Laramie Range brought with it a host of overlying sedimentary formations - the Mesozoic (Mz) and Paleozoic (Pz) age rocks of the Figure 4.2-6 key and Appendix 4A. This entire stack was folded and faulted in complex ways, and the sedimentary layers were eroded off the Laramie Range "granites" and the deformed Paleozic-age rocks of the Richeau Hills, laying down the relatively horizontal layers of the Tertiary-age Formations - the Ogalalla (To), Arikaree (Ta), White River (Twr) and associated strata. The older bedrock sedimentary formations are present beneath the Tertiary rocks throughout the watershed, but only show up at the surface along the edges of the mountain uplift.

The full thickness of sedimentary deposits would be around 16,000 feet and were all the original formations present. Table 4.2-3 summarizes the major stratigraphy in the Lower Laramie Watershed. Appendix 4A provides summary descriptions of the geologic strata of the Lower Laramie watershed, in

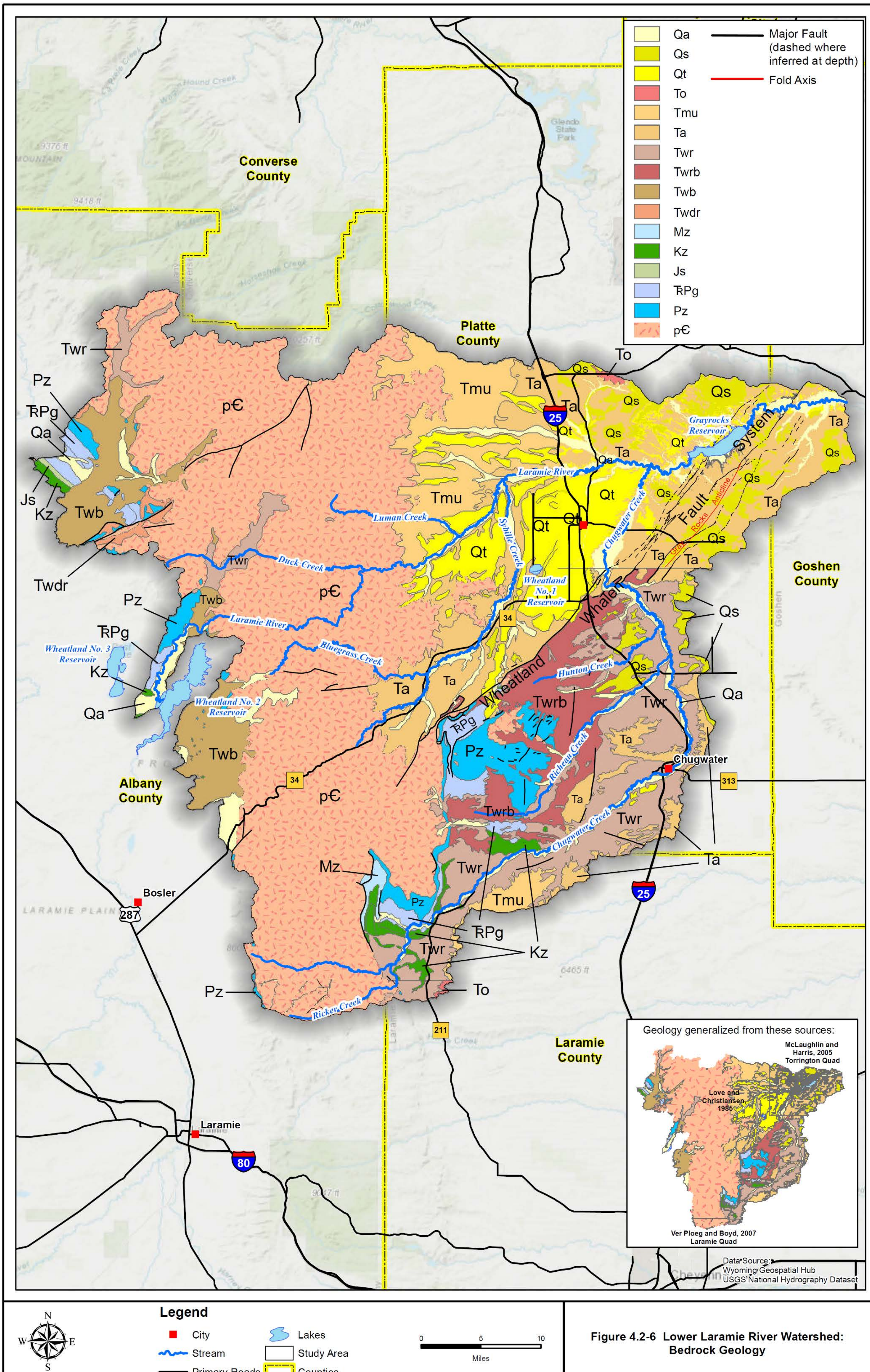


Figure 4.2-6 Lower Laramie River Watershed: Bedrock Geology

age order (youngest to oldest). This is the order in which each formation would be encountered in a vertical drill hole, although all formations are not present at all locations. What lies beneath the Tertiary formations varies substantially from place-to-place. The Forell Baumgardner No. 2 Well (Permit U.W. 43369), near the mouth of Chugwater Creek, for example, penetrated the Arikaree and White River Formations, but then encountered the limestone strata of the Hartville Formation. The entire thickness of Mesozic-age formations had been eroded away at this location before the White River Formation was laid down.

Table 4.2-3- Major Stratigraphy of the Lower Laramie Watershed.

Formation	Lithology	Thickness (feet)	Water Resources
sand deposits (Qs)	dune sand	0 - 50	surficial deposits, generally unsaturated
terrace deposits (Qt)	sand, gravel, silt lenses	0 - 100	useful aquifer where saturated
alluvial deposits (Qa)	sand / silt / clay / gravel	0 - 90	useful aquifer along active streams where sufficiently thick
Arikaree (Ta)	fine sand and silt, basal conglomerate locally	1200	primary aquifer in the Lower Laramie watershed
Brule (Tb)	siltstone	420	can be modestly productive in special circumstances
Chadron (Tc)	clay and silt	700	can be modestly productive in special circumstances
Strata below the Chadron are dominated by thick shale formations. The section includes permeable strata in the Fox Hills, Frontier, Cloverly, Sundance, and Minnekahta Formations, but these are only feasibly accessible for groundwater production at locations where the overlying formations are thin or absent, i.e. at the margins of mountain uplift or over similar structures buried in the subsurface.			
Casper / Hartville	limestone and sandstone	1,000	potentially significant aquifer, but little-developed due to limited opportunity
"basement" rocks (Precambrian)	granite, gneiss, schist	not applicable	yields small quantities of groundwater where fractured
Notes: 1) thicknesses from Morris and Babcock, 1960			

With respect to groundwater-development potential, the strata of primary interest in the Lower Laramie watershed are in the Arikaree Formation, in the alluvial deposits along the major streams, and with limited opportunities in the Casper Formations, present at feasible depths only along the basin margins. Formations between the deeper aquifers (e.g. Casper) and the widespread shallower aquifers (e.g. Arikaree) are dominated by fine-grained material generally poorly productive of groundwater.

Geologic Structure

In the case of the Lower Laramie watershed, the hydrologic basin, defined by surface topography, is a subset of the much larger geologic basin. The Laramie Range marks the western boundary of the regional "Denver-Julesburg" basin, which is created by the gentle eastward dip of the geologic formations off the mountain uplift. The highest elevations are occupied by the oldest rocks, forming the Laramie Mountains. Younger strata dip generally eastward from the mountains, as does the ground surface.

There are no substantial geologic structures that separate the North Platte from the Lower Laramie from the Horse Creek from the Crow Creek drainages in this region.

The extreme western margin of the watershed is an exception, where one is "on the other side" of the mountain uplift geologically, and the bedrock formations dip westward beneath the Laramie Basin. (See the companion study of the Upper Laramie River Watershed (Anderson, 2016) for discussion most relevant to those areas.) The narrowness of the outcrop bands on Figure 4.2-6 in those areas is a reflection of the steepness of the formation dips, i.e. one is only seeing the edges of a stack of cards whereas the "faces" of the cards are exposed on the east side of the Laramie Range, and the stream channels have cut down through the stack.

Groundwater development potential is naturally higher in rocks with abundant porosity and permeability, e.g. coarse sandstones, cavernous limestones, but across most of Wyoming, local fractures provide important, sometimes critical, enhancement of formation productivity. Fractures are created where rocks have been stressed, e.g. through folding or faulting. Because most of the formations of interest in the Lower Laramie watershed are relatively young - younger than Wyoming's major mountain-building episodes - they are relatively undisturbed.   Nonetheless, local small-scale fractures are present at many locations and can provide valuable indications of useful permeability at depth.

Faults of a magnitude to be mapped on Figure 4.2-6 are present in this watershed, primarily associated with mountain uplifts (Laramie Range and Richeau Hills), and along the Wheatland and Whalen Fault Systems running SW-NE through the area. The latter occur along the same alignment as the gentle Greyrocks Anticline, which is a structural response to the same regional stresses.

Morris and Babcock (1960) describe displacement of as much as 300 ft. across the principal Whalen Fault, and note that "many fractures and fissures have been formed in the same general area". None of these structures have been identified as producing the enhanced permeability supportive of groundwater production, but local fracturing is always a potentially important siting criteria for water wells. As noted by Crist (1983), “However, there has been insufficient drilling and testing in these fault areas to determine the hydrologic significance of the fault systems.” As a general statement, it is our understanding that remains true today.

Hoxie (1977) suggests that by juxtaposing the modestly permeable Arikaree Formation against the “impermeable Brule Formation”, the fault system functions as an impermeable boundary along much of the Wheatland Fault System.

Figure 4.2-6 includes many of the small faults in the Richeau Hills area, but additional detail is available through the quad-scale mapping of McGrew (1967i).

4.2.3.3 Geologic Hazards - Landslides and Earthquakes

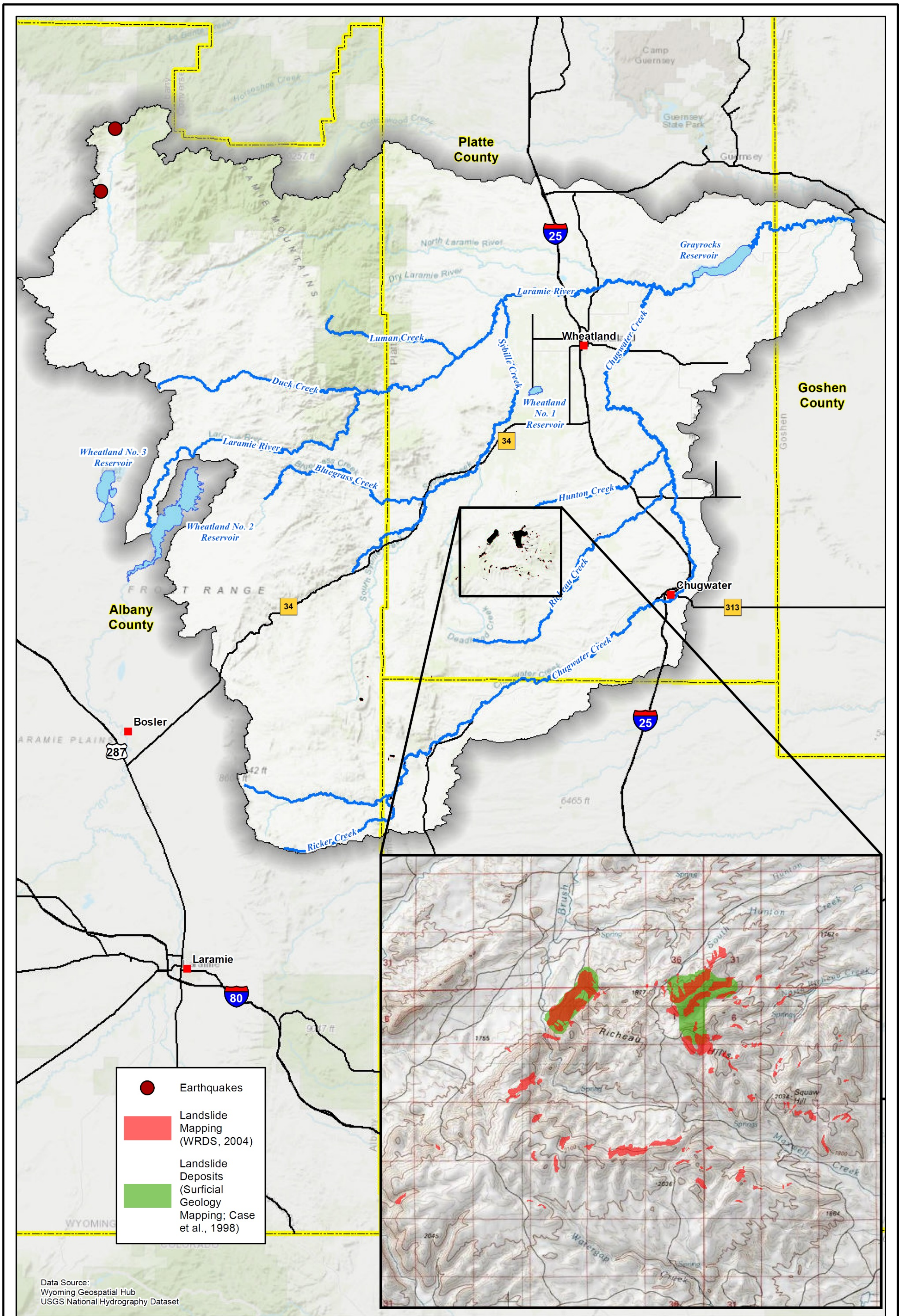
With rare exceptions, deformation and faulting within the study area is the result of activity in the far-distant geologic past. While the fracturing associated with faults can usefully enhance permeability and groundwater production, or create problems in terms of seepage rates and landslide potential, the faults do not represent a constraint on development activity with respect to earthquakes.

Figure 4.2-7 presents landslide information for the study area. Published landslide mapping is available as the "landslide deposits" mapped with the surficial deposits (Figure 4.2-5), and as "landslides" mapped based on surface morphology, independent of geologic materials (WRDS, 2004). The two approaches produce very similar, although not identical results. In any case, landslides are quite rare in this watershed due to the absence of favorable geologic materials and the relatively gentle topography. The one area of significant landslide activity is in the Richeau Hills, associated with the conjunction of relatively steep slopes in that area, geologic materials less stable than the granitic rocks of the Laramie Range, and perhaps somewhat higher precipitation. In general, landslides occur where geology, slope, and moisture (pore pressure) combine to create unstable conditions.

Future landslides are most likely to occur in association with areas of historical slope failure and where water infiltration is locally increased through development activity (e.g. canal construction, irrigation). Past activity suggests this a minor, localized concern in the Lower Laramie watershed.

The National Earthquake Information Center database (NEIC, 2018) lists two seismic events of greater than or equal to 3.0 magnitude, at the locations shown on Figure 4.2-7. (A magnitude 3.0 earthquake is just into the range that can be felt; magnitude 4.0 is described as comparable to a large truck going by; lower magnitudes are only discernable through seismograph monitoring.) The northern of the two earthquakes on Figure 4.2-7 was of magnitude 3.3. It occurred on Nov. 6, 1984. The southern of the two occurred on Feb. 13, 1983, of magnitude 4.0. Both locations are in the upper reaches of the North Laramie River.

Seismic hazard mapping by the USGS (Petersen et al., 2015) concludes a peak horizontal acceleration of 5-6% of gravity has a 10% chance of exceedance in 50 years for the study area. For perspective, this value



Legend

City | Lakes
Stream | Study Area
Primary Roads | Counties

0 5 10
Miles

Figure 4.2-7 Lower Laramie River Watershed: Earthquakes and Landslides

varies between <1 and >100% for the coterminous United States, and between 2 and 30% for all of Wyoming, placing the study area at the lower end of the scale.

4.2.4 Groundwater

The following sections provide an outline of groundwater relationships, the relative productivity of aquifers, the occurrence of springs and wells, and recommendations for site-specific evaluation of groundwater development opportunities in the Lower Laramie Watershed. For copious data, illustrations, and analysis of the entire North Platte River Basin, the reader is directed to the Wyoming Water Development Commission report, “Platte River Basin Water Plan Update - Groundwater Study” (Taucher et al., 2013).

Groundwater information specific to the Lower Laramie Watershed are abundant, due to widespread development for domestic, stock, municipal, irrigation, and industrial purposes (and the special evaluations related to water-rights disputes in the study area).

4.2.4.1 Groundwater Recharge

Groundwater resources are one component of the overall hydrologic cycle. "Groundwater" is not a source of water separate from "surface water". Rather, groundwater is sustained by the input of surface water, moves through the subsurface in response to “downhill” gradients, and is discharged back to the surface via stream gains, springs, and extraction by wells. Groundwater is one portion of a watershed’s total available water resource. Groundwater diversions differ from surface water diversions in timing, location, rate, volume, and quality.

Groundwater originates when rainfall, snowmelt, streamflow, and, in some areas, irrigation water, infiltrate into geologic materials. This constitutes groundwater "recharge". Recharge rates are a complex function of elevation; rainfall/snowmelt distribution, intensity, duration, and seasonality; vegetation; soil moisture condition, and the infiltration characteristics of the soil and underlying bedrock.

Recharge of groundwater varies widely across the watershed. It is highest where water available to provide recharge is most abundant, e.g. at higher altitudes of the watershed, along stream channels, where infiltration rates can readily accept available recharge, e.g. coarse-grained or fractured surfaces, and most importantly for the central area of the watershed, where Laramie River water is widely distributed via the irrigation system of the Wheatland Irrigation District (e.g. Hoxie, 1977). Natural recharge is highly variable temporally, typically most abundant in spring and relatively scarce in late-fall. Irrigation recharge is of course concentrated during the period of active irrigation, typically from May through September.

The generalized annual natural recharge rates developed by Hammerlink and Arneson (1998) are shown on Figure 4.2-8. These were developed with a grid system incorporating estimates of infiltration rates,

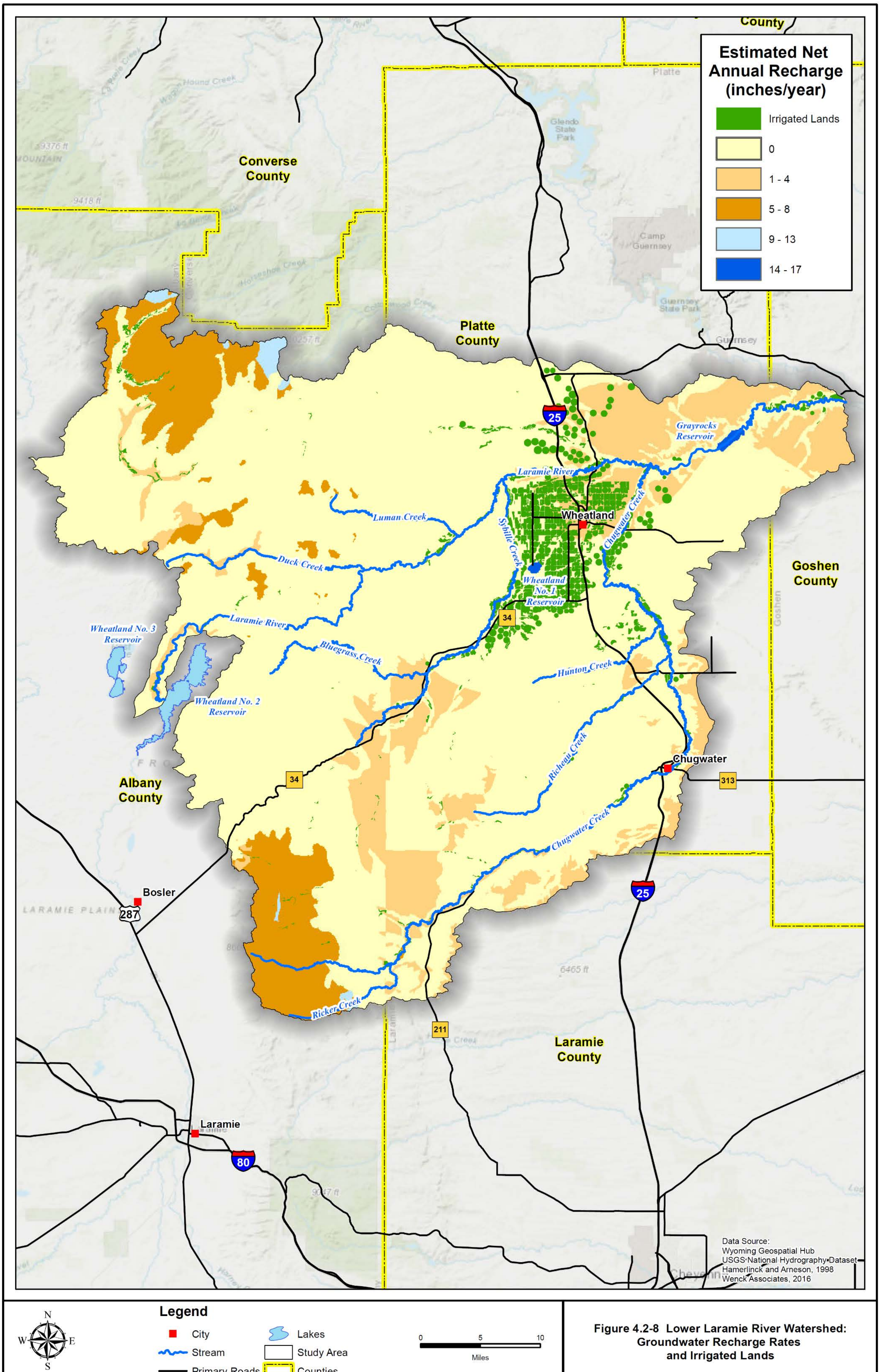


Figure 4.2-8 Lower Laramie River Watershed: Groundwater Recharge Rates and Irrigated Lands

surface characteristics, and annual precipitation (Note that the linear boundaries on Figure 4.2-8 are aberrations reflecting the boundaries of the different county-based maps used for the analysis). The highest estimated recharge rates - 8 to 12 inches - correspond with the highest elevations, i.e. the portions of the Laramie Range around Laramie Peak in the northwest corner of the watershed. Lower elevations are generally rated at less than 1 inch of annual recharge. Exceptions include areas underlain by sand dunes (e.g. in the northeast) due to very high infiltration rates, and the areas under reservoirs, of course.

Further processing of those estimates by Taucher et al. (2013) concluded that for most of the Lower Laramie portion of the North Platte River basin, approximately 1.5 - 5% of the local precipitation found its way into the underlying aquifers. (The remainder is lost to evaporation, runoff, and vegetation evapotranspiration.) Groundwater modeling in the central watershed by Lines (1976) estimated an average recharge rate of 6.5% of precipitation; modification of that model by Hydroscience (2000) used a rate of 5% over the areas of Arikaree Formation and 1% over areas of Brule Formation to reflect the lower permeability and infiltration rates of the latter.

Irrigation is a major source of recharge in the Lower Laramie watershed, concentrated under the 39,000 irrigated acres of the Wheatland Irrigation District and the 25,000 acres irrigated in the watershed outside of the District. (Figure 4.2-8 includes the irrigated lands of the watershed.) This water is diverted from the Laramie River and its tributaries. It enters the aquifers of the watershed by infiltration beneath the canals, laterals, and fields of the irrigation system. Hydroscience (2000) estimated average annual irrigation application of 78,000 ac-ft per year on the Wheatland Irrigation District adopted a steady-state irrigation recharge of 22,400 ac-ft/yr from previous US Bureau of Reclamation studies. Crist (1983) estimated annual recharge to the aquifers beneath the Wheatland Flats portion of the watershed varying from 11,400 ac-ft to 33,700 ac-ft over the 1971 - 1980 period.

4.2.4.2 Groundwater Levels and Flow

Over days, years, centuries, or even millennia (where groundwater circulation is long and deep), this recharge travels through the ground and returns to the surface as discharge. Between the points of recharge and discharge, groundwater flow may be straightforward or quite complex. Because groundwater is continually returning to the surface as springs (discussed below) and, more importantly, as diffuse gains to most of Wyoming's perennial streams, streamflow volumes include large quantities of groundwater. In the absence of storm runoff or snowmelt, most of the flow in Wyoming's streams comes from groundwater discharge at some point upstream.

Like surface water, groundwater flows “downhill”, from areas of high groundwater level elevation to areas of lower groundwater level elevation. The groundwater elevation contours developed by Morris and Babcock (1960) are reproduced here on Figure 4.2-9. Like surface topographic contours, these groundwater elevation contours show “uphill” and “downhill” with respect to groundwater flow. Higher groundwater elevations beneath higher surface elevations are a reflection of local recharge. (Current and local measurements will be superior to this mapping for assessment of depth to water at a specific location, but these basic patterns of groundwater flow persist through time.)

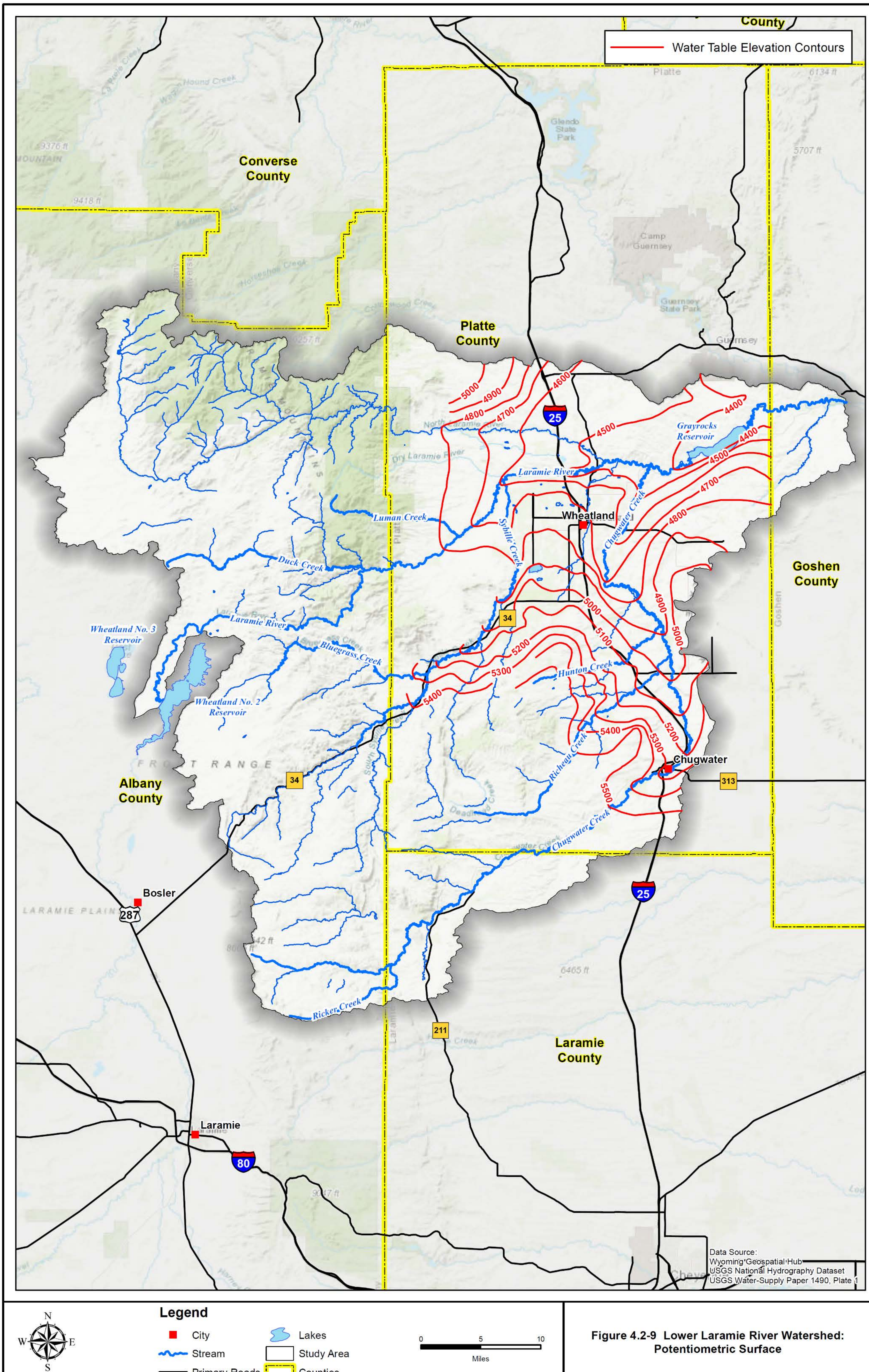


Figure 4.2-9 Lower Laramie River Watershed: Potentiometric Surface

Figure 4.2-9 presents the horizontal gradients in the groundwater flow system, but groundwater flow is 3-dimensional. In the Wheatland Flats area, for example, there are downward gradients within the Arikaree Formation. A 20-foot water-level difference between the upper and lower water-bearing zones of the formation (lower water level in deeper zone) is common, and areas where the difference is up to 100 feet were mapped by Weeks (1964).

On the local scale, this groundwater flow creates springs, often reflecting small, local groundwater flow systems. On a larger scale, the deflections of the groundwater elevation contours along stream channels reflect groundwater flow towards and groundwater discharge into those streams with the Laramie and North Laramie Rivers and Sybille, Richeau and Chugwater Creeks serving as the "base" elevations towards which both the surface water and groundwater flow. This groundwater drainage toward low-elevation opportunities for discharge is what sustains the perennial streams of the Lower Laramie watershed.

Figure 4.2-9 includes the streams along the mountain front which, although perennial in their upper reaches, are ephemeral as they recharge water to the permeable strata of the "basin" areas. Rather than depicting a convergence of the groundwater contours, i.e. a discharge of groundwater, they depict a slight bulge in the groundwater contours as groundwater builds up beneath these "losing" streams.

On the scale of the entire watershed and the deeper aquifers, groundwater flow is generally down-valley, leaving the watershed in the aquifers beneath the Laramie River to continue eastward into and beneath the North Platte River.

Crist (1983) examined 1958 to 1981 hydrographs for four wells in the Wheatland Flats area and, while documenting fluctuations in the depth to groundwater of 10 ft. or more, found no long-term trends. More recent data from the WSEO, which maintains 13 monitoring wells in Platte County, show similar long-term fluctuations for the 1981 - 2018 period, with consistent lows in the mid-2000s drought, and net declines from zero to 10 ft.

Given the importance of irrigation seepage to maintaining groundwater elevations, there is some concern that the increasing use of irrigation sprinklers and the lower seepage "losses" they provide may lead to a decline in the groundwater table in some areas.

4.2.4.3 Groundwater Discharge

Groundwater is naturally discharged to the surface by springs and seeps, by evapotranspiration, and by discharge to streams and other aquifers. Artificial groundwater discharge is provided through construction and operation of wells.

Figure 4.2-10 includes perennial streams in the Lower Laramie watershed as mapped by the U.S. Geological Survey at a scale of 1:100,000. The higher density of perennial streams in the western portion of the watershed is a reflection of both the higher precipitation and the lower infiltration rates in the high-elevation and low-permeability rocks of the Laramie Range. Downstream, there is less precipitation to

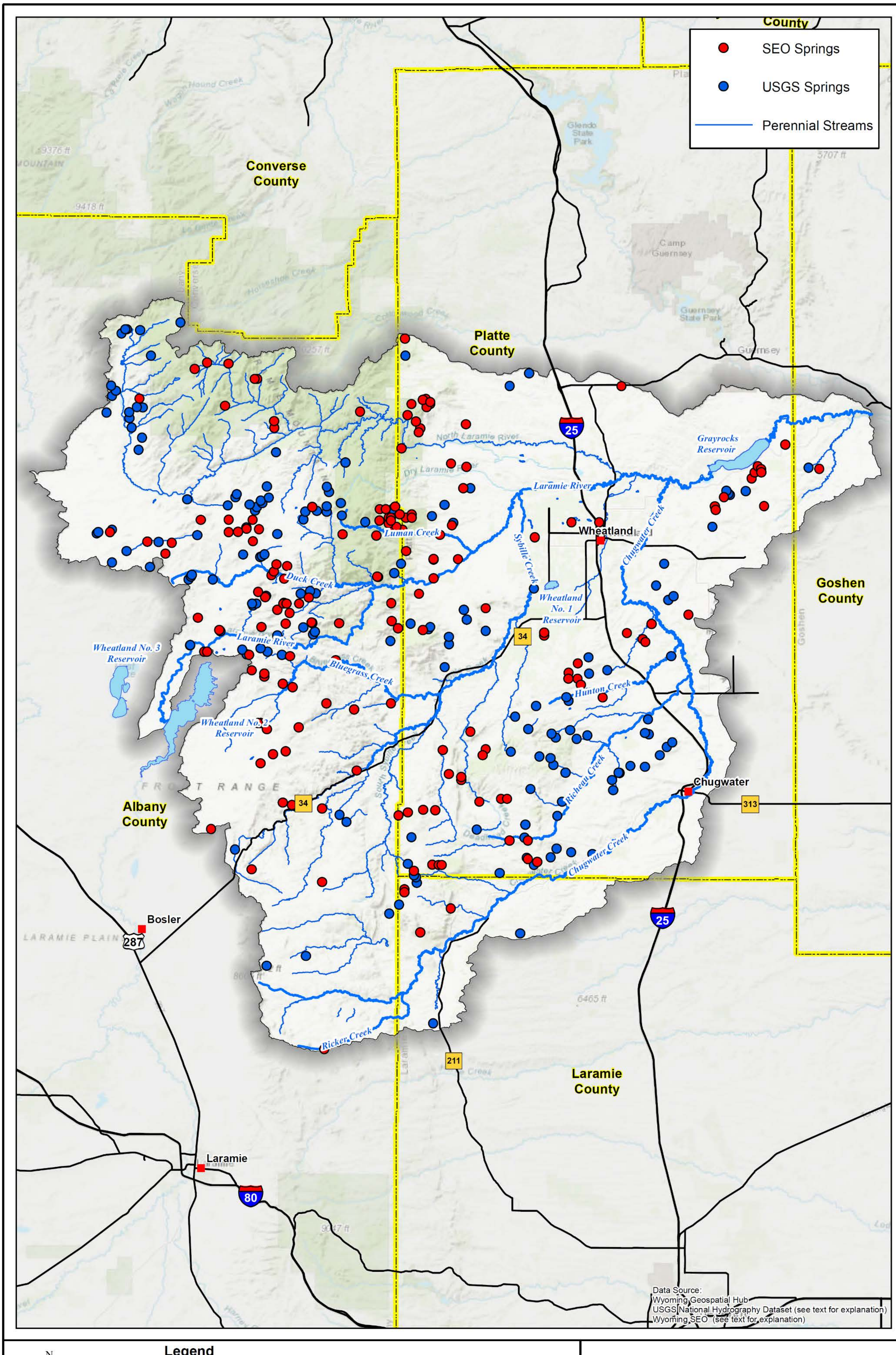


Figure 4.2-10 Lower Laramie River Watershed: Springs and Perennial Streams

sustain local streamflows and infiltration rates are generally higher. Thus, only the major streams, accumulating surface runoff from wide areas and fed by relatively deep-seated groundwater, maintain significant flows year round.

Groundwater output to the streams of the Lower Laramie watershed, i.e. stream “gains”, were directly measured by Weeks (1964). He concluded an average of 17.8 cfs were being added to the flow of the Laramie River from the mouth of Sybille Creek to the head of Grayrocks Reservoir, for example. Hydroscience (2000) developed arguably better groundwater discharge estimates through operation of a numerical groundwater model, including comparisons with available direct measurements:

Sybille Creek from due west of Wheatland to the mouth of the creek - 3.5 cfs

Chugwater Creek from ESE of Wheatland to the mouth of the creek - 8.4 cfs

Laramie River from Sybille Creek to the head of Grayrocks Reservoir - 20.4 cfs

Although groundwater outflow to streams will vary somewhat seasonally in response to higher or lower groundwater levels in the source aquifer, due to the large storage capacity of the aquifers, groundwater outflow to streams is much more consistent through time than the surface runoff created by individual storm events. It is groundwater that supports the “base flow” of these streams year round.

More important to the distribution of groundwater discharge across the wider landscape is the occurrence of natural springs. Springs and seeps occur when the water table intersects the land surface.

Springs commonly result from locally favorable characteristics of lithology, faults and fractures, and/or surface topography. For example, where a sufficiently permeable geologic unit (e.g. a poorly-cemented sandstone or conglomerate) crops out in a swale or on a hillside at an elevation below the prevailing groundwater table in the bedrock unit at that location, a spring may develop. Similarly, a permeable geologic structure (e.g.,an open joint, fracture or fault zone) may intersect the ground surface and serve as a conduit for the discharge of groundwater from deeper aquifers.

Spring flows vary widely due to the nature of the aquifer/structure discharging, the amount of seasonal recharge from snowmelt and rainfall, depletion of storage during periods of drought, and seasonally variable evaporation and evapotranspiration near the site of the spring. The flows can be concentrated or diffuse, again depending on the nature of the geologic conditions causing the spring.

Figure 4.2-10 presents mapped springs for the Lower Laramie watershed. Those marked as “USGS” were digitized by University of Wyoming personnel from standard USGS 1:24,000-scale topographic mapping, i.e. the word “spring” and/or a spring symbol on the printed topographic map (Wyoming Geological Survey, 2010), with limited additions for the present report by the same method. These do not reflect all existing springs, as the USGS mappers typically worked from air photos and all springs do not express themselves conspicuously. However, the locations of these springs are likely quite accurate due to the manner in which they were compiled. There are 170 “USGS” springs on Figure 4.2-10. Fifteen of them were of sufficient interest to have received a specific name.

Those springs on Figure 4.2-10 marked as “SEO” were extracted from the e-Permit database of water rights maintained by the Wyoming State Engineer’s Office. Within the “diversion type” = “Groundwater”, a permit was identified as being a spring based on minimal reported “depth” (18 ft.), the word “spring” or “springs” in the facility name, and a small reported “depth to water”. Five “seeps” (all less than 10 ft. deep) were also included as springs. In addition, an e-Permit search using “Diversion Type” = “Springs” was made. From those, a permit was interpreted as being a spring by the word “spring” or “springs” in the “stream source” (and excluded stream sources with the words “creek”, “draw”, “gulch”, “channel”, “reservoir”, or “river”).

This process is poorly controlled, as it depends almost entirely on owner reporting and consistent administrative categorization. A ditch diversion from a natural stream may have been identified as a “spring” because the owner considered the stream to be spring-fed, for example. The mapping and accompanying GIS listing of Lower Laramie watershed “SEO” springs should be used with caution and individual “springs” of interest individually investigated before assuming accuracy and making any groundwater development plans or decisions.

86% of the SEO springs for which yields are reported list 25 gpm or less; 25 gpm is something of a default value for groundwater rights so this may or may not reflect an actual measurement.

The “SEO” springs are plotted on top of the “USGS” springs on Figure 4.2-10 where the two coincide. Consult the relevant electronic GIS files to discriminate.

The locations of the “SEO” springs are a mix of precise locations based on reported GPS coordinates, and approximate locations based on the center of the permit-reported 1/4 1/4 Section. In the latter case, the actual location could be as much as 900 feet from the posted location, assuming the permit-listed location was correctly reported. (None of these locations have been field verified for this report.) In many cases, the flow of a natural seep or spring with a state water right will have been enhanced through excavation or shallow well construction

The existence of a water right (the “SEO” springs) demonstrates a specific interest in putting a spring to a recognized “beneficial use”. Undeveloped natural springs without attached water rights will not be identified through this process, but a substantial spring is likely to have attracted development interest. Large springs are necessarily associated with productive aquifers (discussed below), but small springs and seeps occur as a result of sometimes quite local conditions of recharge, topography, and aquifer permeability, in many geologic settings.

Most of the springs in the Lower Laramie watershed are in the Laramie Range, basically the western half of Figure 4.2-10. Rather than being a sign of a productive aquifer, however, just the opposite is true. Because these rocks are relatively impermeable, there is little opportunity for deep recharge and shallow infiltration of local infiltration feeds springs in local low-spots in the topography. Springs are typically small, reflecting the local nature of the supporting recharge/discharge process.

East of the mountain front, springs are most common at geologic contacts. Precipitation and snowmelt infiltrate into a relatively permeable unit, like a sandstone. That water migrates downward, creating a local aquifer, until a relatively impermeable layer (e.g. mudstone, shale) is encountered. Groundwater then moves laterally on top of that low-permeability unit until it emerges at the ground surface where the contact between the two strata intersects a hillslope.

This type of spring occurs in the Lower Laramie watershed at the contact between the Brule and the Arikaree Formations, for example in the area south of Grayrocks Reservoir. In that case, sandstone strata within the Arikaree are recharged across broad outcrops to the south and east (see Figure 4.2-6), perhaps facilitated by local sand deposits at the surface ("Qs"). The underlying siltstones and claystones of the Brule are less accommodating of groundwater movement, so where the Arikaree/Brule contact is exposed by the downward erosion of the Laramie River, groundwater discharges from the base of the Arikaree. Morris and Babcock (1960) state that most of the springs in Platte County are contact springs, i.e. of the type discussed here.

The fractured limestones of the Casper Formation also create local conditions conducive to spring discharge where that formation is present at the surface, e.g. in the Richeau Hills south of Wheatland. Morris and Babcock (1960) observe that, "Many springs issue from the Hartville and Casper formations, but most of them yield only small amounts of water."

The springs of the Lower Laramie watershed are mostly small, "generally yield less than 5 gpm each" as stated by Morris and Babcock (1960), who inventoried a total discharge of "about 3,000 acre-feet a year" and opined that "the discharge of all the springs in the county [Platte] would be several times that amount."

Finally, substantial quantities of groundwater are discharged in the Lower Laramie watershed through wells. These are discussed in detail below (Section 4.2.4.4).

4.2.4.4 Aquifers

Classification of a body of geologic material as an "aquifer" depends on how much water is needed for a specific user or purpose. A hydrogeologic unit capable of adequately supplying the modest water needs of a single rural residence may be entirely inadequate to meet the needs of an agricultural operation. Similarly, a groundwater quality suitable for livestock watering may be unacceptable for human consumption.

The 2007 Wyoming Framework Water Plan (WWC, 2007) offered general classifications of the strata of Wyoming as between "major", "minor" aquifers and aquicludes (formations that largely inhibit rather than provide groundwater flow). That terminology has been adopted for Figure 4.2-11, with customization to better match conditions in the Lower Laramie watershed. Formations are classified primarily by lithology:

1 - significant aquifer: strata dominated by sandstone, conglomerate, or limestone.

2 - minor aquifer: strata of mixed sandstone and siltstone/mudstone/shale

3 - marginal aquifer: strata dominated by silstone/mudstone/shale or likely to be thin and poorly saturated

4 - major aquitard: regionally extensive shale strata.

Hydrogeologic analyses in the Lower Laramie watershed (e.g. Weeks, 1964; Lines, 1976; Crist, 1983) have largely focused on the "Wheatland Flats", the area bounded by Chugwater Creek, Sybille Creek, and the Laramie River around the Town of Wheatland that has been extensively developed for irrigated agriculture.

The strata with the highest aquifer potential in the Lower Laramie Watershed are not generally stand-out aquifers on a statewide basis, but under particularly favorable circumstances and aggressive pumping can provide up to 1,000 gpm of good-quality groundwater. "Favorable circumstances" include the presence of higher permeability strata, large saturated thickness, and, ideally, fracture enhancement of permeability.

Where saturated, the alluvial deposits of the watershed can provide locally important aquifers. Such deposits occur across seven mapped terraces (Morris and Babcock, 1960) and along the major stream channels. Terrace deposits up to 90 ft. thick and current-stream alluvium "0 to about 40 ft." thick are reported by Crist (1983), who also notes that in many areas these deposits are too thin to be saturated and the only productive wells are completed in the underlying Arikaree Formation. Hydroscience Associates (2000) describe the terrace deposits as averaging 30 feet thick across the Wheatland Flats, state that "prior to irrigation on the Wheatland Flats, little water was present in the terrace gravels", and ascribe the buildup of a useful water table in these deposits to the abundant recharge from irrigation atop the underlying, less-permeable Arikaree Formation.

Saturation is similarly important for both the Ogalalla and the Arikaree Formations. Both are major aquifers in the Lower Laramie watershed (and are so mapped on Figure 4.2-11), but may not provide significant groundwater supplies where they are isolated in upland areas, due to minimal saturation (e.g. areas in the Chugwater Creek drainage above Wheatland).

The most well-developed aquifer in the watershed is the Arikaree, along with the overlying alluvial terrace deposits where present. The Arikaree Formation in the Wheatland area is commonly divided into two zones (e.g. Morris and Babcock, 1960):

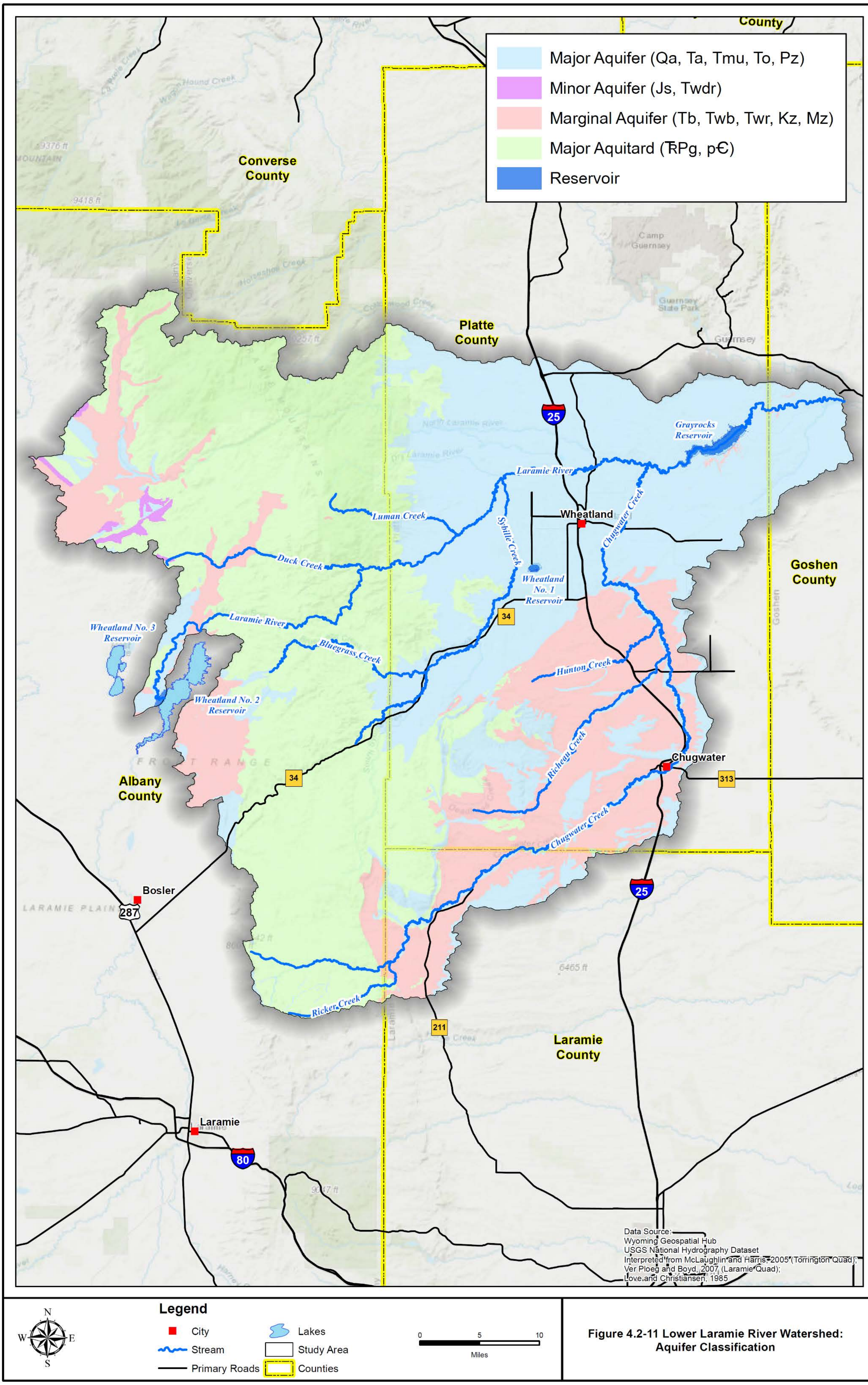


Figure 4.2-11 Lower Laramie River Watershed: Aquifer Classification

1) an upper zone, 400 to 850 feet thick, consisting of very fine grained sandstone and siltstone; and

2) a lower zone, 88 to 340 feet thick, consisting of coarse to very coarse sandstone interbedded with lenses of well-cemented conglomerate.

In local vernacular, these two zones have come to be called the “red aquifer” and the “green aquifer”, respectively. This “upper” vs “lower” distinction is informal, and may vary somewhat depending on the application, e.g. groundwater modeling, groundwater administration, etc. For example, a numerical groundwater model of the Wheatland Flats area was developed by Crist (1983), who defined two “aquifers”: 1) “the saturated terrace deposits and the upper part of the Arikaree”, 100 feet thick; and 2) “the saturated Arikaree Formation below a depth of 100 ft.”. Hydroscience Associates (2000) divided their groundwater model of the same area between the terrace deposits (up to 50 feet thick) and the entire Arkiaree (approximately 500 feet thick). Wyoming State Engineer groundwater permits for the Laramie Power Station wells above Grayrocks assign the 823 feet deep Joseph P Johnson 3rd Well (Permit U.W. 43369) to the “red” aquifer, and the 1130 feet deep Taylor Johnson No. 1 Well (Permit U.W. 17434) to the “green” aquifer.

Low-permeability strata within the Arikaree create a degree of hydraulic separation, both between the Arikaree and the overlying alluvial deposits in some cases, and between the upper and lower portions of the Arikaree. The former situation creates flowing Arikaree wells in topographically low areas, e.g. at select industrial wells along the Laramie River above the mouth of Chugwater Creek. The latter has led to regulatory restrictions like that for the Taylor Johnson No. 1 well (Permit U.W. 17434), “This well shall be constructed in such a manner to allow withdrawal of ground water from only the "green" aquifer. This well shall be constructed in such a manner that no communication of ground water between the "red" and "green" aquifers can occur.”

Discharge from the Arikaree aquifer occurs to the streams surrounding the Wheatland Flats, where the aquifer has been dissected by erosion of the stream valleys. Hinckley (2003) evaluated the water-table aquifers of the Lower Laramie watershed to assess stream depletion effects subject to the provisions of the Modified North Platte River Decree (see Chapter 6 Watershed Management Plan), using the techniques of Jenkins (1968) with application of the Hydroscience (2000) groundwater model in select areas.

Groundwater modelers (e.g. Crist, 1983; Hoxie, 1977; Lines, 1976) have consistently terminated the primary aquifer at the base of the Arikaree, where it is underlain by the well-cemented siltstones of the Brule Member of the White River Formation, e.g. “The Arikaree aquifer overlies relatively impermeable siltstones in the White River Formation in most of the area” (Lines, 1976). This is a function of their focus on the large-capacity wells intended for municipal, irrigation, and industrial use, however, and overlooks the potentially useful lower-productivity aquifers that can be found in the underlying Brule Formation at select locations. (Note that the upper Brule constitutes an important aquifer in select adjacent areas of

Wyoming, where well-developed fracture systems provide groundwater storage and much-enhanced permeability. Those special conditions have not been identified in the Lower Laramie watershed). Similarly, older aquifers present in the watershed that are known to produce useful quantities of groundwater elsewhere include the Lance, Fox Hills, Cloverly, Sundance, Minnekahta, and Casper Formations. With the exception of limited areas around mountain uplifts, however, these aquifers are too deep to present useful alternatives to the overlying strata.

The most notable of these older formations is the Casper (or Hartville) Formation. It hosts the high-capacity springs and wells serving the City of Laramie (in the Upper Laramie watershed) and the phenomenal Lietz No. 1 irrigation well just outside the southwest border of the present study area. The latter has a measured production rate in excess of 6,000 gpm with minimal drawdown. The Casper Formation is present in the south central portion of the Lower Laramie watershed, in the Richieau Hills area, but has been little explored for groundwater.

4.2.4.5. Groundwater Quality / Sensitivity

The alluvial aquifers primarily receive recharge from an adjacent stream (or from irrigation applications of water diverted from an adjacent stream) and/or the surrounding geologic materials. Where the former dominates, groundwater quality is generally good. The aquifer sands and gravels tend to filter sediment and bacteria from the surface source to produce water that is clean and of low salinity. Where the association with surface water is too intimate, filtering of bacteria and viruses may be incomplete, requiring disinfection to be suitable for culinary use.

Where there is substantial inflow to the alluvial aquifer from bedrock, alluvial groundwater quality will reflect that of the surrounding formations. This water will commonly be higher in salinity than the surface water and may render the alluvial aquifer of limited value for many applications.

Bedrock aquifers receive recharge to their outcrop areas through the infiltration of rainfall, snowmelt, streamflow (although discharge from groundwater to streams is more common than the other way around), and irrigation. Groundwater developed close to the areas of recharge may be of relatively high quality, regardless of the host formation. As water moves deeper, it generally becomes more mineralized.

In general, groundwater quality tends to be better in the more productive aquifers because of the more active groundwater circulation and less soluble minerals. An exception is the crystalline rocks (i.e. the Precambrian rocks of the Laramie Range) in which quality is generally good due to the very low solubilities of the constituent minerals, but productivity is low due to the virtual absence of porosity or permeability in the rock.

The Wheatland municipal water supply is likely the most closely monitored groundwater source in the Lower Laramie watershed. It produces from the Arikaree Formation. It is consistently described as of very good quality and meets all EPA Drinking Water Standards, with the following exception: “There is a deep zone within the Arikaree Formation that has a persistently high gamma count on geophysical logs.

When this zone is developed, the gross alpha tends to be higher than the EPA primary standards, but upon further analyses meets the EPA radionuclide requirements except for gross alpha." (Wester Wetstein, 2010; p. 4-4).

Taucher et al. (2013) provide summaries of groundwater quality information for the North Platte Basin in Wyoming east of the Laramie Range (i.e. including the lower Laramie watershed). Their compilations demonstrate the wide variability within any one aquifer that is the expected result of variations in depth, local composition, recharge, groundwater flow paths, and groundwater residence times. Median values for select paramaters for the aquifers of primary interest in the Lower Laramie are compiled from that report in Table 4.2-4.

Table 4.2-4 - General Groundwater Quality - Median Values (mg/l).

	Arikaree	Brule	Casper
Total Dissolved Solids	265	357	259
Hardness	171	140	220
Sodium	16.0	32.0	9.6
Magnesium	9.4	11.0	20.6
Calcium	50.5	39.0	51.3
Chloride	6.3	9.0	3.5
Alkalinity	171	162	190
Sulphate	17.0	32.0	26
Iron	0.037	0.015	
Uranium	0.007	0.017	

For the Arikaree Aquifer east of the Laramie Range, Taucher et al. (2013) report Total Dissolved Solids (TDS) concentrations from 202 to 868 mg/l, with a median value of 265 mg/l. [12% of the samples reported TDS concentrations in excess of the US EPA Secondary Drinking Water Standard. TDS is 500 mg/l (but this is an aesthetic standard rather than a health-based standard).] The only other constituents of potential concern in that study were sulphate, for which 3% exceeded the EPA Secondary standard, and radon, for which some samples exceeded proposed EPA standards.

For the Brule Formation, Taucher et al. (2013) report Total Dissolved Solids (TDS) concentrations from 214 to 676 mg/l, with a median value of 357 mg/l. Other constituents of potential concern cited in that study, found in some samples, were sulphate, radon, nitrate, boron, and sodium adsorption ratio (SAR). SAR is relevant to irrigation, as high SAR values indicate a tendency to reduce soil permeability. 12% of the samples analyzed for SAR exceeded the agricultural use standard.

In general terms, the groundwater quality in both of these aquifers is widely suitable for most uses. Specific uses for which any of the constituents cited above might prove problematic should acquire site-specific water-quality analysis, particularly for the Brule and Chadron Formations. Note that groundwater quality generally deteriorates with depth. The same formation may provide a TDS of 200 mg/l from an outcrop spring and a TDS of 5,000 mg/l from a deep well.

Where aquifers receive recharge from the surface, they are potentially subject to contamination. In 1998, the University of Wyoming completed a statewide study of groundwater contamination potential that assessed seven factors, including depth to groundwater and recharge rates, to produce 1:100,000 scale county-by-county maps. (The recharge rates of Fig. 4.2-8 are from this same study.)

Figure 4.2-12 presents this mapping of "Aquifer Sensitivity" for the Upper Laramie Watershed. Rankings are relative and carry no specific units. The most sensitive lands are those where a contaminant at the surface such as a spill, over-application of agricultural chemicals, or septic system effluent can most easily enter the aquifer. The most sensitive areas on Figure 4.2-12 basically coincide with the alluvium along the major streams of the watershed and the alluvial terrace deposits of the Wheatland area. These are areas where contaminants readily enter the groundwater recharge system. Least sensitive are bedrock aquifers where they are overlain by substantial thicknesses of low-permeability material.

The high-sensitivity designations on Figure 4.2-12 in the mountainous areas are likely the result of an unfavorable combination of high precipitation, shallow soils, and, in the case of the southwest corner of the watershed, the prevalence of extremely permeable grus deposits at the surface (see Figure 4.2-5).

4.2.4.6 Groundwater Use

All diversions or extractions of water in Wyoming, both surface and groundwater, require permitting through the Wyoming State Engineer's Office (SEO). Thus, the history and distribution of groundwater permits provide an empirical picture of the groundwater resource to the extent this resource has been developed for human use.

There are approximately 3,256 groundwater permits in good standing in the Lower Laramie watershed (monitor and test wells and cancelled permits not included), too many to be usefully listed here. (A complete electronic listing accompanies the GIS files associated with this report.) The following sections address permits issued for groundwater use in each of five use classifications - irrigation, municipal, domestic, stock, and industrial. Wyoming water rights include specific use designations, and a single water right may carry multiple uses. For this report, we have applied the following taxonomy:

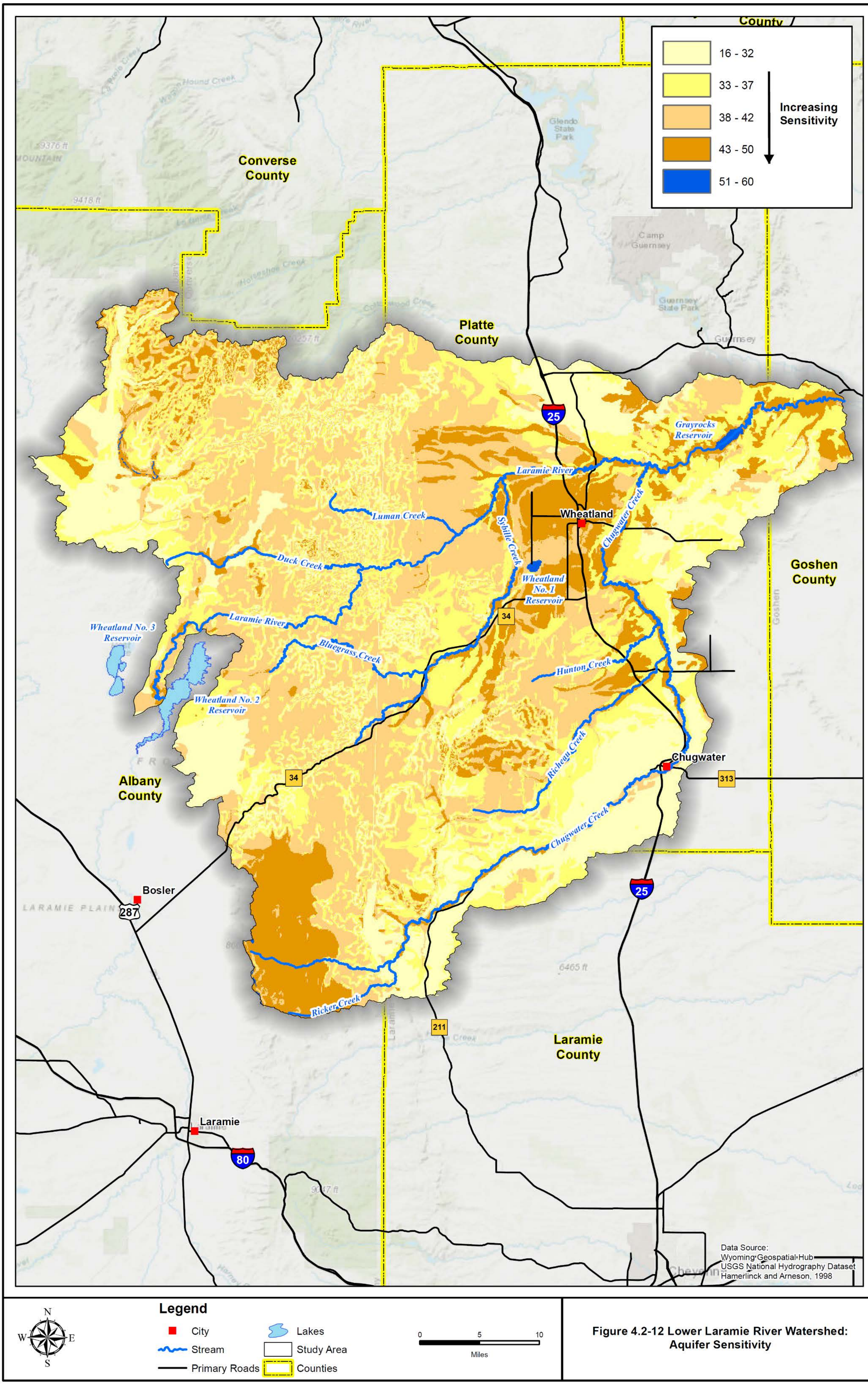


Figure 4.2-12 Lower Laramie River Watershed: Aquifer Sensitivity

- Domestic: any groundwater permit listing only "DOM " or "STO/DOM" as one of the uses; and any permit listing "DOM" as one of the uses, and with a permit yield < 25 gpm.
- Stock: any groundwater permit not listing "DOM" use, for which "STO" is a listed use, and with a permit yield <25 gpm.
- Municipal: any groundwater permit listing "MUN" as one of the uses, and with a permit yield > 25 gpm.
- Irrigation: any groundwater permit listing "IRR" as one of the uses, and with a permit yield > 25 gpm.
- Industrial: any groundwater permit listing "IND" as one of the uses, and with a permit yield > 25 gpm.

Note that permit yields are the maximum discharge rate allowed and may or may not represent the actual yield available. Permit yields are rarely pumped on a sustained basis, and particularly for low-yield wells, may significantly overstate the groundwater actually available.

Wells that do not involve the routine extraction of groundwater are not included in this discussion, e.g. monitor and test wells. The 113 groundwater permits in the watershed outside the use categories listed above are included on the electronic files accompanying this report, but are not discussed here (e.g. subdivision supply, wetlands maintenance, etc.).

Additional details for all groundwater permits (total depth, water level, lithology, use, etc.) may be on the individual Statement of Completion, available electronically at:

http://seoweb.wyo.gov

An approximate, easily accessible geographic presentation of groundwater permits is available electronically from the Wyoming State Geological Survey at:

http://wsgs.maps.arcgis.com/apps/webappviewer/index.html?id=09ebeedba94048a0b1ec4dcfc71eb9b5

To a significant extent, the distribution of wells is a reflection of the productivity of the local aquifers, i.e. "groundwater is where you find it" and history has outlined the resource. Figures 4.2-13 through 4.2-16 provide this empirical mapping of the groundwater resource, in ascending order of the quantity demanded. The base map for these figures is the grouping of geologic formations by general productivity discussed above (Fig. 4.2-6).

Figures 4.2-13 and 4.2-14 display the least demanding wells. Domestic and livestock wells are typically deemed satisfactory if yields exceed 2 gpm. Tables 4.2-5 and 4.2-6 summarize the permit records for groundwater use under these two categories. Twenty-five gpm is something of a default permit listing, i.e. the highest use rate permitted under these use categories, rather than necessarily being an actual, measured production rate (note that groundwater permits U.W. 46286 and U.W. 1359 are for "DOM" use,

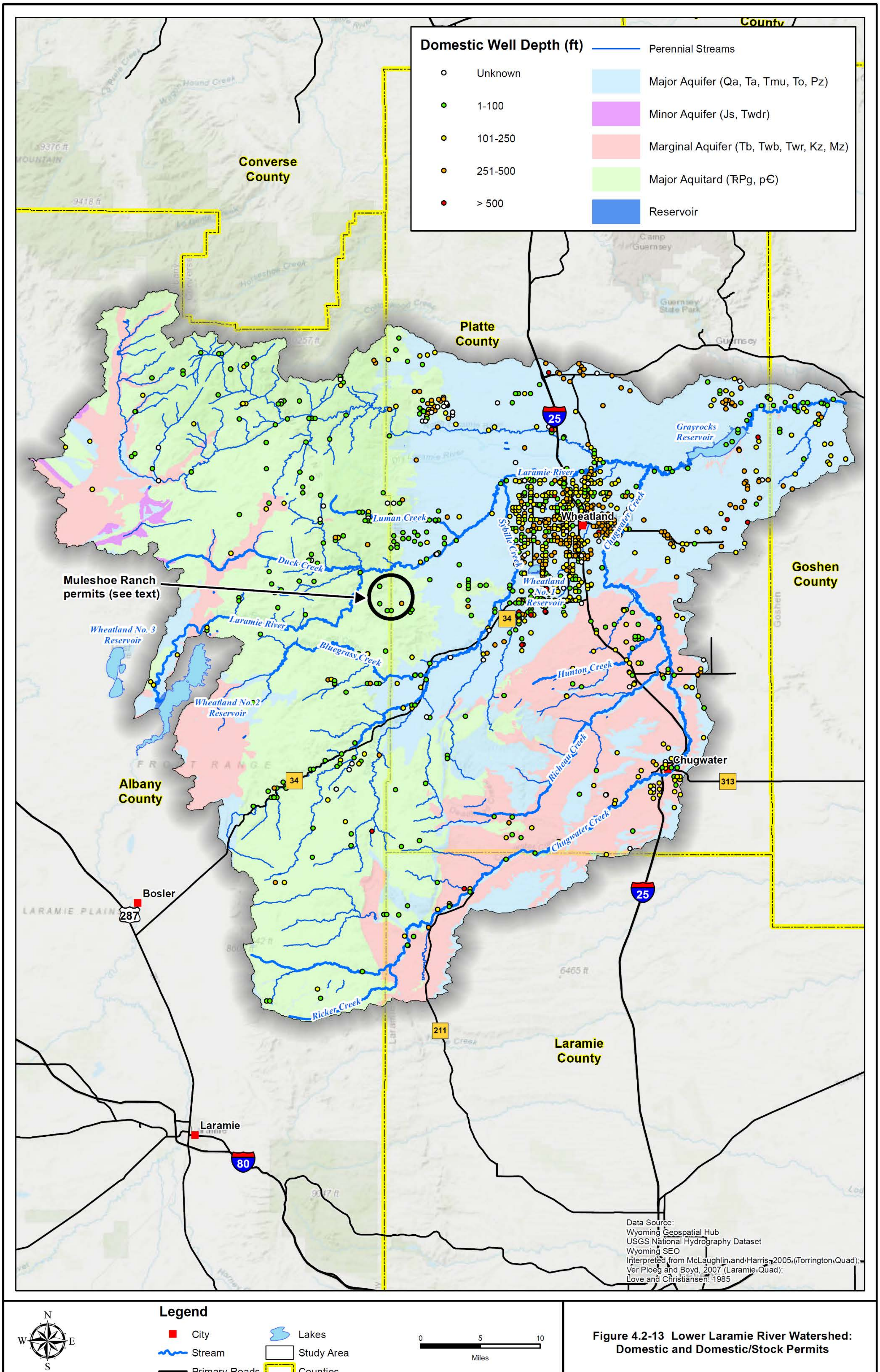
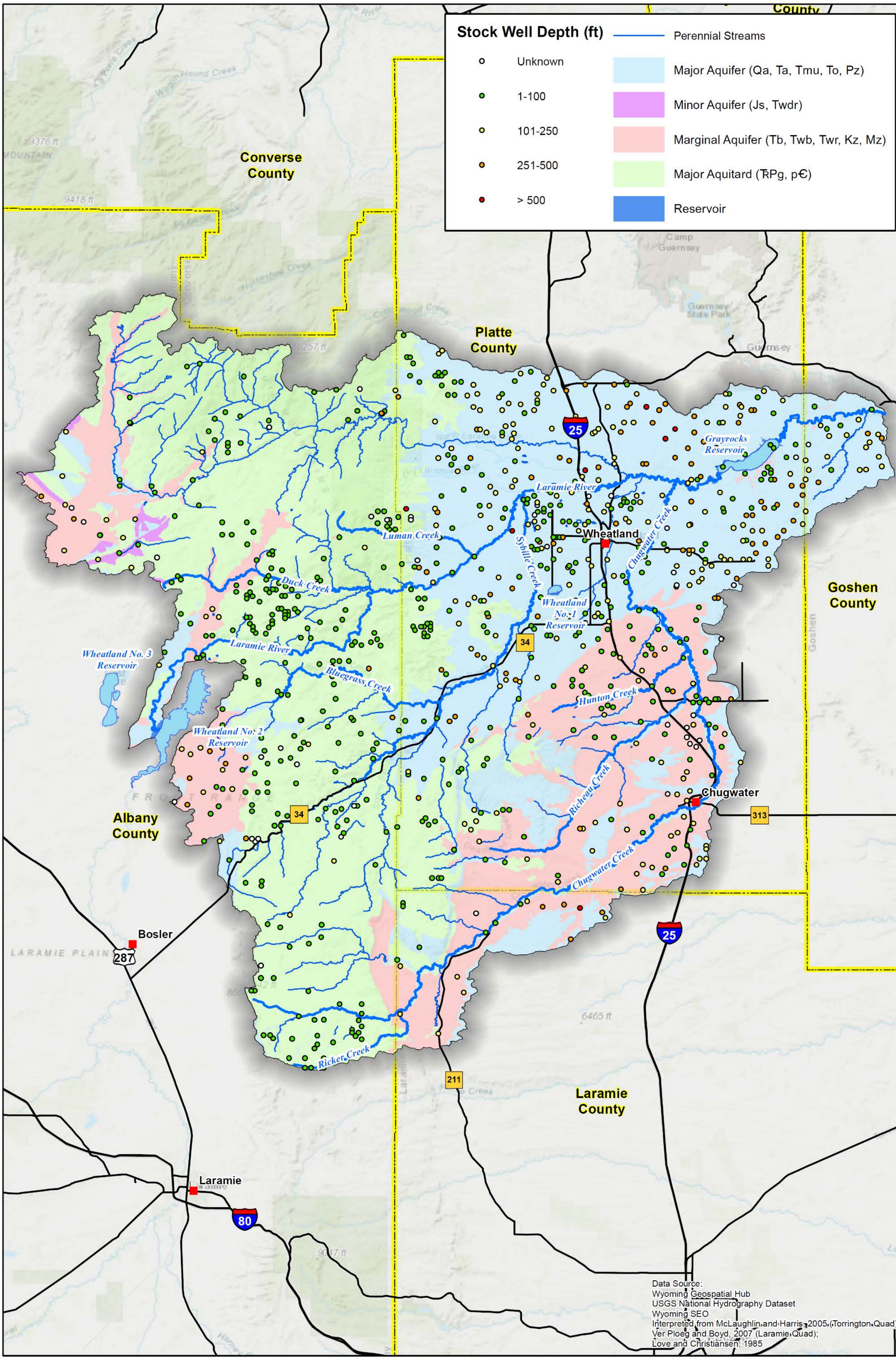


Figure 4.2-13 Lower Laramie River Watershed: Domestic and Domestic/Stock Permits



Legend

City | Lakes
Stream | Study Area
Primary Roads | Counties

0 5 10
Miles

Figure 4.2-14 Lower Laramie River Watershed: Stock Permits

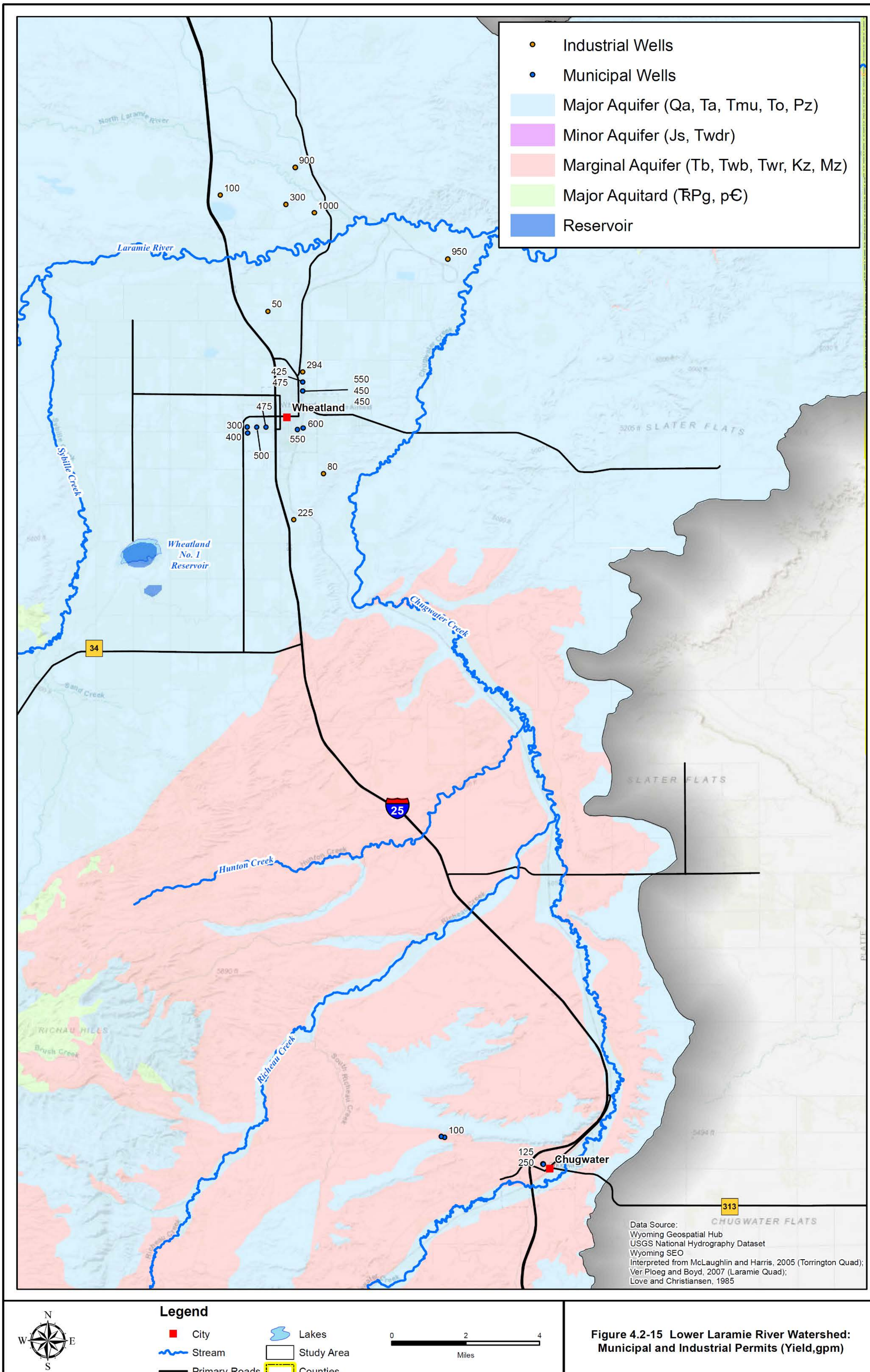


Figure 4.2-15 Lower Laramie River Watershed: Municipal and Industrial Permits (Yield,gpm)

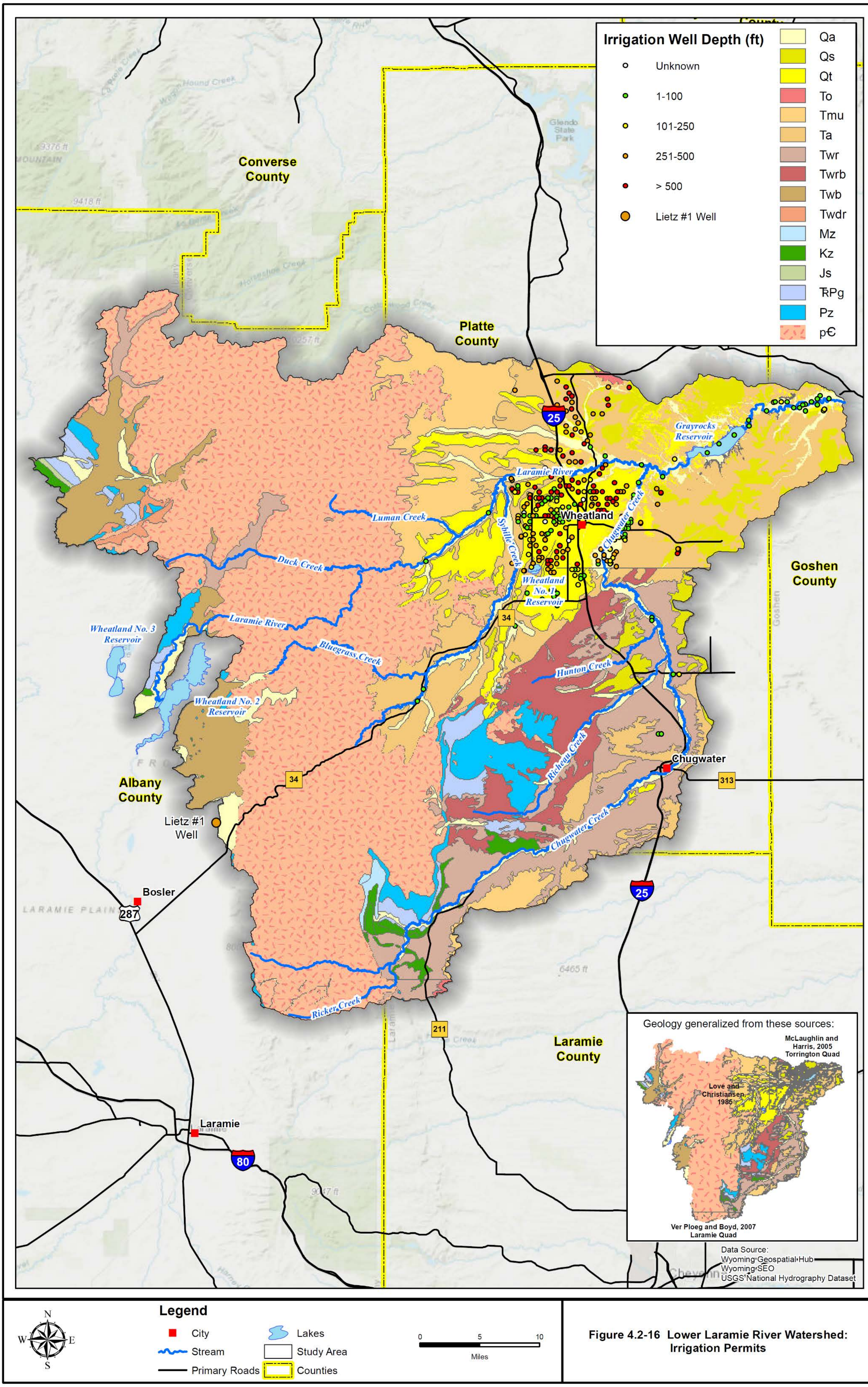


Figure 4.2-16 Lower Laramie River Watershed: Irrigation Permits

but with listed yields of 900 and 60 gpm, respectively. These are assumed to be either typos or mis-classifications). Individual Statements of Completion may include more precise data for these wells.

The distribution of domestic wells, Figure 4.2-13, is more a function of the desirability of a location for a residence than a reflection of general groundwater availability e.g. wells cluster around the communities of Wheatland and Chugwater, in the Wheatland Irrigation District, and along stream valleys. Typically, residents make do with what is available and, as a last resort, may haul water to support their specific location.

The cluster of domestic wells northwest of Wheatland are in the Laramie Peak Ranch subdivision. Wells in this small area vary from 100 to 500 feet deep, with depths-to-water from 5 to 97 feet, and permit yields from 2 to 25 gpm. This reflect its location on the thin edge of the sedimentary aquifer overlying the granitic rocks of the Laramie Range. Groundwater is “hit-or-miss” here, rather than occurring in a thick and consistent aquifer as is available in the central part of the watershed.

Figure 4.2-13 includes a special notation for the “Muleshoe Ranch”, a small area in which there are 64 “domestic/stock” groundwater permits in the Wyoming State Engineer’s Office database. All of these permits list 1903 or 1905 construction dates and depths of less than 4 feet. There is no indication of such intense development in aerial imagery of the site. Rather than include these points on Figure 4.2-13, suggesting a “real” concentration of domestic groundwater development, we have simply flagged the area pending further investigation.

Domestic (and other) wells that plot in Grayrocks Reservoir are either a demonstration of the margins of error in the reported well locations (as discussed above) or reflect the inundation of previously-existing wells by the construction of the reservoir.

Table 4.2-5 - Domestic-Use Groundwater Permits - Lower Laramie Watershed.

Surface Formation	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
	min	med	max	min	med	max	min	med	max
Arikaree, Tmu, Qt, and Qs (1128)	2	200	1000	1	50	380	0.75	15	25
Brule and Twr (77)	8	128	700	1	46.5	690	3	12	25
Precambrian (227)	1	40	544	0.5	12	380	0.5	10	25
other (180)	2	65	500	1	15	260	3	17.5	25

Table 4.2-5 presents summary data for domestic groundwater development in the Lower Laramie watershed. The table is based on permits rather than wells. The former is a slightly larger dataset in that a single well may have more than one permit. This table includes permits for combined stock and domestic use. (Permits solely for stock use are addressed below.) Full data are not reported for all wells. The statistics of Table 4.2-5 (and subsequent tables) reflect all available data, e.g. a database entry of "0" for well depth is considered to mean "unknown", and is excluded. Similarly, a database entry of "0" for yield is excluded as it likely represents an "enlargement" permit for an existing well (e.g. changing place of use, adding a type of use), rather an actual well-yield of zero. Database entries of "0" for depth-to-water could reflect actual measurements, but are more likely to simply reflect an absence of data and are excluded from calculations here.

While groundwater permits are routinely thought of as "wells", that need not be the case. A very small listed depth likely reflects shallow excavation to enhance the flow of a natural spring rather than construction of a cased boring into the aquifer. (Groundwater permit U.W. 39864, for example, has a permit-listed depth of 4 ft. The name of this facility is House Spring #2.)

As reflected in Table 4.2-5, most domestic wells have been able to obtain adequate water supplies within well depths of 200 feet or less, and are pumping water up from a static water level of 50 feet or less. The median yields listed likely overstate actual production somewhat because "25 gpm" is something of a default water-right request in the absence of actual measurement.

Permits are only identified by surface formation, i.e. the formation in which the well started. Deep wells may penetrate through the formation in which they started, developing water from deeper strata. In the Lower Laramie watershed, this is probably less common than elsewhere because the deeper strata are generally less productive. The "1,000 feet" entry in Table 4.2-5 may be an example, however (Permit U.W. 182137). This well is located near the Arikaree / Brule contact at the south boundary of the Wheatland Irrigation District. That it was drilled to a depth of 1,000 feet, yet only reports producing 20 gpm suggests it did not encounter significant water in the thin Arikaree present at that location, but was continued into the underlying Brule in search of adequate supply.

Because domestic well construction tends toward lower elevations, e.g. along streams and across agricultural areas, well depths and depths to water can be expected to be somewhat larger in the upland areas of the watershed.

The shallower median depth of wells in Precambrian rocks are an exception reflecting a basic difference in the hydrogeology of those materials. In those granitic rocks, groundwater production is commonly a function of near-surface fractures. Drilling deeper is less likely to produce additional water than it would be in the sedimentary rocks of the Arikaree Formation, for example, where deeper wells typically encounter additional water-bearing strata and can thus accumulate groundwater from multiple zones to achieve supply objectives.

Because that demand is widely distributed across the landscape, the distribution of stock wells, Figure 4.2-14, provides a more general view of the basic availability of at least the small quantities of groundwater of a quality suitable for livestock. Again, the consistently shallow depths of wells in the mountainous areas is more reflective of the small yields needed and the marginal utility of drilling deeper in search of more water, than of a productive aquifer.

Table 4.2-6 provides summary data for stock wells. Similar to domestic wells, most stock wells have been able to obtain adequate water supplies within well depths of 170 feet or less, and are pumping water up from a static water level of 60 feet or less. The median yields listed likely overstate actual production somewhat because "25 gpm" is something of a default water-right request in the absence of actual measurement.

Table 4.2-6 - Stock-Use Groundwater Permits - Lower Laramie Watershed.

Surface Formation	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
	min	med	max	min	med	max	min	med	max
Arikaree, Tmu, and Qt (411)	2	165	1700	1	59.5	640	0.6	10	30
Brule and Twr (111)	1	90	760	1	47	220	0.3	7.8	25
Precambrian (303)	1	5	640	0.5	3	97	0.3	7.3	25
other (118)	1	85	480	1	30	305	1	10	26

The 1700-feet well in Table 4.2-6 is an anomaly; the next deepest stock well in the watershed is only 761 feet deep. Unfortunately, there is no information in the records (Permit U.W. 12198) that sheds light on why it was necessary to drill so deeply.

The 640-feet well in Precambrian rocks (Permit U.W. 161433; 15 miles west of Wheatland) demonstrates the lengths to which one may have to go to extract useful quantities from these granite rocks. The static water level in the well is only 30 feet deep, but the pump is set at 610 feet to get a reported 4 gpm.

Between the domestic and stock well groups, there is demonstration that some quantity of useful groundwater is fairly widespread across the landscape in the Lower Laramie watershed. Particularly in those areas identified as marginal aquifers or major aquitards, however, that water may be of low quantity and poor quality and considerable effort may be required to locate, develop, and, potentially, treat groundwater to meet specific needs.

Groundwater of adequate quality and quantity to meet municipal demands has been developed for the City of Wheatland and the Town of Chugwater, as indicated on Figure 4.2-15. (There are no municipal or industrial wells in the watershed beyond the extent of Figure 4.2-15.) In the former case, the City benefits from the abundant recharge to the Arikaree Formation from the surrounding irrigation operations. In the latter, the demand is smaller, and adequate wells have been completed in the Brule Formation.

Table 4.2-7 lists all municipal permits of record in the Lower Laramie watershed. Reflecting the importance of a secure water supply for municipal purposes (and the larger budgets typically available), the Wheatland municipal wells average 560 feet deep and are typically completed through long intervals in the upper and lower Arikaree. Yields for these wells average 470 gpm. Depths to water are somewhat higher than the median for domestic and stock wells, perhaps reflecting the downward gradients in the Arikaree Formation.

Figure 4.2-15 also provides the location of groundwater permits in the Lower Laramie for industrial use; Table 4.2-8 lists the individual wells. The first group of wells in Table 4.2-8, along the river west of Grayrocks Reservoir, were constructed as a back-up water supply for the Laramie River Power Station. Several were converted from their previous irrigation use and these wells are part of the elaborate water-rights accounting for the Station under the terms of the Settlement Agreement and Compromise (see Chapter 6: Watershed Management Plan).

The administration of these wells is an example of the distinction discussed above between the "red" and "green" aquifers of the Arikaree Formation. Monthly reports are filed of the production from the red aquifer - Rex Johnson #1 and Joseph P Johnson 3rd Well, and from the green aquifer - Taylor Johnson No. 1 and Moses Johnson. In July, 2018, for example, the respective volumes were 176 acre-ft. and 21 acre-ft. (1284 and 153 gpm on average for the month).

Figure 4.2-16 and Table 4.2-9 reflect the relative high-quantity demands of most irrigation systems. As expected, irrigation wells are concentrated in the Wheatland Flats area, many of them supplying additional water to fields irrigated under the Wheatland Irrigation District.

Nearly all irrigation wells in the watershed are in one of two aquifers: 1) the shallow but locally highly productive alluvial aquifer along the perennial streams of the watershed; or 2) the Arikaree Formation, like the City of Wheatland municipal wells taking advantage of the relatively higher permeabilities and the abundant recharge provided by the Wheatland Irrigation District surface-water irrigation. Irrigation wells near the mouth of the Laramie River are classified in the former group. This is where the alluvial aquifer of the Laramie River merges with the "valley fill" aquifer (Rapp et al., 1957) of the North Platte River.

The two irrigation wells on Chugwater Creek downstream of the Town of Chugwater are also alluvial wells, demonstrating that where alluvial deposits are thick enough to provide sufficient saturated thickness, productive wells can be completed where the underlying bedrock is inhospitable (Brule Formation). For example, the wells under permits U.W.68692 and U.W. 68693 are 33 and 34 feet deep, respectively, both with reported yields of 300 gpm.

Table 4.2-7 - Municipal-Use Groundwater Permits - Lower Laramie Watershed.

Name	Owner	Formation	Depth (ft)	Depth to Water (ft)	Permit Yield (gpm)	Permit No.
#3	Town of Chugwater	Brule	128	40	125	P1395W
Chugwater Well #4	Town of Chugwater	Brule	120	32.8	250	P119526W
Chugwater #5	Town of Chugwater	Brule	380	98	100	P154780W
Black Mtn #1	Town of Wheatland	Arikaree	585	100	475	P48832W
Black Mtn #2	Town of Wheatland	Arikaree	619	84.5	300	P55321W
Black Mtn #3	Town of Wheatland	Arikaree	650	130	400	P203648W
Black Mtn #4	Town of Wheatland	Arikaree	650*	?	500*	P208961W
Town Well #3	Town of Wheatland	Arikaree	560	73	600	P109C
Wheatland #5	Town of Wheatland	Arikaree	509	20	550	P490C
Wheatland #6 Well	Town of Wheatland	Arikaree	506	17	475	P491C
Town of Wheatland Well #7	Town of Wheatland	Arikaree	453	50	425	P36W
Wheatland #7 Well	Town of Wheatland	Arikaree	620	71.5	550	P204169W
Wheatland #8	Town of Wheatland	Arikaree	500	61.3	450	P2187W
Wheatland #9	Town of Wheatland	Arikaree	551	50	450	P2188W
* - Black Mountain #4 well is incomplete; no well completion data are yet available. The well depth and the permitted yield are estimates on the permit application.						

Table 4.2-8 - Industrial Wells - Lower Laramie Watershed.

Name	Owner	Formation	Depth (ft)	Depth to Water (ft)	Permit Yield (gpm)	Permit No.
Rex Johnson #1	Basin Electric Power Co.	Arikaree (red)	500	120	900	P23653W P43367W
Taylor Johnson No. 1 Well	Basin Electric Power Co.	Arikaree (green)	1130	flowing	300	P17434W
Moses Johnson Well	Basin Electric Power Co.	Arikaree (green)	1040	flowing	100	P43368W
Joseph P Johnson 3rd Well	Basin Electric Power Co.	Arikaree (red)	823	63.8	1000	P43369W
Forell Baumgardner No. 2 Well	Basin Electric Power Co.	Arikaree	560	75	950	P171681W
Lidstrom Inc #1	Lidstrom Inc.	Arikaree	361	140	225	P31871W
Wheatland Factory #1	Great Western Sugar Co.	Arikaree	285	21	294	P90W
Wright No. 1	Christopher Wright	Arikaree	305	80	50	P198469W
DJH1	Alexander Construction	Arikaree	500	156	80	P205455W

Table 4.2-9 - Irrigation-Use Groundwater Permits - Lower Laramie Watershed.

Surface Formation	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
	min	med	max	min	med	max	min	med	max
Arikaree (424)	9	378	1085	0.5	31	350	10	600	2125
Brule (8)	8	72	130	4	30	40	125	175	600
Alluvium (55)	4	59	100	5	14	35	25	675	1800

Notes: 1) "Arikaree" includes permits for which the formation at the surface may be terrace or alluvial deposits, but the underlying formation is the Arikaree.

2) "Brule" includes both the Brule and the undivided White River Formation.

3) "Alluvium" includes only permits for wells less or equal to 100 feet deep; deeper wells are assumed to have penetrated the alluvium into the underlying formation.

4) There are no irrigation wells in the Precambrian rocks.

Finally, Figure 4.2-16 includes one remarkable irrigation well just outside the Lower Laramie watershed, just beyond the head of Sybille Creek. This is the 7,000 gpm Leitz No. 1 well, an irrigation well that penetrated an open cavern in the Casper Formation, connecting it with virtually unlimited permeability. While no other well in the region can match this productivity, it marks the potential for very high yields from especially favorable locations in this aquifer that has been little explored in the Lower Laramie watershed.

4.2.5 Surface Water

4.2.5.1 Hydrography

Streams are classified based upon the existence of streamflow and their runoff patterns. Very briefly, there are three flow regimes considered:

- Perennial streams are those that contain water year-round in normal years.
- Intermittent streams contain waters only a portion of the year, typically during winter and spring.
- Ephemeral streams carry water in direct response to precipitation events.

The majority of the HUC-12 sized streams in the Lower Laramie watershed would be considered perennial by nature, meaning that they contain water year-round. The other smaller tributaries throughout the region are classified as ephemeral or intermittent. The USGS provides classification of streams in the study area and indicates their assessment on their published topographic maps. Figure 4.2-17 displays perennial, intermittent, and ephemeral streams in the watershed. Note that on United States Forest Service (USFS) lands, channel assessment was conducted at a greater level of detail. Consequently, these lands contain a high density of ephemeral stream classifications whereas no streams outside of the USFS boundary were classified as such.

4.2.5.2 Water Quality

The Water Quality Division of the Wyoming Department of Environmental Quality (WDEQ) has classified water bodies in the state into two parts: primary bodies and secondary bodies. The primary bodies are listed in what is referred to as "Table A" and represent those water bodies either named on the USGS 1:500,000 scale hydrologic map or those specifically classified by the WDEQ. The secondary bodies listed in "Table B" are taken from the WGFD's "Streams and Lakes Inventory" and are based on the presence or absence of fish species. Where there are differences in classification, "Table A" takes precedence. The water bodies are then classified based upon their use.

The Lower Laramie Watershed study area has 959 miles of streams classified in "Table A", and 375 miles classified in "Table B" as displayed in Figure 4.2-18. Table 4.2-10 presents this information in tabular format. Figure 4.2-19 summarizes the various stream classes and their associated use designations. Appendix 4B contains the WDEQ's narrative descriptions of the classifications.

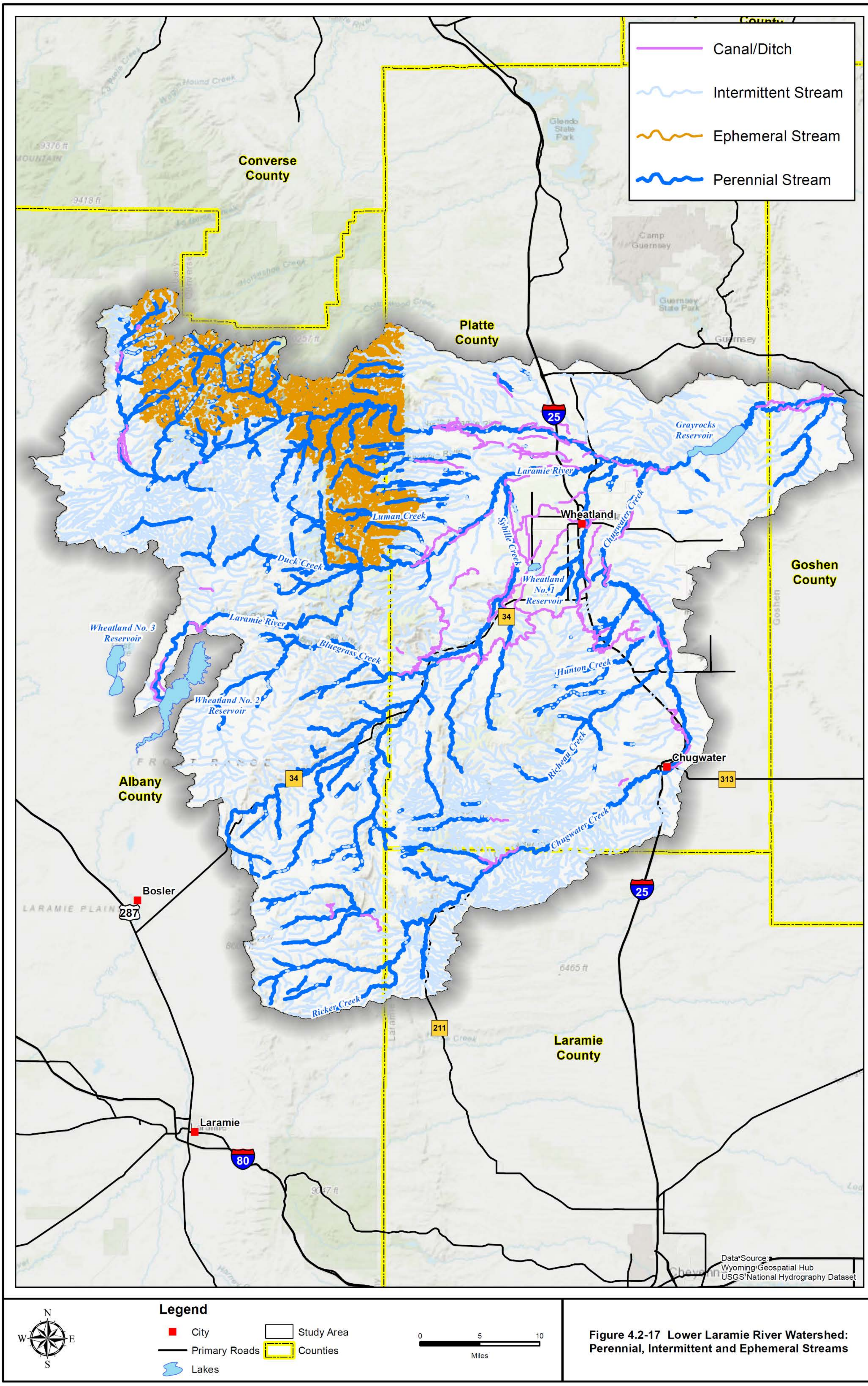


Figure 4.2-17 Lower Laramie River Watershed: Perennial, Intermittent and Ephemeral Streams

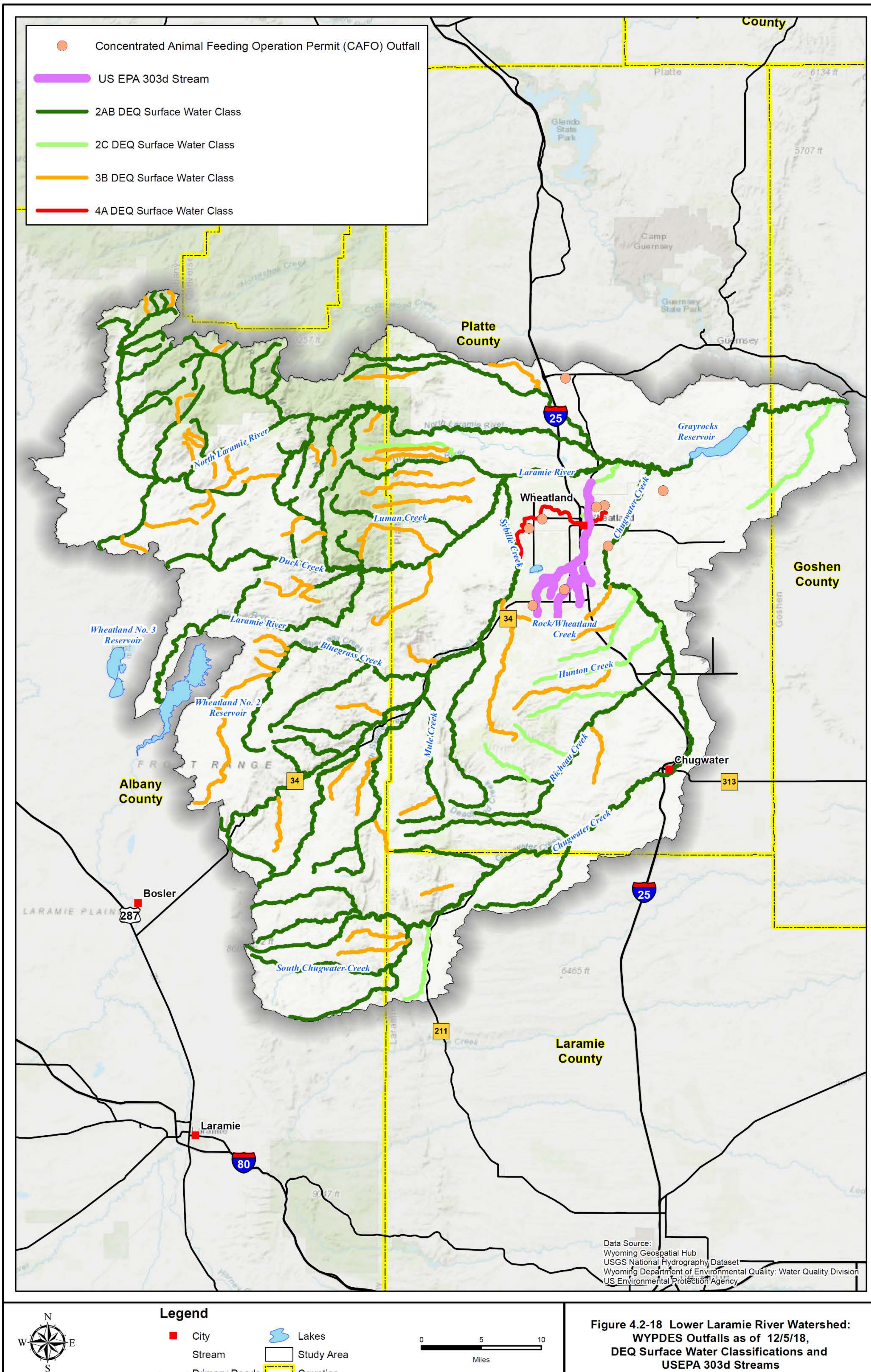


Figure 4.2-18 Lower Laramie River Watershed: WYPDES Outfalls as of 12/5/18, DEQ Surface Water Classifications and USEPA 303d Streams

Table 4.2-10 Tabulation of Stream Classification in Lower Laramie Study Area.

Waters are listed within each drainage as they proceed upstream. An indented entry is tributary to the previous entry. All Class 2AB and 2B waters are designated as cold water game fisheries unless identified with a "ww" notation. All Class 2C waters are designated as warmwater fisheries. Waters designated for secondary contact recreation are identified by an "(s)". Classifications changed through the UAA process are identified by "(UAA)". UAAs that have been approved by the administrator, but not acted on by EPA are identified by an asterisk (*).

LARAMIE R 2AB			
	DEER CR 2C (UAA)		
	COTTONWOOD FALLS SPRING 3B		
	EAGLES NEST CANYON CR 3B		
GRAY ROCKS RES 2AB			
	CHUGWATER CR 2AB		
		NUMBER 2 CANAL 4A	
		ANTELOPE CR 2C	
		HUNTON CR 2C	
			S HUNTON CR 3B
		RICHEAU CR 2AB	
			MAXWELL CR 2C
		N CHUGWATER CR 2AB	
		SPRING CR 2AB	
		S CHUGWATER CR 2AB	
		M CHUGWATER CR 2AB	
			STRONG CR 2AB
	ROCK CREEK (WHEATLAND) 2C		
		AYERS DR 2C	
	N LARAMIE R 2AB		
		FISH CR 2AB	
			S FK FISH CR 2AB
		OWEN CR 2AB	
		STURGEON CR 2AB	
		BEAR CR 2AB	
			FRIEND CR 2AB
		COW CR 2AB	
		PINTO CR 2AB	
		COTTONWOOD CR 2AB	
		ANTELOPE CR 2AB	
		BAR M CR 2AB	
		SOLDIER CR 2AB	
	DRY LARAMIE R 2AB		
		COLLINS CUTOFF CR 3B	
		CAMP CR 2C	
	SYBILLE CR 2AB		
		RESERVOIR #1 2AB	
		BRUSH CR 3B	
		DEADHEAD CR 2AB	
		BLUEGRASS CR 2AB	
			HALLECK CR 2AB
		MULE CR 2AB	
		S SYBILLE CR 2AB	
		CANYON CR 2AB	
		M SYBILLE CR 2AB	
		N SYBILLE CR 2AB	
	MARBLE QUARRY CR 3B		
	LUMAN CR 2AB		
	RABBIT CR 3B		
	SLATE CR 3B		
	DUCK CR 2AB		
		CHERRY CR 2AB	
	DODGE CR 2AB		

Designated Use	Surface Water Classification												
	1	2AB	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C
Drinking Water	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Cold Water game fish	Yes	Yes	No	Yes	No	If Present	No	No	No	No	No	No	No
Warm Water game fish	Yes	Yes	No	Yes	No	If Present	No	No	No	No	No	No	No
Nongame Fish	Yes	Yes	No	Yes	Yes	If Present	No	No	No	No	No	No	No
Fish Consumption	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No
Aquatic life other than fish	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Recreation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wildlife	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scenic Value	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Class 2C
- Deer Creek
- Antelope Creek
- Hunton Creek
- Maxwell Creek
- Rock Creek (Wheatland)
- Ayers Draw
- Camp Creek

Class 4A
- Number 2 Canal

Class 3B
- Cottonwood Falls Spring
- Eagles Nest Canyon Creek
- South Hunton Creek
- Collins Cutoff Creek
- Brush Creek
- Marble Quarry Creek
- Rabbit Creek
- Slate Creek

Class 2AB
- Laramie River
- Gray Rocks Reservoir
- Chugwater Creek
- Richeau Creek
- North Chugwater Creek
- Spring Creek
- South Chugwater Creek
- Middle Chugwater Creek
- Strong Creek
- North Laramie River
- Fish Creek
- South Fork Fish Creek
- Owen Creek
- Sturgeon Creek
- Bear Creek
- Friend Creek
- Cow Creek
- Pinto Creek
- Cottonwood Creek
- Antelope Creek
- Bar M Creek
- Soldier Creek
- Dry Laramie Creek
- Sybille Creek
- Reservoir #1
- Deadhead Creek
- Bluegrass Creek
- Halleck Creek
- Mule Creek
- South Sybille Creek
- Canyon Creek
- Middle Sybille Creek
- North Sybille Creek
- Luman Creek
- Duck Creek
- Cherry Creek
- Dodge Creek

Figure 4.2-19 WYDEQ Surface Water Classification and Use Designations.

WYPDES Permitted Discharges

A database of permitted discharges under the National Pollution Discharge Elimination System (NPDES) was obtained from the Wyoming Department of Environmental Quality. As of the time this report was prepared, there were a total of 9 active (WYPDES) permitted discharges present within the study area. Table 4.2-11 summarizes pertinent information regarding the permits. The locations of these discharges are shown on Figure 4.2-18.

Table 4.2-11 Summary of Active WYPDES Permitted Discharge Locations.

WY Permit Number	Receiving Water	Permittee	PermitType	Facility Name
WY0022306	Laramie River (2AB), North Platte River Basin	Shepard Farms, Inc.	CAFO	Shepard Farms, Inc.
WY0022314	Chugwater Creek (2AB), North Platte River Basin	Bard Ranch Company	CAFO	Bard Ranch Company
WY0022756	Number 2 Canal (4A), North Platte River Basin	True Ranches LLC	CAFO	Wheatland Feedlot
WY0035874	Laramie River (2AB), North Platte River Basin	Stevenson Cattle Co.	CAFO	Stevenson Cattle Co. (aka Double S Livestock Feedlot)
WY0040401	Ayers Draw (2C), North Platte River Basin	M.R. Angus Ranch	CAFO	M.R. Angus Ranch-Feedlot
WY0042773	Laramie River (2AB) via pasture land and a retention pond, North Platte River Basin	4S Cattle Company	CAFO	4S Cattle Company
WY0094714	Containment unit (3B) located in unnamed epehemeral tributary (3B) to Sybille Creek (2AB), North Platte River Basin (2AB)	Hedstrom Land & Cattle LLC	CAFO	Hedstrom Feedyard
WY0096164	Tributary (3B) to Fish Creek (2AB)	AMVC Production, LLC	CAFO	Site 20
WY0096172	Ephemeral tributary (3B) to North Platte River (2AB)	AMVC Production, LLC	CAFO	Site 22/24

Waters Requiring TMDLs

A Total Maximum Daily Load (TMDL) is the amount of pollutant which a stream can accept and still meet its designated uses. TMDLs must be established for each pollutant which is a source of stream impairment. They must be measurable and must consider both point and nonpoint source pollutant loads, natural background conditions, and a margin of safety.

Rock Creek originates south of the Town of Wheatland, flowing northeast through the town where the name changes to Wheatland Creek, eventually joining the Laramie River near the Basin Electric Power Plant. Below Wheatland's wastewater treatment facility, Rock Creek has periodically exceeded WDEQ criteria for ammonia, pH, and fecal coliform. According to the 2016/2018 Integrated 305(b) and 303(d) Report (WDEQ, 2018):

> *"A segment of Wheatland Creek (WYNP101800110502_01), from the confluence with Rock Creek downstream to Wheatland Highway was added to the 303(d) List in 1996 for exceeding criteria for ammonia and pH protective of its aquatic life other than fish and nongame fish designated uses. To address high ammonia concentrations in Wheatland Creek, the WWTF began using zeolite (a clay material) to remove ammonia from the plant's effluent. In 1998, WDEQ (2002) collected physical, chemical, and biological data at four study sites along Wheatland Creek to evaluate the effectiveness of these changes on water quality in Wheatland Creek. The study concluded that a*

segment of Wheatland Creek below the Town of Wheatland continued to exceed criteria for ammonia and pH during the winter and spring; the Wheatland WWTF was identified as the source of these pollutants."

In 2002, two segments of Rock Creek were added to the 303(d) List because fecal coliform levels exceeded criterion for its recreation designated use. This included the entire Rock Creek watershed above the confluence with Wheatland Creek and a segment of Wheatland Creek from the confluence with Rock Creek downstream to Wheatland Highway. The source of the fecal coliform was unknown. The 2016/2018 Integrated 305(b) and 303(d) Report states (WDEQ, 2018):

"*The Platte County Conservation District (PCNRD) sponsored efforts to identify and address sources of fecal contamination in Rock Creek, and these efforts were summarized and published in the 2007 Rock Creek watershed plan. To date, 79 irrigation efficiency, 12 water quality improvement, 12 grazing management, and 32 wildlife habitat enhancement projects have been implemented, primarily using NRCS funding. Two AFO relocation projects have also occurred in the drainage (WACD, 2011). In 2008, the Town of Wheatland's WWTF went to a non-discharging treatment facility, and instead of discharging to Wheatland Creek, all of the treated water from the WWTF is piped to an adjacent farm where it is stored in two reservoirs and used for crop irrigation. These remediation efforts effectively removed the anthropogenic sources of elevated ammonia and pH to Wheatland Creek, so these two segments were removed from the 303(d) List in 2014."*

A section of Chugwater Creek extending from an irrigation diversion in NE SW S26 T25N R67W upstream an undetermined distance to Antelope Gap Road was added to the 303(d) List in 2000 for excess sedimentation from unknown sources. According to the 2016/2018 Integrated 305(b) and 303(d) Report (WDEQ, 2018):

"Restoration efforts were implemented along the threatened reach of Chugwater Creek by landowners, WGFD, and Pheasants Forever to improve riparian conditions and wildlife habitat. These efforts mostly involved the installation of riparian fencing in grazed pastures. Additionally, the irrigation district built a small reservoir on a bench above the creek to improve irrigation efficiency by capturing excess irrigation water and converted some flood irrigation to sprinkler irrigation."

A technical review team mediated by the Wyoming Department of Agriculture evaluated the efficacy of the restoration efforts and determined that the segment was no longer impaired. Therefore, the WDEQ moved this reach from the 303(d) List to Category 2 in 2008, and the restoration of Chugwater Creek was approved by USEPA as a Section 319 nonpoint source pollution success story.

4.2.6 Geomorphology

The field of fluvial geomorphology is the study of how land is formed under processes associated with running water. The balance between processes such as erosion, deposition, and sediment transport determine the character and condition of a stream. The objective of the geomorphic evaluation of the study area is to determine the nature of this balance, and where the balance has been upset.

The condition of a stream can be assessed with respect to its basic form (width, depth, slope, etc.), as well as its state of equilibrium, or geomorphic stability (Thorne, et al., 1996; Johnson, et al., 1999). *Stable* channels are generally defined as those that have achieved a balance between flow energy and sediment delivery, such that sediment is transported at the rate at which it is delivered, and the form and pattern of the channel is maintained (Thorne, et al., 1996). In geomorphically stable conditions, minor changes in either sediment supply or transport energy result in gradual adjustment of channel form to accommodate those changes (Lane, 1955). Channels destabilize when changes in those factors are extreme enough that rapid and dramatic alterations in pattern or form occur. Common indicators of channel instability include active downcutting and accelerated bank erosion, major changes in channel width/depth ratios, and increased flooding due to sediment deposition.

Dynamically stable channels are adjustable in nature, and “stability” does not preclude lateral migration and associated dynamics such as bank erosion and sediment deposition. A stream in dynamic equilibrium has adjusted its width, depth, and slope such that the channel is neither aggrading nor degrading. However, change may be occurring in the stream bank, erosion may result, and bank stabilization may be necessary even on the banks of a stream in dynamic equilibrium.

The equilibrium concept of streams discussed above can also be described by various qualitative relationships. One of the most widely used relationships is the one proposed by Lane (1955) which states that:

$$Q_s \cdot D_{50} \propto Q_w \cdot S$$

Where Qw is the water discharge, S is the slope, Qs is the bed material load, and D50 is the median size of the bed material. This relationship, commonly referred to as Lane's Balance, is illustrated in Figure 4.2-20.

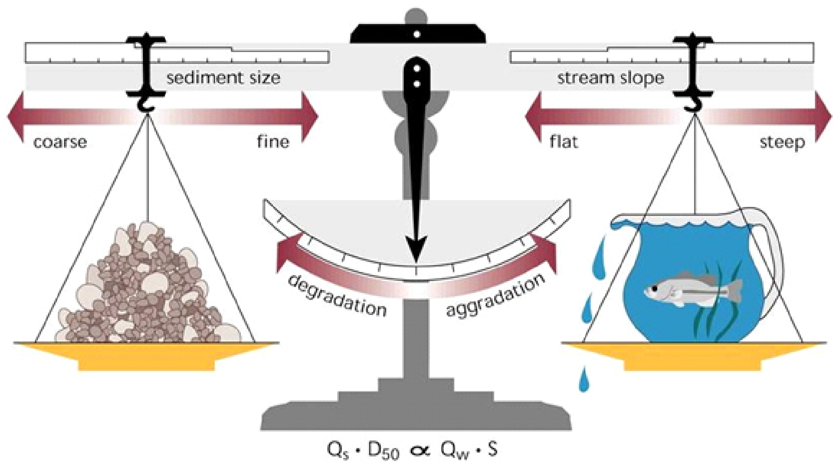


Figure 4.2-20 Lane's Balance.

This graphic indicates that a change in any of the four variables will cause a change in the others such that equilibrium is restored. When a channel is in equilibrium, it will have adjusted these four variables such that the sediment being transported into the reach is transported out, without significant deposition of sediment in the bed (aggradation), or excessive bed scour (degradation). It should be noted that by this definition of stability, a channel is free to migrate laterally by eroding one of its banks and accreting the one opposite at a similar rate.

In summary, a stable river, from a geomorphic perspective, is one that has adjusted its width, depth, and slope such that there is no significant aggradation or degradation of the stream bed or significant planform changes (meandering to braided, etc.). By this definition, a stable river is not in a static condition but rather is in a state of dynamic equilibrium where it is free to adjust laterally through bank erosion and bar building (Watson, et al, 1999).

Geomorphic function is achieved when a channel is in equilibrium, while undergoing processes such as lateral migration, sediment reworking, and occasional overbank flooding that effectively create and sustain quality aquatic and terrestrial habitat elements, such as bars, pool/riffles, step/pools, and healthy, regenerating riparian corridors. Impairments to geomorphic function reflect a significant loss of the functional potential of the river channel segment. These impairments are typically described in general, qualitative terms and any rehabilitation of impaired channel segments requires a more thorough site-specific assessment of impacts, impairments, and feasible remedies.

4.2.6.1 Rosgen Classification System

The literature presents descriptions of numerous systems for classifying and evaluating stream systems. Of these, perhaps the most widely used today is the Rosgen classification system (Rosgen, 1996). This system, based upon the stream's existing channel morphology, was utilized in this study. Parameters such as the sinuosity, slope, width/depth ratio, and size of channel materials are evaluated and used to classify the stream into one of the various "types" included in the system.

There are four levels of classification in the Rosgen system, each being more detailed than the previous level. Figure 4.2-21 displays the hierarchy of the assessment levels and the general nature of effort associated with each. Much of the Level I geomorphic characterization is qualitative and utilizes aerial photography and topographic maps. Streams are divided into eight (8) broad types on the basis of their channel and floodplain geometry. Rosgen's classification system stream types can be thought of in their relative location within the watershed from the headwaters through the lowlands. The major stream types reflect their location in the watershed. For example, "A" type streams are located in headwaters; "C" & "E" stream types are located in meandering lowlands, etc. The Level II effort provides a more detailed description of the stream using measurements at selected locations. Stream types are further subdivided into 94 subtypes based upon degree of entrenchment, width-to-depth ratio, water surface slope, streambed materials, and sinuosity (Figure 4.2-22). Consequently, the Level II characterization is more quantitative than the Level I effort. Levels III and IV require more extensive data collection and quantification of stream characteristics. The Lower Laramie Watershed Study included a Level I evaluation of the mainstem streams and their principal tributaries.

Level I Methods

The purpose of the Level I geomorphic classification is to provide an inventory of the study area's overall stream morphology, character, and condition. It is intended to serve as an initial assessment for use in more detailed assessments and to determine the location and approximate percentage of stream types within the basin. The results of the Level I classification can be integrated directly into the project GIS providing a graphical "snapshot" of the basin. Based upon this initial effort, potential stream reference reaches can be identified for further study in Level II classification efforts. The end product of the Level I classification is the determination of the major stream types, A through G.

Figure 4.2-23 shows the major stream types within the Rosgen Classification System along with their relative locations within a typical watershed. Brief descriptions of the various stream types encountered in the watershed are presented in the following paragraphs.

A-Type Channels are relatively steep channels that form in headwater areas as well as within bedrock canyons. These channels are entrenched and confined by steep valley margins such that little to no floodplain area borders them. As the boundaries of A-type channels are typically highly resistant to erosion, these stream types are generally quite resilient with respect to human impacts. The most common cause of geomorphic change within A-type channels is due to large-scale sediment transport events, (landslides, debris flows, debris jam failure) that may result in blockage or deflection of channel flow.

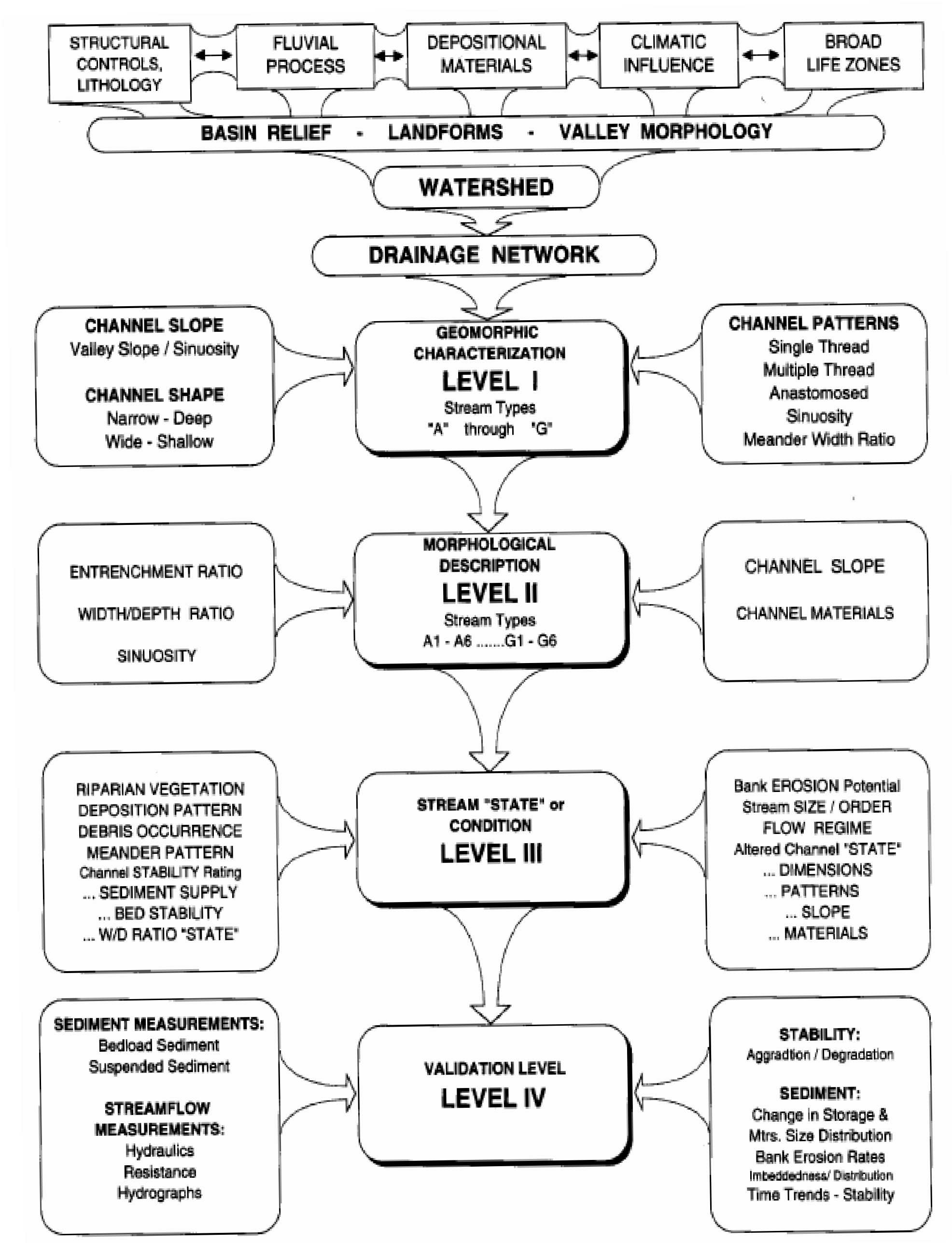


Figure 4.2-21 Hierarchy of the Rosgen Stream Classification System.

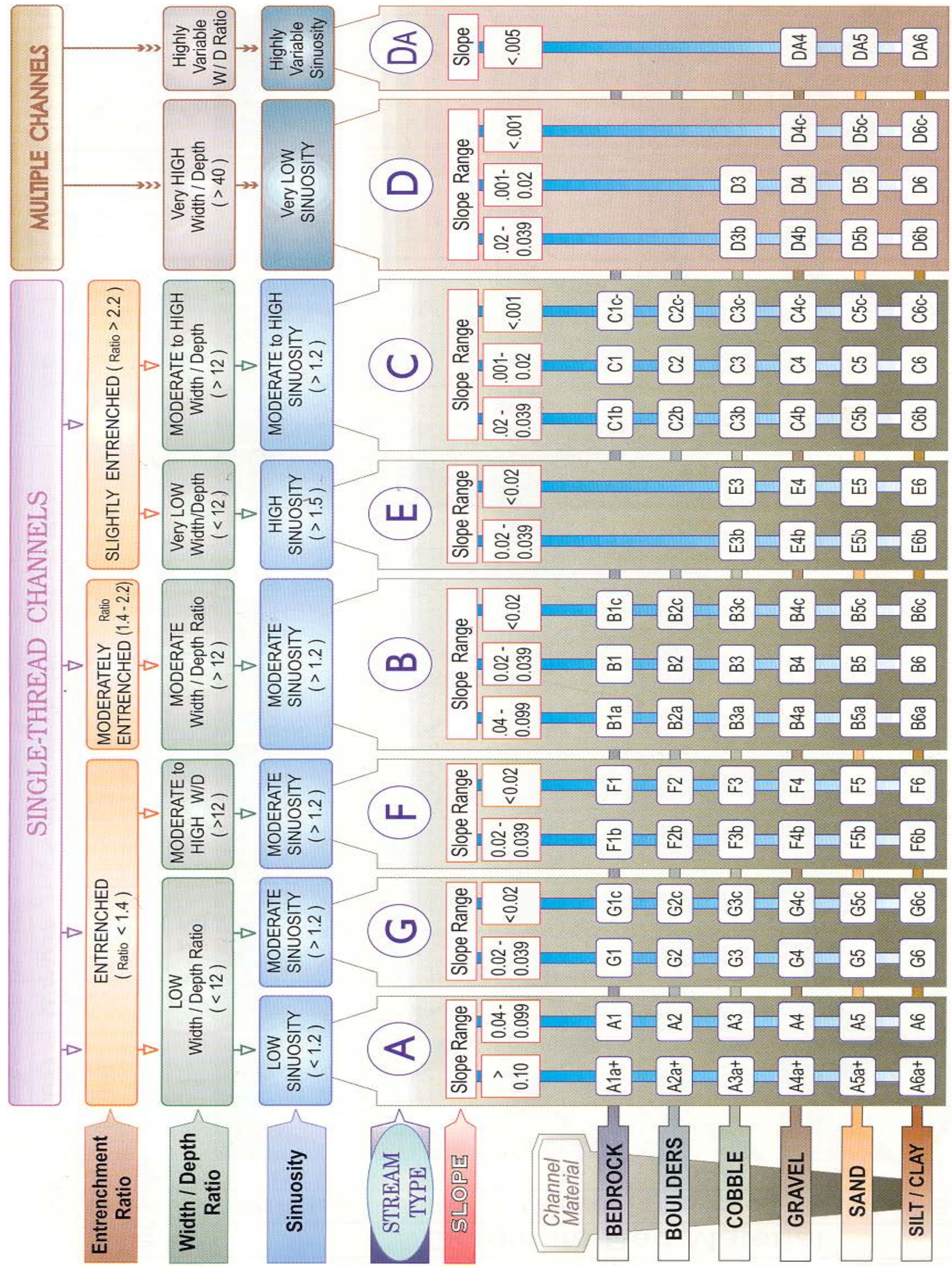


Figure 4.2-22 Rosgen Classification Matrix (Rosgen, 1996).

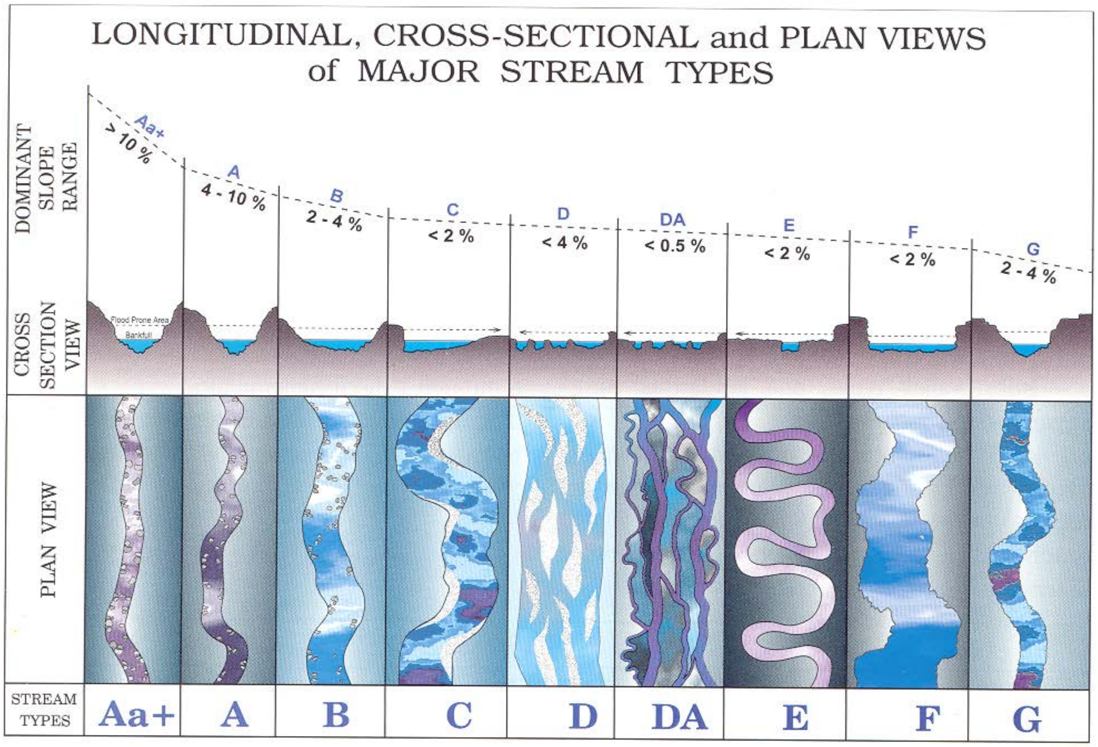


Figure 4.2-23 Major Stream Types within the Rosgen Classification System (Rosgen, 1996).

B-Type Channels tend to form downstream of headwater channels, in areas of moderate slope where the watershed transitions from headwater environments to valley bottoms (Figure 4.2-24). B-Type channels are characterized by moderate slopes, moderate entrenchment, and stable channel boundaries. Due to the relatively steep channel slopes and stable channel boundaries, B-channels are moderately resistant to human impacts, although, their reduced slopes relative to headwater areas can make them prone to sediment deposition and subsequent adjustment following a large sediment transport event such as an upstream landslide, debris flow, or flood.

Figure 4.2-24 Example Type B Channel: Segment of Sybille Creek, WY.

C-Type Channels are typically characterized by relatively low slopes, meandering planforms (i.e., the shape one would see if viewing from above, as on a map or aerial photo), and pool/riffle sequences (Figure 4.2-25). The channels tend to occur in broad alluvial valleys, and they are typically associated with broad floodplain areas; they are not entrenched and still have 'access' to their floodplains. C channels tend to be relatively sinuous, as they follow a meandering course within a single channel thread. In stream systems in which the boundaries of C-type channels are composed of alluvial sediments, channels tend to be dynamic in nature, and susceptible to rapid adjustment in response to disturbance.

Figure 4.2-25 Example Type C Channel: North Laramie River, WY.

F-Type Channels typically have relatively low slopes (<2%), similar to C and E channel types. The primary difference between C/E channels and F channels is with respect to entrenchment. F channels are entrenched, which means that the floodplain is quite narrow relative to the channel width. The entrenchment of alluvial F-type channels typically is an indicator of a historic downcutting event. F-type channels may form in resistant boundary materials (e.g., U-shaped bedrock canyons) and relatively erodible alluvial materials (e.g., arroyos). When the boundary materials are erodible, the steep valley walls are prone to instability, and channel widening commonly occurs within the entrenched channel cross section (Figure 4.2-26).

Figure 4.2-26 Example Type F Channel: Segment of Chugwater Creek, WY.

G-Type Channels are narrow, steep entrenched gullies. G-Type channels typically have high bank erosion rates and a high sediment supply. Channel degradation and side slope rejuvenation processes are typical.

The Level I classification effort was conducted primarily using existing information incorporated into the project GIS. Several analytical tools were developed and integrated into the GIS which allowed the evaluation of various geomorphic parameters (sinuosity, slope, and stream station determination). The data collated and incorporated in the project GIS include digital aerial photography, USGS topographic maps, Landsat color infrared imagery, a digital elevation model (DEM), and digitized hydrography information. The most current data available were used in the geomorphic evaluation. Because the DEM was limited to a 10-meter grid, elevations and subsequent slope calculations are approximate. Stream alignments were digitized using 2011 aerial photography and represent the best available estimate of current channel alignment.

The streams evaluated were divided into reaches based upon definable geographic factors (e.g. confluences with tributaries, major road crossings, etc.) or where their geomorphic character displayed changes. Each reach was evaluated in light of the characteristics required at the Level I classification. These parameters, as indicated in Figure 4.2-22, were channel slope, channel shape, channel patterns, and valley morphology. Note that in the Level I classification, these parameters are not typically quantified and the relative magnitude (i.e., “moderate”, “slightly”, etc.) is utilized to classify the stream.

Level I Classification

Results of the Level I classification effort are presented in Figure 4.2-27. This figure displays a map of the study area depicting the various stream types as well as the reach designations used in the classification effort.

The headwater reaches of most major streams within the basin are located in steeper terrain and are typically classified as A type channels transitioning to B downstream in a manner typical of the Rosgen classification scheme. As the headwater streams enter the lower valley reaches, their character changes. The widening valley floor reduces lateral confinement, sediment size tends to reduce, and boundary conditions typically weaken in conjunction with a change from narrow colluvial valleys to broad riparian alluvial valleys.

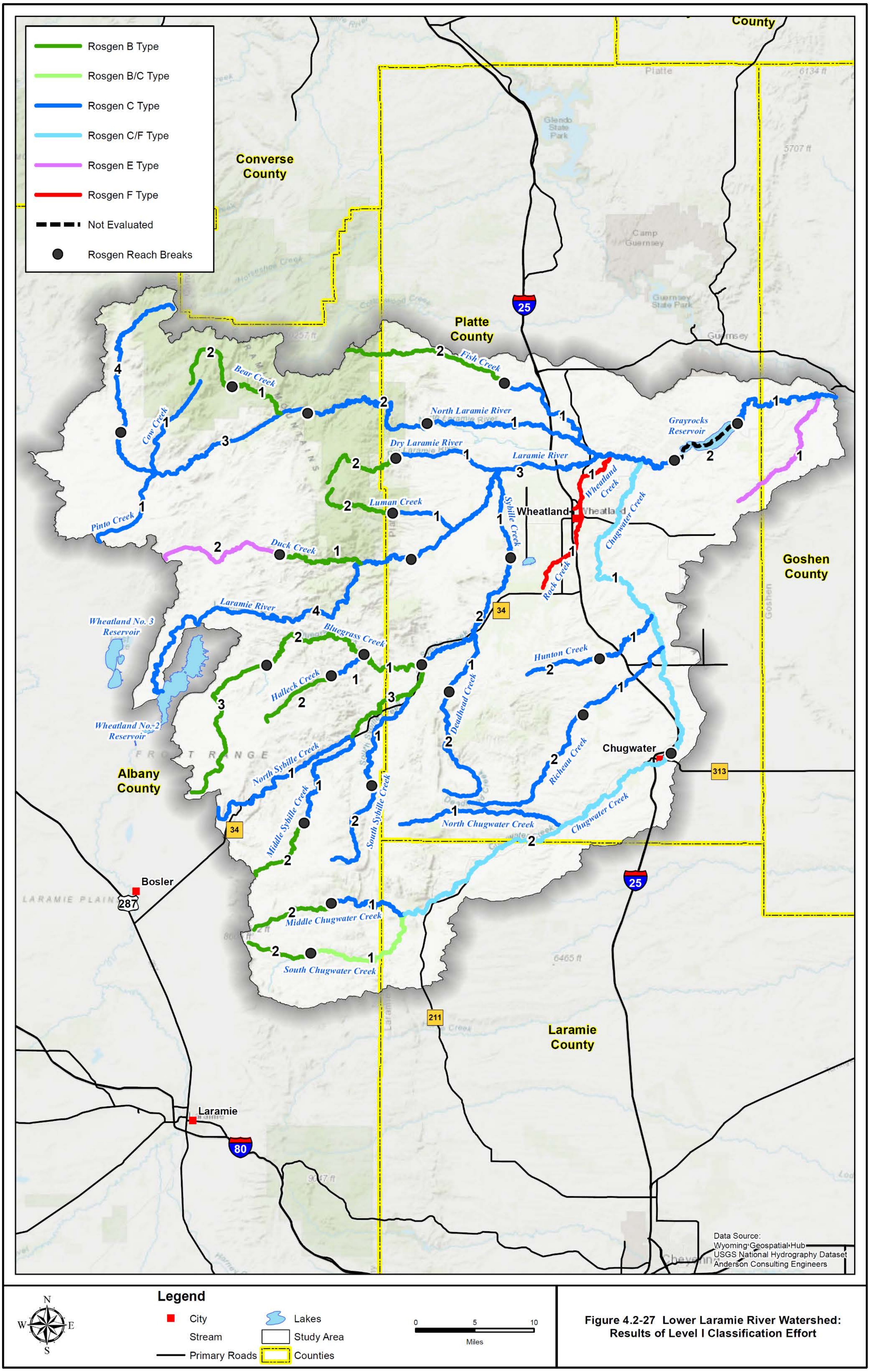


Figure 4.2-27 Lower Laramie River Watershed: Results of Level I Classification Effort

The common stable stream type within these settings is the C channel type. Figure 4.2-28 displays a photo of a stable reach of Richeau Creek.

Figure 4.2-28. Richeau Creek: C-type Channel

Most of the mainstem streams in the study area (Laramie River, North Laramie River, Chugwater Creek, Sybill Creek, etc.) were classified as C-type channels for at least part of their extent. However, all are experiencing bed and bank erosion to some extent. All would have reaches classified as F-type yet delineating the actual extent of the changes would require more detailed evaluation and field mapping which was beyond the scope and budget of the current project. Consequently, several stream segments have been classified as C/F type to denote this condition. Channel degradation does not appear to be systemic. That is, it does not appear that the entire watershed is experiencing downcutting but erosion is more isolated and reflective of local conditions. Figure 4.2-29 displays a photo of a segment of Lower Chugwater Creek where the stream impinges upon the left bank causing a loss of pasture and irrigated acreage. A lesser number of channels were classified as either Type F or Type G stream channels in at least portions of their extent. Type F and Type G stream classifications both denote channels which have "disconnected" from their floodplains. These channels are typically erosive, actively downcutting, or widening. Based upon the GIS classification effort followed by field verification, it was concluded that the majority of stream channels within the study area are entrenched to some degree. Entrenchment occurs for a variety of reasons including presence of erosive soils coupled with land use practices including road construction, energy development, grazing, etc. Observations of channel conditions within the study revealed entrenchment ranging from slight to severe.

Figure 4.2-29. Bank Erosion on Lower Chugwater Creek.

Although not pervasive, some of the first-order tributaries in the lower portions of the basin can be classified as G-Type channels, or gullies. These channels are highly erosive, generate high sediment volumes, and can result in the loss of productive lands and destabilize upland conditions. These channels could be forming in response to one or more of numerous stimuli including but not necessarily limited to: channel realignment (straightening), road and culvert construction, range management practices, or base-level lowering associated with main channel incision.

4.2.6.2 Impairments

Based upon this basin-wide overall review, study area history and existing or on-going studies, impairments to stream channels within the study area appear to fall into the following broad and interrelated categories:

- Riparian Vegetation Degradation: Impaired riparian condition and habitat, and
- Riparian Degradation: Generally bank erosion and physical disturbance of stream banks.
- Imbalance of Sediment Supply: Imbalance between stream capacity and sediment supply can lead to channel degradation or aggradation

Management Implications:

The objective of a Rosgen classification is to provide insight into the inherent resiliency of the stream and where there may be stability issues. This insight can then be included in future planning efforts or consideration with project-specific designs.

For instance, type A and B channels are typically headwater streams and are inherently resilient to disturbance. Bedrock and valley-type typically contain the channels to a narrow corridor and migration is minimal and they're generally geomorphically stable. Management implications of these types of channels could be how to stabilize culverts, irrigation diversions, etc.

Type C channels are non-entrenched and have "access" to their floodplains. These channels migrate, we see oxbow features, bank erosion is a natural feature (within limits), etc. Management implications could include irrigation diversion design, bank stabilization, wetland creation / enhancement (i.e. oxbow wetlands), etc.

From a watershed planning perspective, knowing where the various types of channels lie and their extent all adds to the understanding of the watershed health and function. With an abundance of F-type channels (entrenched), systemic issues may be indicated. G channels (gullies) indicate other watershed health issues: overgrazing, energy development, roads, etc. These all add to the understanding of sediment loading to the mainstems which affects habitat, receiving stream stability, etc.

Within the project study area, there do not appear to be systemic geomorphic issues associated with channel degradation. In general, streams appear to be relatively stable from a geomorphic standpoint and bank erosion and incision were evident, but not prevalent. There are areas where channel widening is evidenced by active bank erosion and high width depth ratios.

Tributaries to the system mainstems were observed to be degrading and would be classified as Type-G channels under the Rosgen system. However, again it is important to keep in mind that these channels do not appear to be associated with widespread systemic watershed rejuvenation as would be expected if the mainstems were degraded. In other words, there was not sufficient evidence of channel degradation in the tributaries to indicate instabilities associated with base-level lowering of the mainstems. The Type-G channels observed through the course of this project were likely caused by local land use practices.

4.3 Biological Systems

4.3.1 Land Cover

4.3.1.1 Overview

Land cover within the watershed was evaluated using several databases; each with its own strengths and emphasis. The databases used to characterize land cover, vegetation, riparian areas and wetlands included:

National Land Cover Database (NLCD): We used the NLCD data to provide a general description of the watershed in terms of its ground cover (vegetation classification, urban, open water, etc.) The database is useful for large scale evaluations. The NLCD classifies cover into 16 categories.

The Landscape Fire and Resource Management Planning Tools Project, or LANDFIRE: This raster-based database was created at a 30-meter resolution. We used it to quantify and map riparian areas because of its resolution. This database is useful for evaluation of smaller areas but does not lend itself to map presentations. The LANDFIRE database provides more detailed classifications with 844 categories.

Wyoming GAP Analysis (GAP): The GAP data were used to characterize vegetation coverage because it has a greater number of vegetation classifications than the NLCD dataset and is better suited for map presentation and graphics than the LANDFIRE data.

National Wetlands Inventory (NWI): We used the NWI data, created by the US Fish and Wildlife Service, to quantify and map wetland communities. The NWI data is a commonly used database, however, ground truthing is recommended.

It is important to keep in mind when reviewing the results of these analyses, that results can vary depending upon the database referenced. Different methodologies were used in their creation, accuracy and resolution vary, and they may use different vegetation and land use classes.

4.3.1.2 Vegetation and Plant Communities

The NLCD is distributed by the Multi-Resolution Land Characteristics Consortium (MRLC) and serves as the definitive Landsat-based, 30-meter resolution, land cover database for the Nation. NLCD provides spatial

Table 4.3-1 National Land Cover Database Analysis for the Lower Laramie River Watershed.

Lower Laramie River Watershed: National Land Cover Database (NLCD)			
Classification	**Description**	**Acres**	**Percent of Watershed**
Grassland/Herbaceous	Areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.	970752	65.02%
Shrub/Scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	326721	21.88%
Evergreen Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.	81434	5.45%
Cultivated Crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.	53504	3.58%
Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	19874	1.33%
Woody Wetlands	Areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	18167	1.22%
Developed, Open Space	Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	7874	0.53%
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.	5775	0.39%
Open Water	Areas of open water, generally with less than 25% cover of vegetation or soil.	5405	0.36%
Developed, Low Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.	2070	0.14%
Barren Land (Rock/Sand/Clay)	Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.	609	0.04%
Developed, Medium Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.	459	0.03%
Developed, High Intensity	Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.	128	0.01%
Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.	117	0.008%
Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.	27	0.002%
	Total	1492917	100.00%

reference and descriptive data for characteristics of the land surface such as thematic class (for example, urban, agriculture, and forest), percent impervious surface, and percent tree canopy cover. NLCD supports a wide variety of Federal, State, local, and nongovernmental applications that seek to assess ecosystem status and health, understand the spatial patterns of biodiversity, predict effects of climate change, and develop land management policy. NLCD products are created by the Multi Resolution Land Characteristics (MRLC) Consortium, a partnership of Federal agencies led by the U.S. Geological Survey (Homer, C.H., Fry, J.A., and Barnes C.A., 2012, the National Land Cover Database, U.S. Geological Survey FactSheet 2012-3020, 4 p.). Table 4.3-1 presents the results of National Land Cover Database analysis for the study area.

In order to draw a clearer picture of the land cover within the watershed the vegetative cover within the study area was also evaluated using data obtained through the LANDFIRE project (*www.landfire.gov*).

LANDFIRE (Landscape Fire and Resource Management Planning Tools Project) is an interagency vegetation, fire, and fuel characteristics mapping project. It is a shared project between the Department of Interior (DOI) and Forest Service Wildland Fire Management programs. The primary purpose of the LANDFIRE project is to collect the data necessary to develop wildland fire models. The data are generated using remote sensing techniques with on-the-ground truthing. Data products accessed for this project included 30-meter spatial resolution raster data sets describing vegetation type and cover. LANDFIRE vegetation map units are derived from NatureServe's Ecological Systems classification (Comer and others, 2003). While the geographic resolution (30-meter) of the LANDFIRE data is the same as the NLCD data discussed previously, the classification system used by the LANDFIRE dataset is more highly evolved than the NLCD data. This allows for a finer classification of the vegetative cover within the study area.

The LANDFIRE data describes numerous attributes pertinent to this study, including:

- Environmental Site
- Potential Biophysical Settings
- Existing Vegetation Type
- Existing Vegetation Height
- Existing Vegetation Cover

The LANDFIRE "existing vegetation type" (EVT) data were analyzed and the distribution of vegetation classes at the HUC12 scale is summarized in Appendix 4C. The LANDFIRE existing vegetation data indicate a diverse collection of vegetation types totaling 73 different vegetation classes within the Lower Laramie watershed.

Grassland dominates the watershed, and the most common existing vegetation type is Western Great Plains Shortgrass Prairie, covering 21% of the watershed. Northwestern Great Plains Mixed grass Prairie is the second most common vegetation type, followed by Inter-Mountain Basins Montane Sagebrush Steppe and Inter-Mountain Basins Big Sagebrush Shrubland. These four vegetation types alone cover a more than half of the watershed (58%).

The bar chart at the end of Appendix 4C shows the relative distribution of physiognomy (form/morphological structure of vegetation) for each HUC12 subwatershed (12-digit hydrologic units). The physiognomy field from the LANDFIRE database is more general than the "existing vegetation type" field, and thus is more presentable in graphical form. Many of the subwatersheds are dominated by grassland, while others such as Twentytwo Mile Draw, Upper and Middle Bluegrass Creek are almost entirely shrubland. The subwatersheds with highest agricultural activity are Laramie River - Laramie River Ditch, Lower Sybille Creek, and Wheatland Creek. Tributaries of the North Laramie river tend to have a higher portion of coniferous land than the other subwatersheds.

In order to aid in future analysis and enable the LANDFIRE data to be utilized as a land management/planning tool, the Existing Vegetation Type (EVT) data has been intersected with the sub-watersheds (12-digit hydrologic units) within the study area. The result of this analysis has been included in the project GIS and Digital Library delivered with this report. This data intersection will facilitate a more focused vegetation analysis based on the sub-watersheds within the study area. Analytical tools available within the project GIS facilitate use of the LANDFIRE data for regional watershed planning. For example, areas of the watershed identified as any of several juniper species communities can be identified and evaluated onsite to determine potential encroachment areas. Similar evaluations within the project GIS can be completed for wetland/riparian communities in order to determine areas where the PCRD may concentrate future planning efforts.

While the LANDFIRE data provides valuable insight into watershed conditions, its display is difficult because of the fact the data are represented by a grid with 30-meter spacing. The LANDFIRE data set is included within the project GIS and available for use in subsequent projects and associated efforts.
The Wyoming GAP dataset was produced "with an intended application at the state or ecoregion level - geographic areas from several hundred thousand to millions of hectares in size. The data provide a coarse-filter approach to vegetation analyses, meaning that not every occurrence of habitat is mapped; only large, generalized distributions are mapped, based on the USGS 1: 100,000 mapping scale in both detail and precision. Therefore, this dataset can be used appropriately for coarse-scale (> 1: 100,000) applications, or to provide context for finer-level maps or applications" (University of Wyoming, Spatial Data Visualization Center, 1996).

For the purposes of this project however it is the most "display-friendly" vegetative dataset available and provides generalized distributions of the vegetative land cover located within the Lower Laramie watershed. Figure 4.3-1 displays the Wyoming Gap Analysis results for the study area. Note that the classifications in the figure are listed in their order of abundance within the watershed. Of the 19 different GAP classifications present in the watershed, mixed grass prairie dominates the landscape, making up 43% of the study area. Xeric upland shrub, ponderosa pine, irrigated crops and Wyoming big sagebrush are the next most abundant, each making up about 10% of the watershed.

Distinct plant communities within the study area are influenced by characteristics such as soil depth, texture, and salt content; climate variables, particularly temperature, total and seasonal distribution of precipitation, and wind; and topographic features, most importantly elevation, aspect, and slope. Plant communities respond to other environmental influences such as wildlife foraging, rodent burrowing, and ant hills. Plants themselves also influence soil chemistry and soil resistance to wind and water erosion.

4.3.1.3 Riparian Areas

The LANDFIRE data includes a limited determination of riparian areas as well. The LANDFIRE data does not graphically represent well at the watershed scale, therefore the riparian vegetation communities in

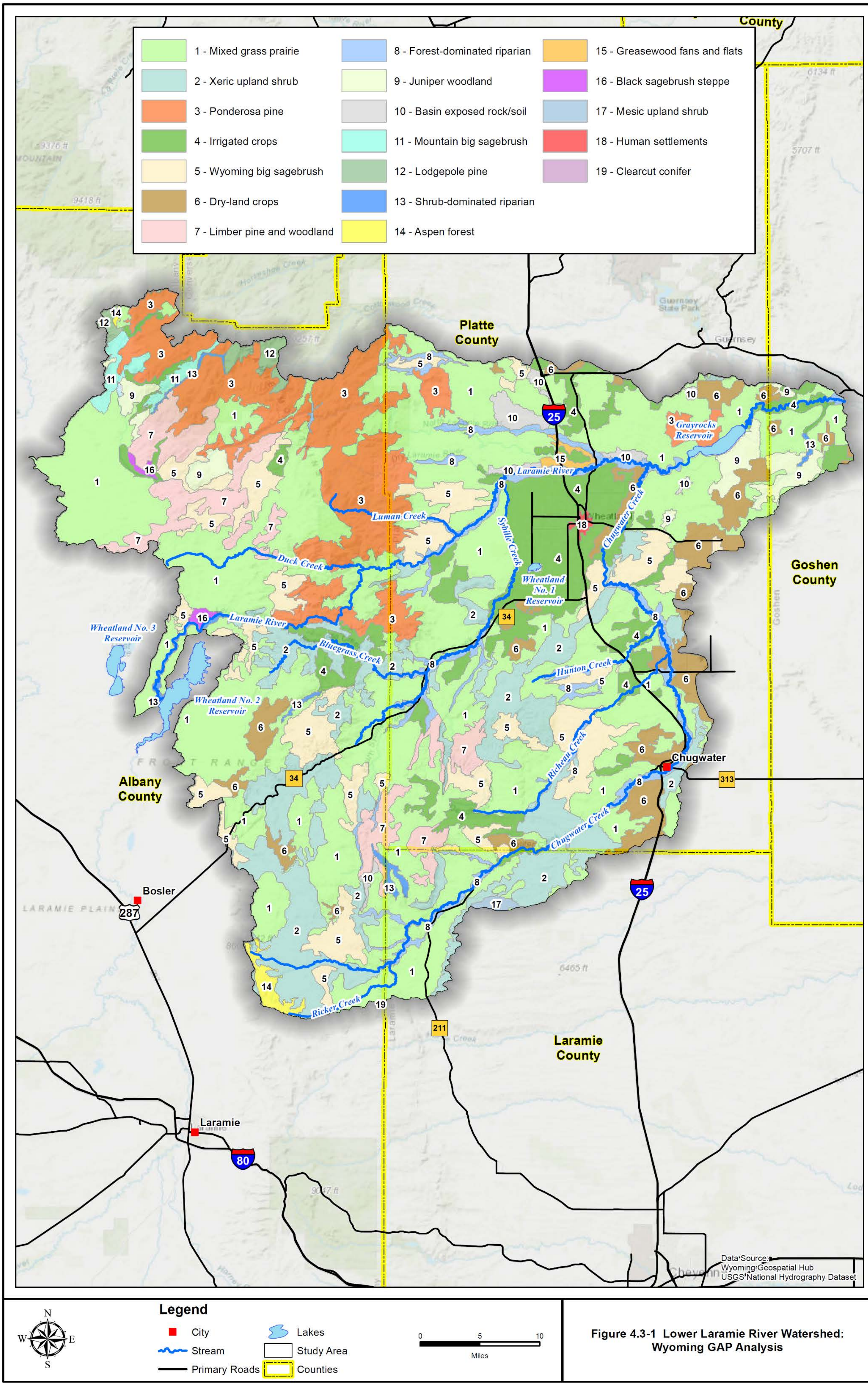


Figure 4.3-1 Lower Laramie River Watershed: Wyoming GAP Analysis

the dataset are presented in Table 4.3-2. There is a total of 42,571 acres designated Riparian in the LANDFIRE dataset. As this table clearly indicates, riparian areas in the study area are extremely limited in extent (2.85% of the watershed).

Table 4.3-2 LANDFIRE Riparian/Wetlands Classifications.

Lower Laramie River Watershed : LANDFIRE				
Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Acres	Percent of Watershed	Cumulative Percent
Rocky Mountain Montane Riparian Forest and Woodland	Riparian	22808.4	1.53%	1.53%
Western Great Plains Floodplain Forest and Woodland	Riparian	9558.6	0.64%	2.17%
Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	4332.2	0.29%	2.46%
Rocky Mountain Wetland-Herbaceous	Riparian	4314.5	0.29%	2.75%
Western Great Plains Floodplain Herbaceous	Riparian	647.4	0.04%	2.79%
Rocky Mountain Montane Riparian Shrubland	Riparian	506.9	0.03%	2.82%
Rocky Mountain Subalpine/Upper Montane Riparian Forest and Woodland	Riparian	172.3	0.01%	2.84%
Western Great Plains Floodplain Shrubland	Riparian	119.3	0.01%	2.84%
Western Great Plains Wooded Draw and Ravine	Riparian	104.4	0.01%	2.85%
Western Great Plains Depressional Wetland Systems	Riparian	6.8	0.00%	2.85%

4.3.1.4 Wetlands

Existing mapping of wetlands within the study area consisted of the National Wetlands Inventory (NWI) created by the US Fish and Wildlife Service (USFWS). The NWI mapping was completed using aerial photographs within the GIS environment and digitizing by analysts, however due to the relatively limited extent of mapped wetlands in relation to the size of the watershed, the data does not lend itself to presentation at the watershed scale. Based upon the NWI mapping, approximately 30,748 acres of wetlands exist within the watershed, which is only about 2.1% of the total study area.

Figure 4.3-2 presents a pie chart showing the relative distribution of the general wetland types. The major contiguous wetlands in the watershed are Grayrocks Reservoir and other reservoirs associated with irrigation. Riverine wetlands are also found throughout the study area, making up just over a third of the total wetlands. Freshwater emergent wetlands are the most common type of wetland in the watershed, and they are normally found near riverine areas. The USFS describes these areas as follows:

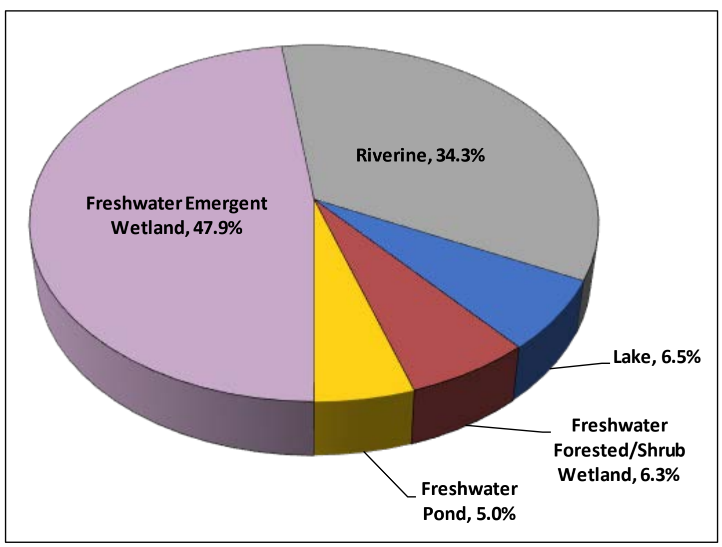


Figure 4.3-2 Percent of NWI Wetlands Types.

"Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants."

It is generally understood by users of the NWI mapping that the data are suitable for broad scale planning efforts such as this Level I investigation; however, before design and completion of any project potentially affecting wetlands, detailed onsite delineation should be conducted.

The Nature Conservancy utilized the existing NWI data as the basis for development of their 2010 Wetland Complex dataset in which they identified 221 wetland complexes in the State of Wyoming. The Laramie Range Wetland Complex is the largest in the watershed, occupying 267,009 acres on the western side of the watershed. The Wheatland Wetland Complex occupies 148,519 acres in the northern-central portion of the watershed. The Goshen Hole Wetland Complex intersects the downstream-most portion of the watershed near the Platte River confluence, and the Laramie Plains Complex intersects the upstream-most portion of the watershed near Wheatland Reservoir No. 2. Five unnamed complexes also exist within the study area (Figure 4.3-3).
The Wetland Complex dataset has been included in the project GIS and includes attributes such as:

- Number of Wyoming Species of Greatest Conservation Need (SGCN) in the complex.
- Number of rare species of Greatest Conservation Need (SGCN). See "Ecological Indicators" (Copeland et al, 2010) for a list of rare species.
- Biological diversity ranking of the complexes.
- Vulnerability of complexes to oil and gas development, residential development, and drought.

4.3.1.5 Grazing Allotments Administration

Grazing resources within the Lower Laramie Watershed Study area are influenced by land ownership. As previously discussed, of the approximately 1.35 million acres within this study area, over 1.03 million acres are privately owned, over 201,500 acres under Federal management, and 121,500 acres managed by the State.

Significant portions of this land base are devoted to livestock grazing which in turn provides a major contribution to the local ranching and farming industry. Livestock grazing on BLM and USFS lands is managed under allotments as shown in Figure 4.3-4. There are 190 BLM allotments and 17 Forest Service allotments. Federal land grazing is managed under the Federal Land Policy and Management Act of 1976 and the Taylor Grazing Act of 1934.

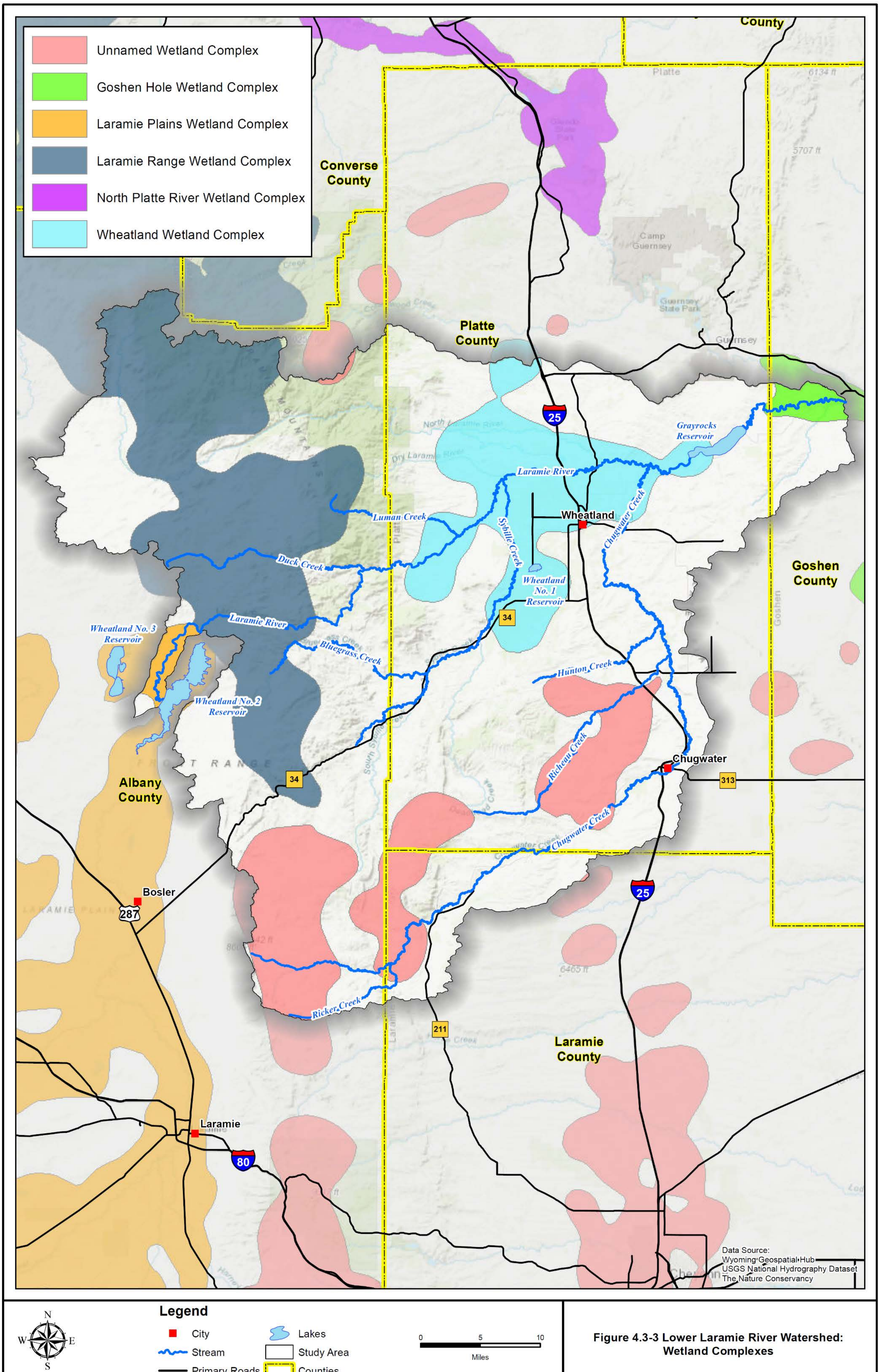


Figure 4.3-3 Lower Laramie River Watershed: Wetland Complexes

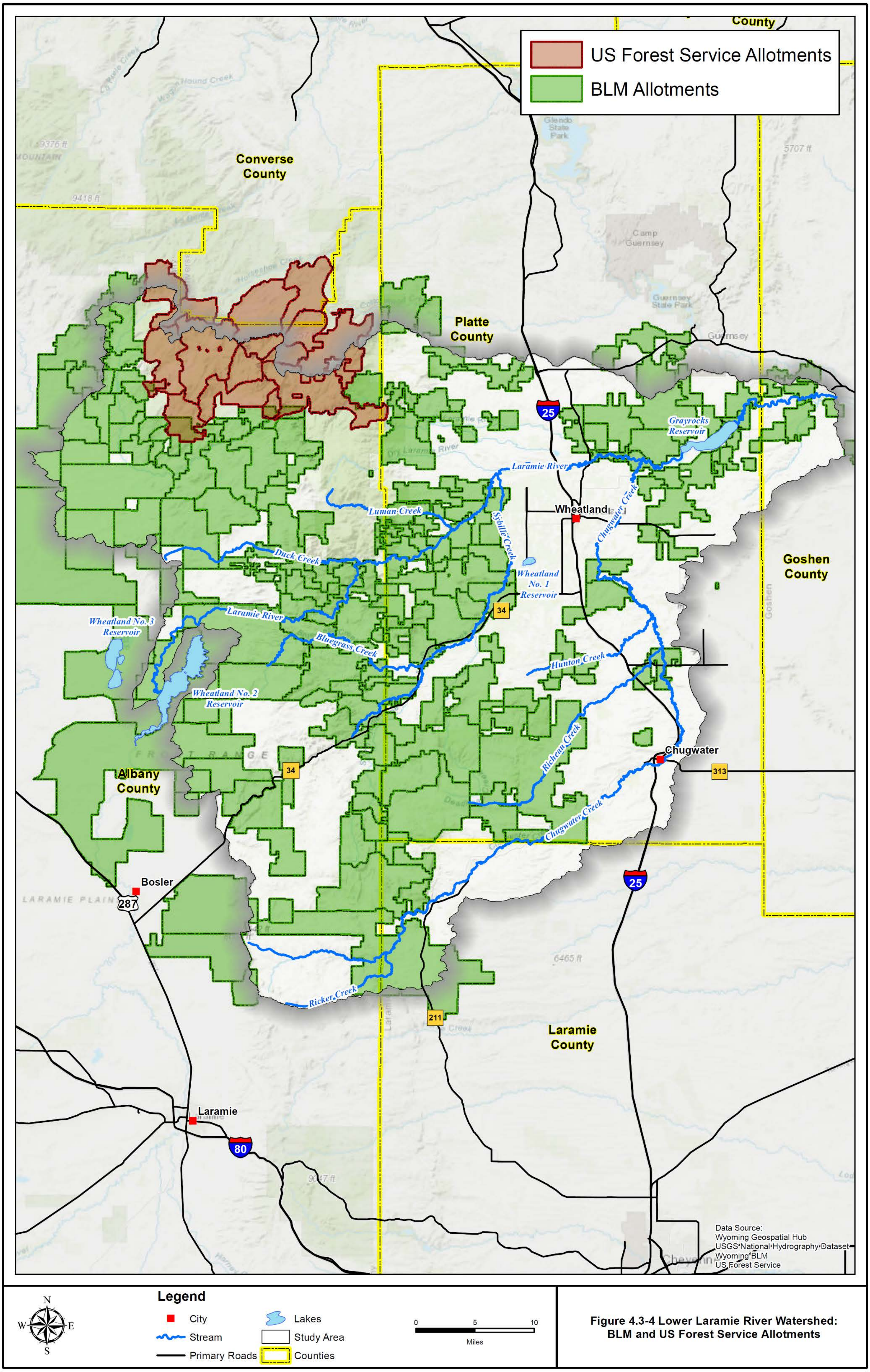


Figure 4.3-4 Lower Laramie River Watershed: BLM and US Forest Service Allotments

Bureau of Land Management Administration

Grazing activities on BLM lands are required to meet Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands as established in 1997. These Standards and Guidelines are to support infiltration, maintain soil moisture, stabilize soils, and provide sufficient water to maintain system function and soil permeability; restore, maintain, or improve riparian plant communities to sustain adequate residual plant cover for sediment capture and groundwater recharge; implement riparian improvements to maintain or enhance stream channel morphology; develop springs, seeps, reservoirs, wells, or other water development projects in a manner that protects watershed ecological and hydrological functions; implement range improvements away from riparian areas to avoid conflicts in achieving or maintaining riparian function; and adopt management practices and implement range improvements that protect vegetative cover and thereby maintain, restore, or enhance water quality.

United States Forest Service Administration

In addition to the BLM allotments within the watershed, the USFS administers 17 grazing allotments. The Medicine Bow - Routt National Forest is the administrative unit of the US Forest Service located in eastern Wyoming. Each forest and grassland is guided by a unique Land and Resource Management Plan (available on the Forest web site at http://www.fs.usda.gov/land/mbr/landmanagement) that outlines desired conditions, goals, objectives, standards, and guidelines for the Plan area. Each Plan also provides direction to monitor resources to determine if the Forest or Grassland is moving toward or maintaining the desired conditions of the Plan area.

The USFS conducts resource monitoring that pertains to maintenance and improvement of watershed health. Included are reviews of roads and trails, riparian area grazing use by livestock and wildlife, and recreation. Data collection and information gathered is used to understand the maintenance or improvement of watershed condition and how management being applied to the resource area is maintaining a healthy watershed condition. Specific interest is directed toward proper functioning condition of riparian areas and wetlands and how management is affecting those habitat environs.

State Land Administration

State lands within the watershed are generally leased to private landowners for agriculture production, including livestock grazing. These permits are obtained through the Office of State Lands and Investments as approved by the State Board of Land Commissioners. Management practices, including infrastructure improvements on state leases, are usually determined and implemented by the lessee (refer to the land ownership map for state land locations as shown in Figure 4.4-11).

4.3.1.6 Weeds and Invasive Species

Vegetation of particular importance with respect to land use and habitat that were identified by the Wyoming Weed and Pest Council include:

Designated Noxious Weeds W.S. 11-5-102 (a) (xi). For more information, see: http://www.wyoweed.org/

- Field bindweed (Convolvulus arvensis L.)
- Canada thistle (Cirsium arvense L.)
- Leafy spurge (Euphorbia esula L.)
- Perennial sowthistle (Sonchus arvensis L.)
- Quackgrass (Elymus repens (L.) Gould.)
- Hoary cress (whitetop) (Cardaria draba & Cardaria pubescens (L.) Desv.)
- Perennial pepperweed (giant whitetop) (Lepidium latifolium L.)
- Ox-eye daisy (Leucanthemum vulgare Lam.)
- Skeletonleaf bursage (Ambrosia tomentosa Nutt.)
- Russian knapweed (Acroptilon repens L.)
- Yellow toadflax (Linaria vulgaris (P.) Mill)
- Dalmatian toadflax (Linaria dalmatica (L.) Mill.)
- Scotch thistle (Onopordum acanthium L.)
- Musk thistle (Carduus nutans L.)
- Common burdock (Arctium minus (Hill) Bernh.)
- Plumeless thistle (Carduus acanthoides L.)
- Dyer's woad (Isatis tinctoria L.)
- Houndstongue (Cynoglossum officinale L.)
- Spotted knapweed (Centaurea stoebe L. ssp. micranthos (Gugler) Hayek)
- Diffuse knapweed (Centaurea diffusa Lam.)
- Purple loosestrife (Lythrum salicaria L.)
- Saltcedar (Tamarix spp.)
- Common St. Johnswort (Hypericum perforatum L.)
- Common Tansy (Tanacetum vulgare)
- Russian olive (Elaeagnus angustifolia L.)
- Black Henban (Hyoscyamus niger)

Additionally, as of February 2017 the Wyoming Weed and Pest Council lists the following weeds as declared weeds by county:

Albany County:

- Plains larkspur/Geyer larkspur (Delphinium geyeri Greene)
- Locoweed (Oxytropis spp.)

- Cheatgrass / downy brome (Bromus tectorum L.)

Goshen County:

- Puncturevine (Tribulus terrestris L.)
- Wild licorice (Glycyrrhiza lepidota Pursh)

Laramie County:

- Jointed goat grass (Aegilops cylindrica Host.)
- Puncturevine (Tribulus terrestris L.)
- Sandbur (Cenchrus incertus Curtis)
- Wild licorice (Glycyrrhiza lepidota Pursh)
- Hairy goldenaster (Heterotheca villosa (Pursh) Shinners)
- Common mullein (Verbasum thapsus L.)
- Viper's bugloss (Echium vulgare L.)
- Locoweed (Oxytropis spp.)
- Plains prickly pear (Opuntia polyacantha Haw.)
- Plains larkspur/Geyer larkspur (Geomys bursarius (Shaw))

Platte County:

- Chicory (Cichorium intybus L.)
- Cheatgrass / downy brome (Bromus tectorum L.)
- Puncturevine (Tribulus terrestris L.)
- Jointed goat grass (Aegilops cylindrica Host.)

"Designated noxious weed" is defined by the Wyoming Weed & Pest Control Act as follows:

> *"weeds, seeds or other plant parts that are considered detrimental, destructive, injurious or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within this state, and are on the designated list, which is formed by joint resolution of the Wyoming Board of Agriculture and the Wyoming Weed and Pest Council. If a plant is listed as a Designated Noxious Weed, that listing provides statewide legal authority to regulate and manage it."*

"Declared weed" is defined as follows:

> *"any plant which the Wyoming Board of Agriculture and the Wyoming Weed and Pest Council have found, either by virtue of its direct effect, or as a carrier of disease or parasites, to be detrimental to the general welfare of persons residing within a district (county). If a plant is listed as a County Declared Weed, that listing provides that county with legal authority to regulate and manage it."*

The county Weed and Pest Districts actively conduct control measures to reduce the spread and reproduction of weed species. Interested landowners should contact the Albany, Goshen, and Laramie County Weed and Pest Districts for more information.

Data Sources:

Wyoming Weed and Pest Council: http://www.wyoweed.org/
Albany County Weed and Pest Control District: http://www.albanycountyweedandpest.com/index.html
Goshen County Weed and Pest Control District: http://www.goshenweedandpest.com/
Laramie County Weed and Pest Control District: http://1000laramiecountyweed.publishpath.com/

4.3.1.7 Sensitive Species

The Wyoming Natural Diversity Database (WYNDD) lists vegetative Species of Concern (SOC) or Species of Potential Concern (SOPC) which have been documented within the study area. The database was queried, identifying 26 plants as SOC or SOPC. The results are presented in Appendix 4D.

4.3.2 Fish and Wildlife

4.3.2.1 Fisheries

The Wyoming Game and Fish Department uses a stream classification system to identify and rank the most important coldwater recreational fisheries, and to assess the relative potential impacts of proposed development projects to streams. Categories are based on pounds of trout per mile based on the WYGFD population monitoring data and include:

- Blue Ribbon (national importance) >600 pounds per mile,
- Red Ribbon (statewide importance) 300 to 600 pounds per mile,
- Yellow Ribbon (regional importance) 50-300 pounds per mile,
- Green Ribbon (local importance) <50 pounds per mile.

Figure 4.3-5 shows the stream classifications within the Lower Laramie Watershed. Trout are present in many of the higher elevation streams. The only stream in the watershed that is classified as blue ribbon (>600 pounds of trout per mile) is a small segment of Sybille Creek between the Platte-Albany county line and the confluence with Middle Sybille Creek. There are a few red ribbon streams (300 to 600 pounds of trout per mile), including upper Sybille Creek, Mule Creek, Duck Creek, Dry Laramie River, Brandel Creek, and Bear Creek.

The upper portion of the Laramie River and most of its larger tributaries (such as Chugwater Creek, Richeau Creek, and Bluegrass Creek) are classified as yellow ribbon streams (50-300 pounds per mile). Many of the tributaries of these streams are classified as green ribbon streams (<50 pounds per mile). Only one category is used for cool/warm water streams. Those with cool/warm sport fish species (other than trout) are indicated as orange ribbon. The lower portion of the Laramie River and North Laramie River have cool/warm water sport fish present.

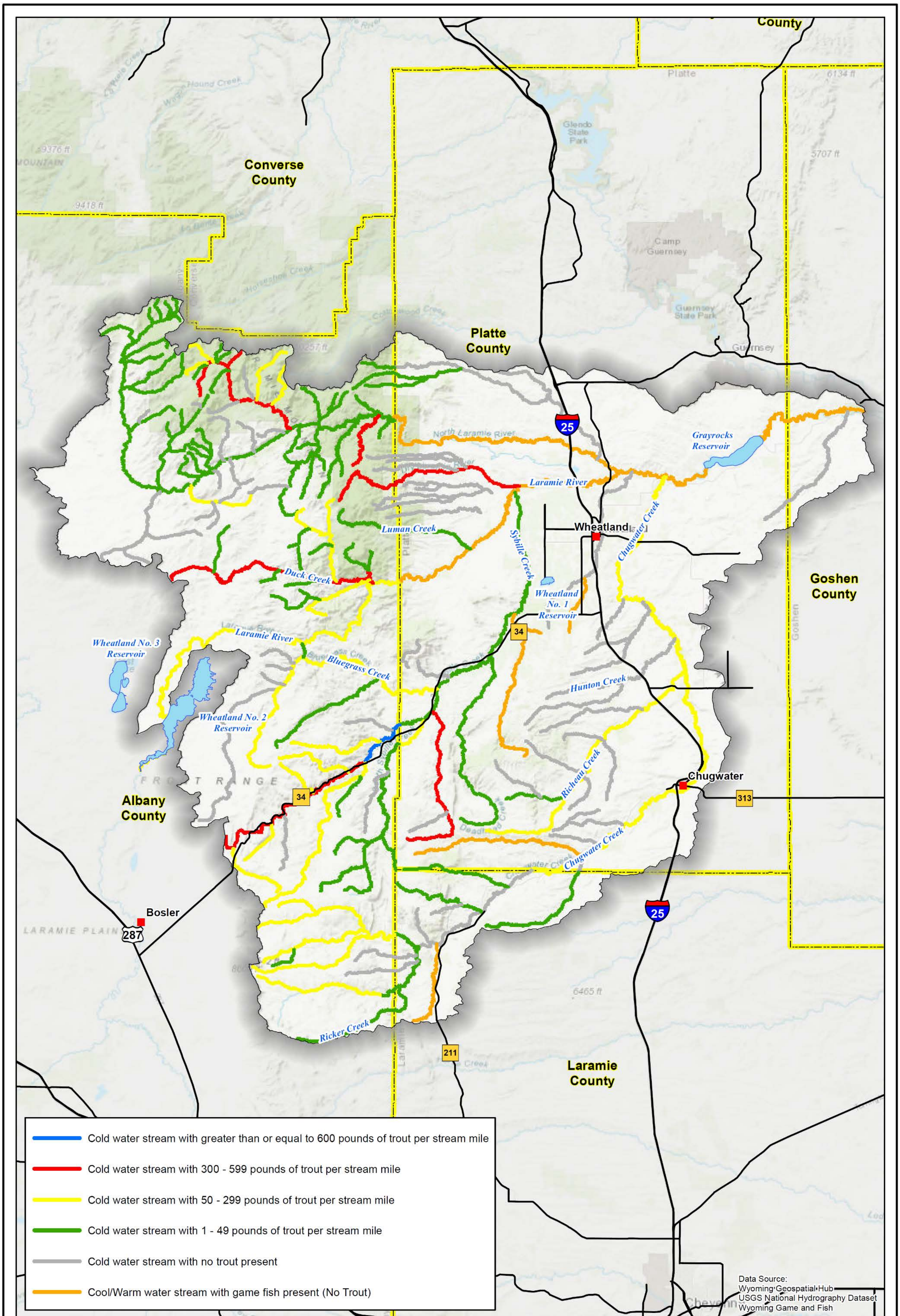


Figure 4.3-5 Lower Laramie River Watershed: Wyoming Game and Fish Trout Stream Classifications

The Species of Greatest Conservation Need (SGCN) classification was developed as part of Element 1 of the Congressional guidelines for State Wildlife Action Plans (SWAPs). The SGCN designation is reserved for species whose conservation status warrants increased management attention, and funding, as well as consideration in conservation, land use, and development planning in Wyoming. The Lower Laramie River Watershed is home to several fish species designated as SGCN (Figure 4.3-6). The lower portion of the watershed has the highest number of SGCN-designated fish species. The SWAP reports for these species and a document detailing the Wyoming SGCN designation can be found in the digital library submitted with this report.

The WGF has identified the hornyhead chub (Nocomis biguttatus) as a species that is imperiled due to greatly restricted distribution. In Wyoming, hornyhead chub (HHC) are found only in Laramie and North Laramie rivers. Due to siltation, debris flows, and other habitat alterations associated with wildfire, the HHC population was greatly reduced in the North Laramie River drainage following the 2012 Arapaho Fire. In 2013 and 2014, the North Laramie River was sampled in areas of known distribution of HHC, but no HHC were captured or observed. HHC were transplanted from the Laramie River at Tunnel Road to the North Laramie River in October 2014, and again in August 2015. Other conservation actions denoted in the State Wildlife Action Plan include reducing entrainment in the North Laramie Canal, resolving nongame passage issues, protecting and managing native riparian vegetation, filing for instream flow water rights, and preventing stocking of non-native species.

In an effort to enhance fisheries populations, WGF has identified several irrigation diversion structures where modifications to either provide fish passage or to improve barrier capabilities would be of value. Specifically, the Wilson No. 2 and the North Laramie Land Company Canal diversions have been identified for potential fish passage improvement projects. Both diversions are located on the North Laramie River as indicated in Figure 4.3-6. At the time this report was prepared, WGF was in the process of evaluating design alternatives and cost estimates. In addition, the Burger Ditch diversion, also on the North Laramie River, has been identified as a barrier beneficial to fisheries population management strategies. WGF is currently evaluating design alternatives to enhance the structure's fish passage capabilities.

WGF also notes that in recent years, smallmouth bass have migrated upstream the Laramie River from Grayrocks Reservoir to stream reaches upstream of Palmer Canyon Road where populations of numerous native nongame species are found. At this time there are no specific structures identified which could be utilized/enhanced to help manage populations but future planning efforts are anticipated to investigate several structures.

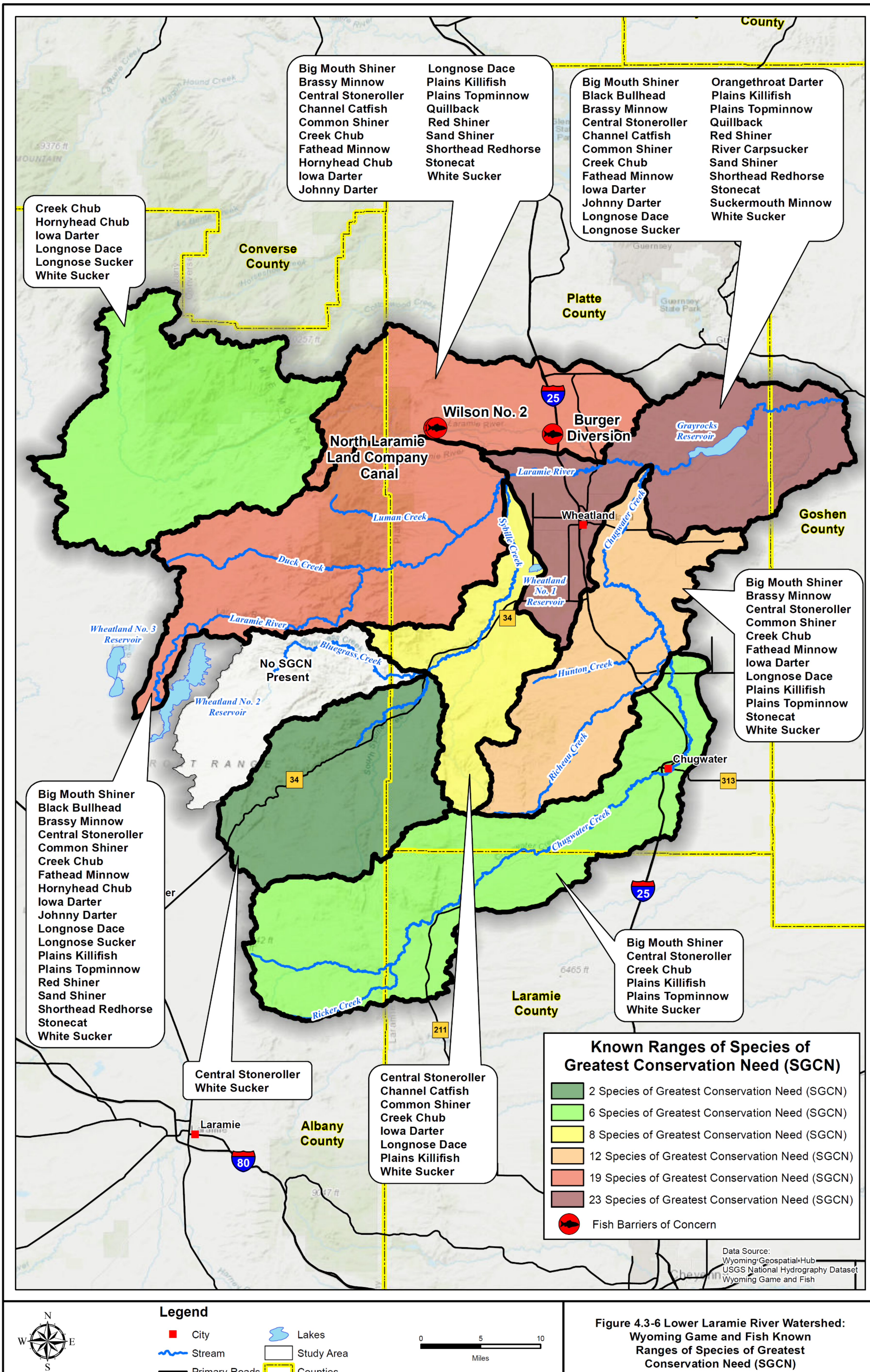


Figure 4.3-6 Lower Laramie River Watershed: Wyoming Game and Fish Known Ranges of Species of Greatest Conservation Need (SGCN)

4.3.2.2 Big Game

The Wyoming Game and Fish Department (WGFD) maps the seasonal ranges by herd unit for each big game species and makes special note of areas listed as crucial habitat and parturition (birthing areas). WGFD's crucial habitat, or range, is defined as those seasonal ranges or habitats (mostly winter range) that have been documented as the determining factor in a population's ability to maintain itself at a certain level over a long period of time. In the Lower Laramie River watershed, the primary big game present are pronghorn antelope, elk, bighorn sheep, mule deer, and white-tailed deer. Approximately 670,713 acres (roughly 45 percent of the study area) have been determined to be crucial habitat for one or more of antelope, bighorn sheep, elk, or mule deer. Of the big game species mapped by the WGFD, only bighorn sheep and elk have parturition areas within the watershed. The parturition areas total only 15,873 acres (approximately 1.1% of the study area). According to the Game and Fish data provided, white-tailed deer may utilize the study area, but only as seasonal range.

Figures 4.3-7 through 4.3-11 display the WGFD seasonal range, crucial range, parturition areas, and migration routes for antelope, elk, bighorn sheep, mule deer, and white-tailed deer within and immediately adjacent to the study area. Examination of these figures shows that the entire watershed is classified as seasonal range for the big game species. The crucial ranges and parturition areas of the primary big game species within the watershed were aggregated individually and are shown in Figure 4.3-12. The figure shows that the crucial range of the four primary species is generally concentrated in the central portion of the watershed. The crucial ranges are located near Sybille Creek and its headwaters, middle Chugwater Creek, Medicine Bow National Forest (northern portion of the watershed), and Grayrocks reservoir. As previously mentioned, the crucial ranges tend to be winter range areas where foraging is easier due to lower snow depths, and the landscape provides some sort of thermal cover (BLM, 2008). The parturition areas for elk and bighorn sheep are in the highlands near the headwaters of Sybille Creek and the Lower Laramie River. These areas provide particularly good security cover and succulent forage (BLM, 2008). No parturition areas for antelope, mule deer, or white-tailed deer are located within the study area.

To address declining mule deer populations, the WGFD published "Recommendations for Managing Mule Deer Habitat in Wyoming" (Oct 2015) which is included with the digital library delivered with this report. The document provides management recommendations related to seasonal mule deer diet, important vegetation types, human disturbance (fences, roads), predators and invasive species.

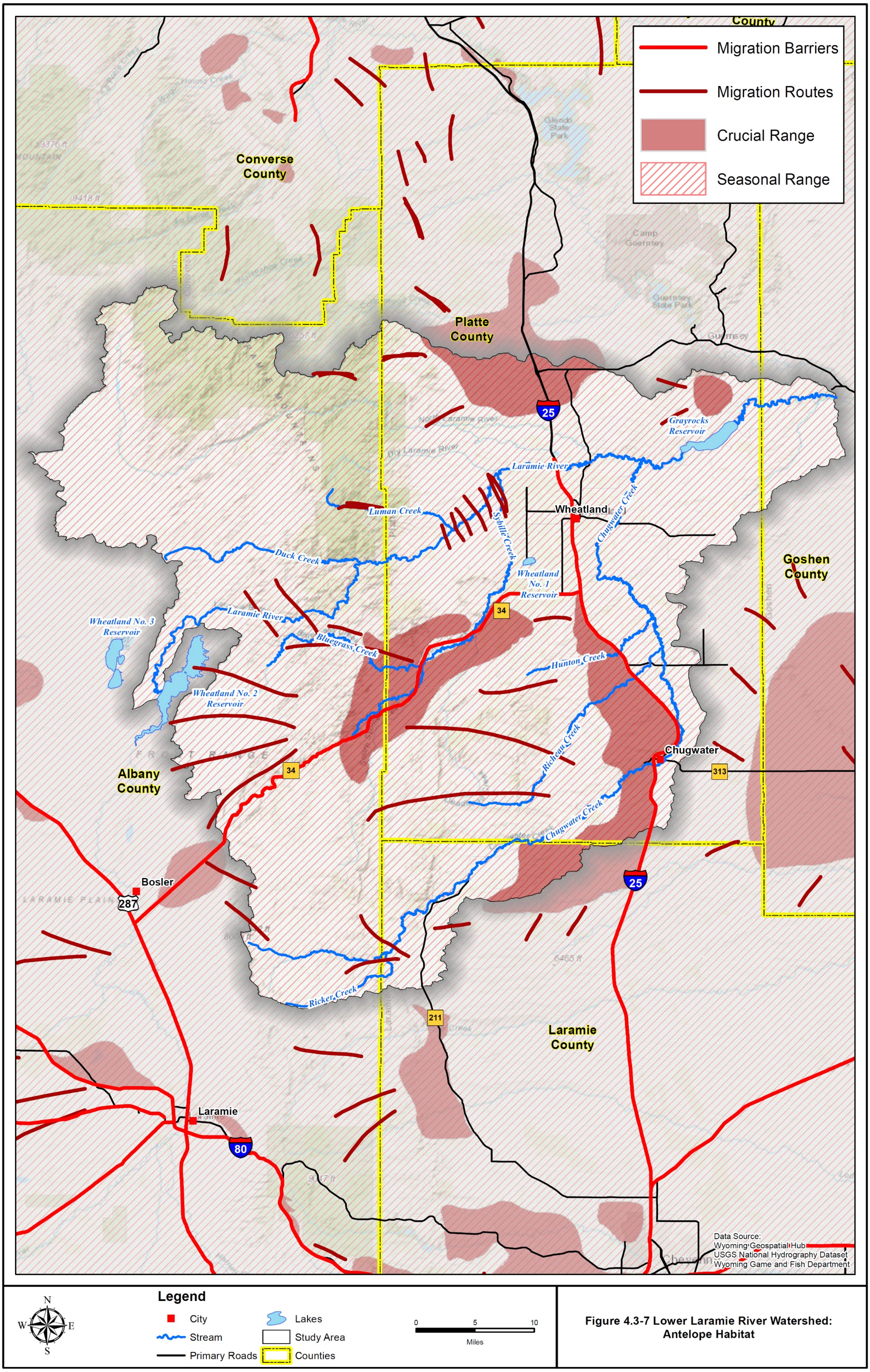


Figure 4.3-7 Lower Laramie River Watershed: Antelope Habitat

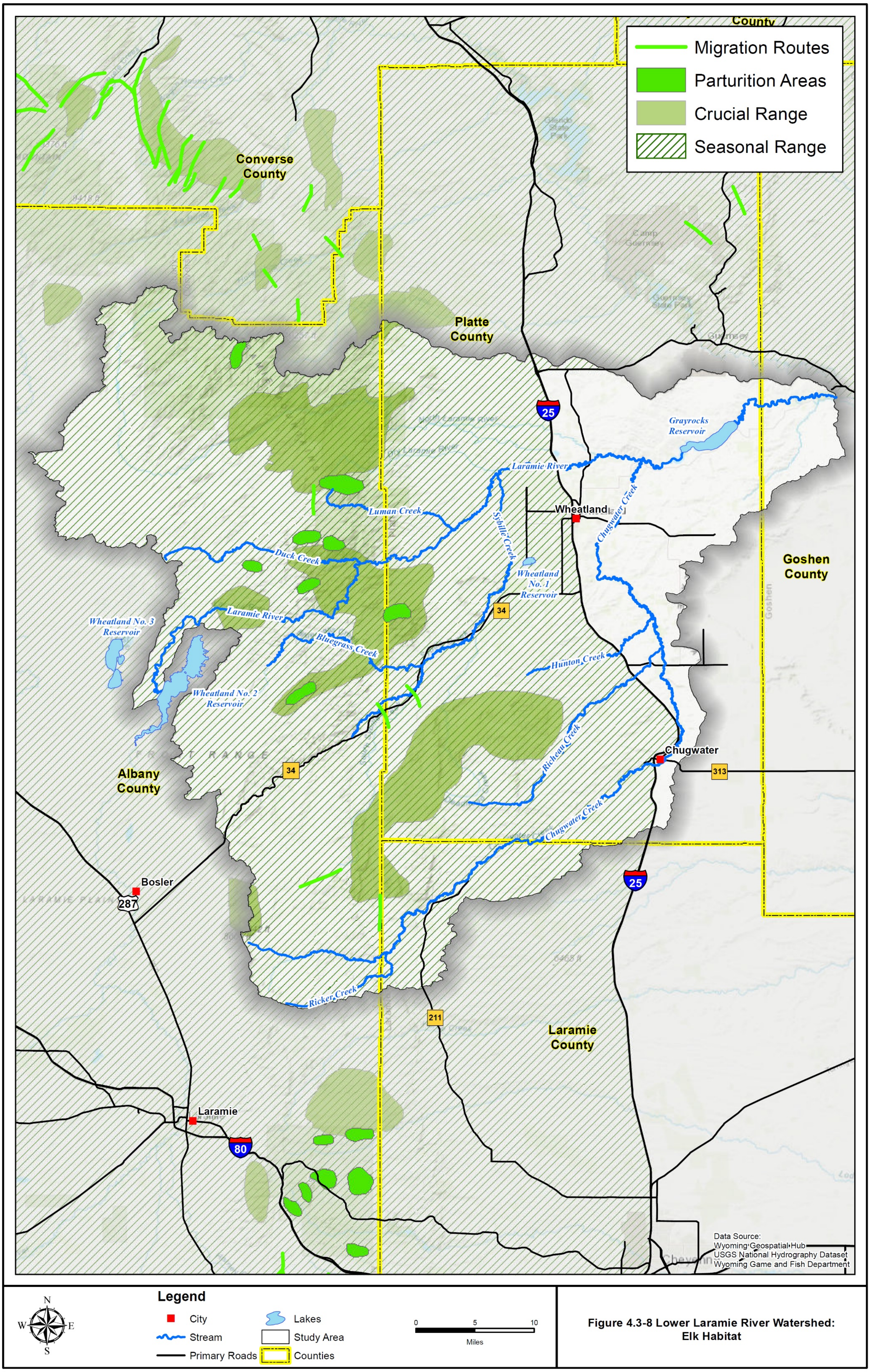


Figure 4.3-8 Lower Laramie River Watershed: Elk Habitat

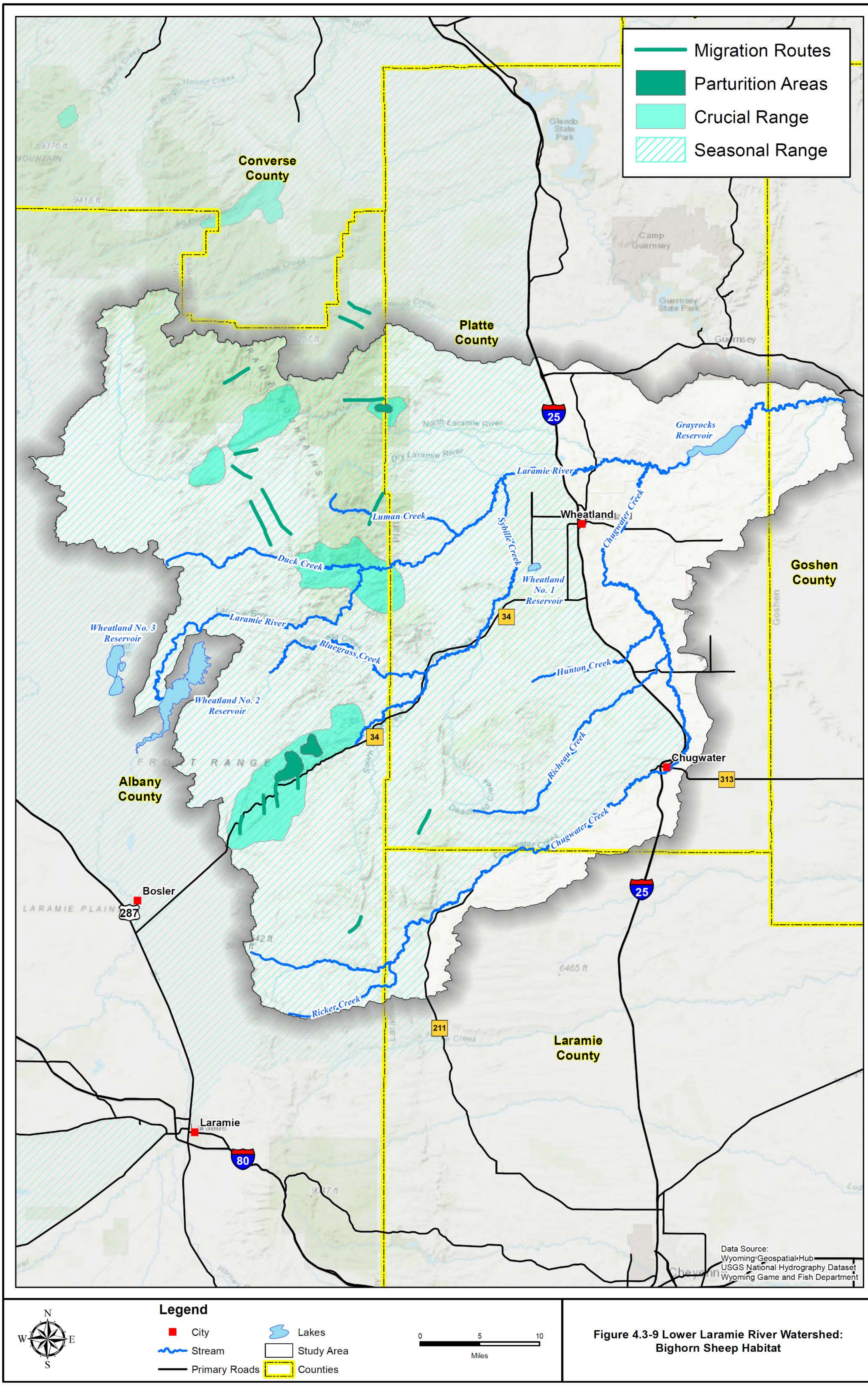


Figure 4.3-9 Lower Laramie River Watershed: Bighorn Sheep Habitat

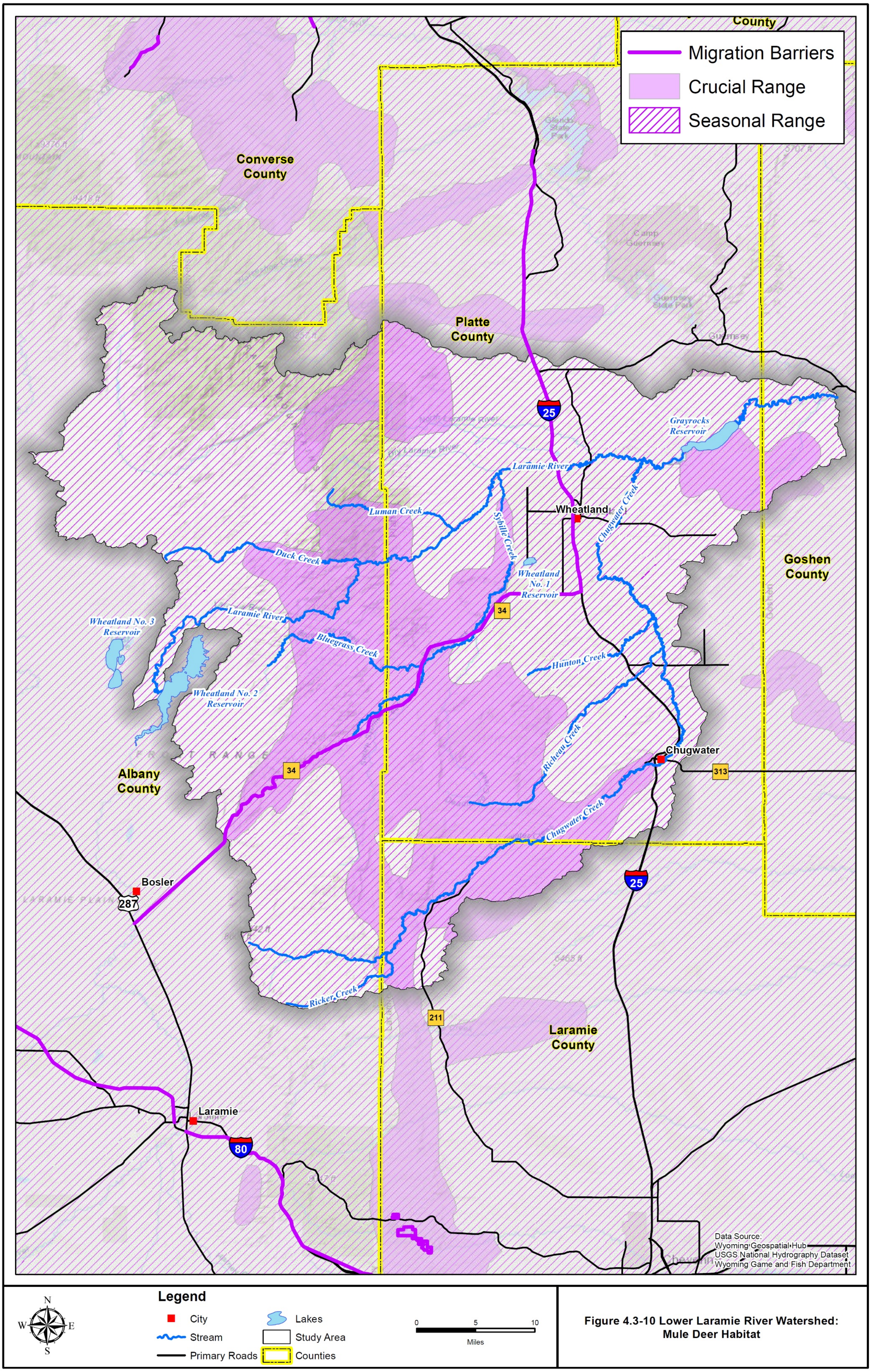


Figure 4.3-10 Lower Laramie River Watershed: Mule Deer Habitat

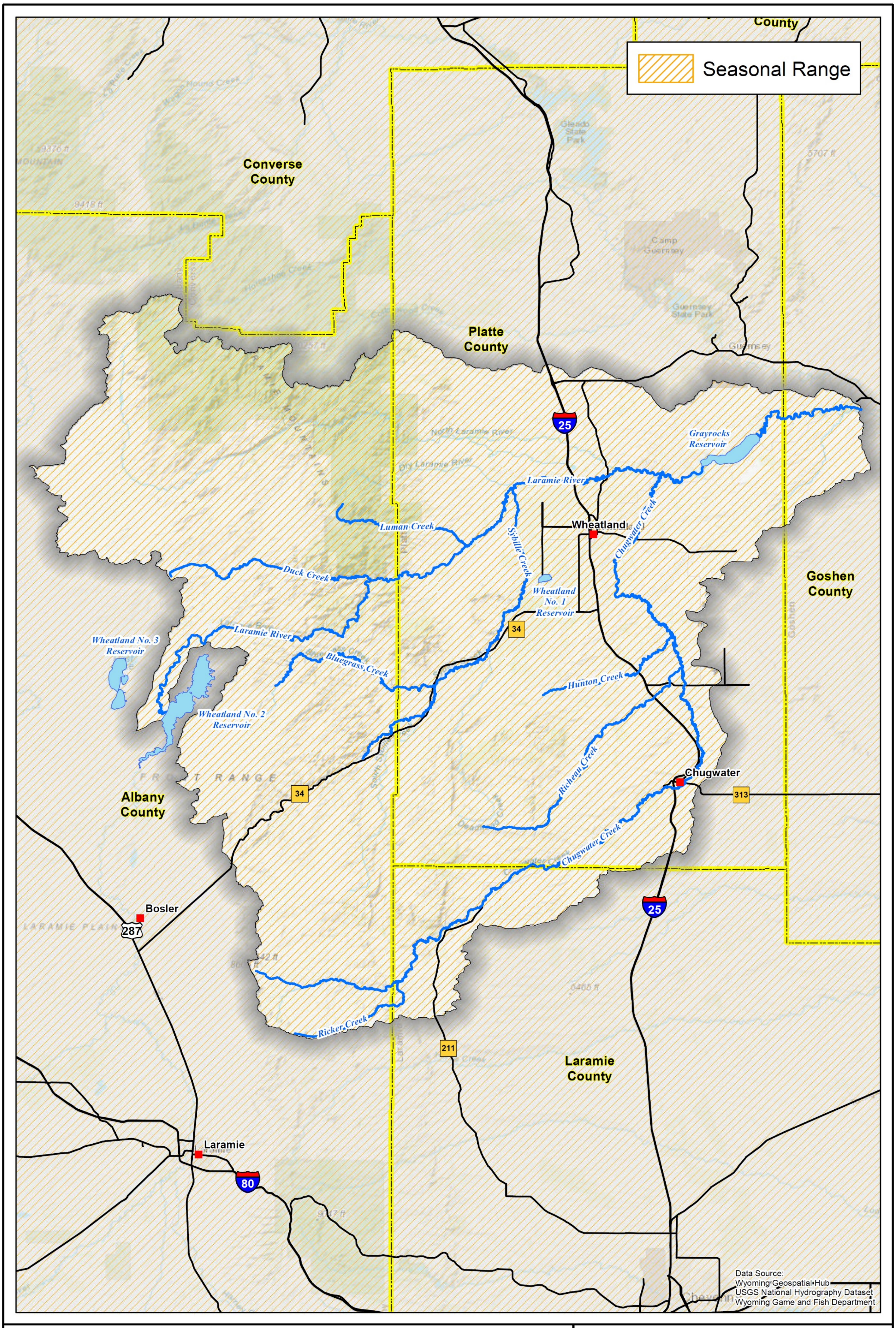
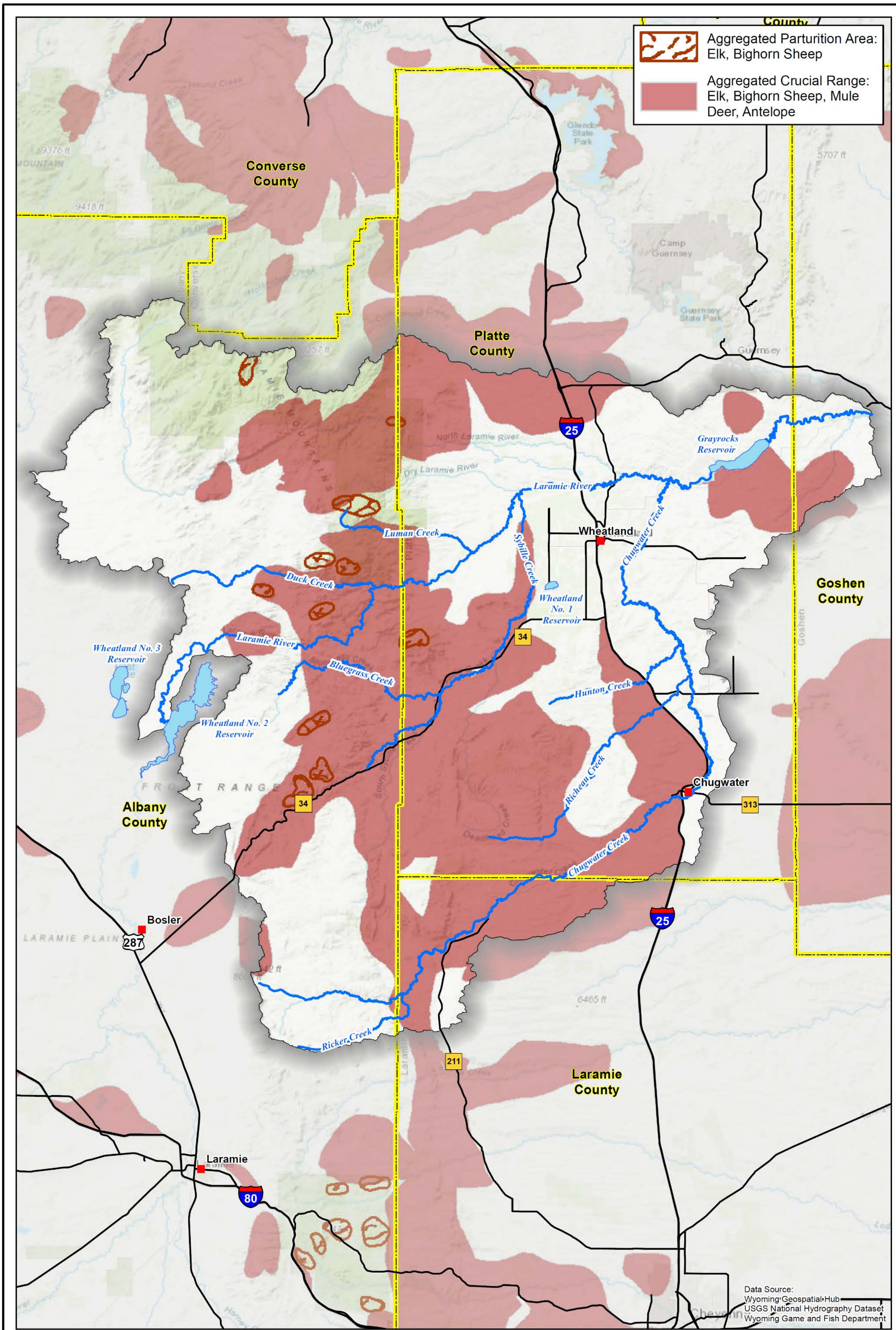


Figure 4.3-11 Lower Laramie River Watershed: White Tail Deer Habitat



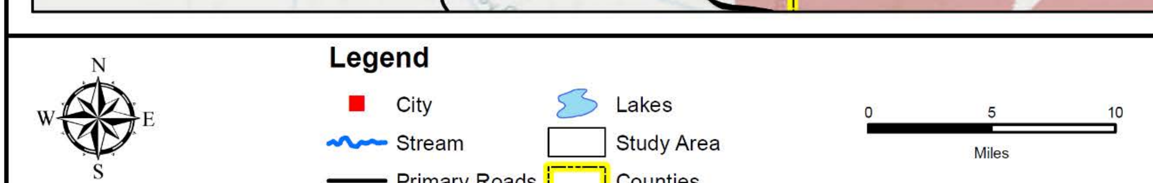


Figure 4.3-12 Lower Laramie River Watershed: Aggregated Parturition Area (Elk, Bighorn Sheep) and Aggregated Crucial Range (Elk, Bighorn Sheep, Mule Deer, Antelope)

4.3.2.3 WGFD Priority Areas

As part of the WGFD Strategic Habitat Plan Revision (2015), previously existing priority habitat areas within the state were refined into Goal 1 Crucial Priority Areas and Goal 2 Enhancement Priority Areas for both aquatic and terrestrial terrain (Figure 4.3-13). "Combined" areas were created where significant overlap occurred between aquatic and terrestrial areas. As defined by WGFD at: https://wgfd.wyo.gov/Habitat/Habitat-Plans/Habitat-Priority-Areas.

> *"Goal 1 Crucial Priority Areas are based on significant biological or ecological values. These are areas that need to be protected or managed to maintain viable healthy populations of terrestrial and aquatic wildlife for the present and future. They represent habitat values and identify where those values occur on the landscape. Examples of values include crucial winter range, sage grouse core area seasonal habitats, Species of Greatest Conservation Need (SGCN) diversity and uniqueness, quality and condition of vegetative communities, movement corridors, quality of watershed hydrologic function, etc. The Department will concentrate habitat protection and management activities in these areas."*

> *"Goal 2 Enhancement Habitat Priority Areas represent those with a realistic potential to address wildlife habitat issues and to improve, enhance, or restore wildlife habitats. These areas offer potential for improving habitat and focusing Department habitat efforts. They may overlap crucial areas or be distinct from them. Enhancement areas are based on habitat issues. Like crucial areas where values are key, issues were identified by regional personnel and used to select enhancement habitat areas. Examples of issues include loss of aspen communities, habitat fragmentation, development, loss of connectivity, water quality effects, water quantity limitations, beetle killed conifer, lack of fish passage, loss of fish to diversions, degraded habitat, etc."*

Review of the WGF Crucial Habitat Area Narratives (available at https://wgfd.wyo.gov/Habitat/Habitat-Priority-Areas/Statewide-Maps/Green-River) provides the following information regarding sensitive habitat within the study area. Full relevant habitat narratives have been downloaded and included with the Digital Library included with this report. The following paragraphs were extracted directly from the narratives provided by WGFD for crucial and enhancement priority areas:

Lower Laramie and North Laramie Rivers (Goal 1 Aquatic Crucial Area)

- **Habitat Value:**
  Functioning stream habitat to support native, non-game fish species and a functioning riparian community.
- **Reason Selected:**
  Dr. Timothy Patton in his PhD research found the Lower Laramie River and North Laramie River to have some of the highest densities of native fishes, and also some of the highest densities of

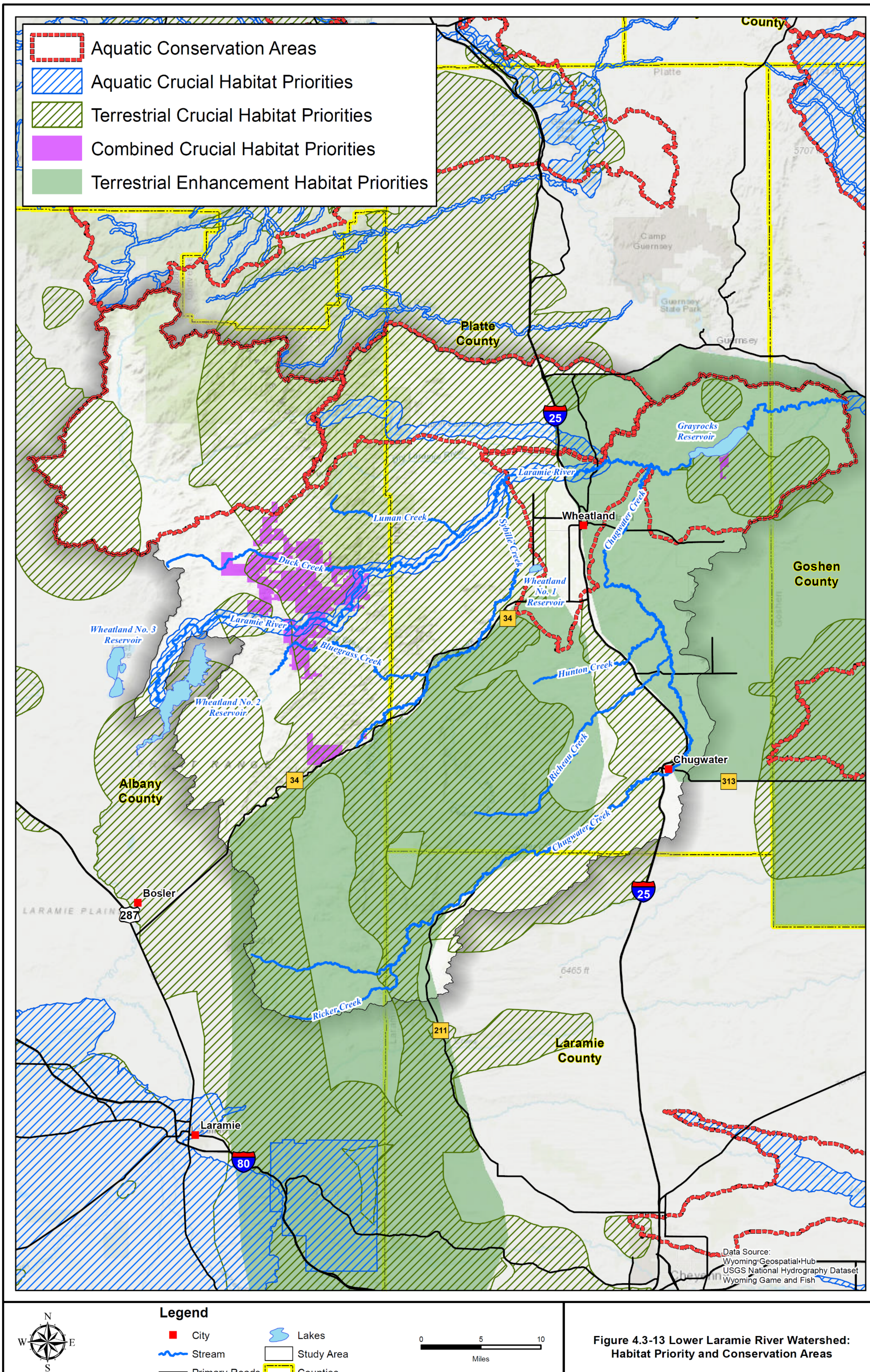


Figure 4.3-13 Lower Laramie River Watershed: Habitat Priority and Conservation Areas

fishes of concern among the 83 streams he sampled in the Missouri River drainage of Wyoming (Patton 1997). Recent studies have also confirmed the diversity of native fishes in the Lower Laramie and North Laramie Rivers (Bear and Barrineau 2007, Moan et.al. 2011).

- **Primary species or assemblages of species:**
  Hornyhead chub, plains topminnow, orangethroat darter, Iowa darter, common shiner, brassy minnow, boreal toad (SWAP Tier I)
- **Solutions or actions:**
  - Seek opportunities for conservation easements to provide protection for stream and riparian corridors. Apply active stream rehabilitation when necessary.
  - Promote restoring or maintaining beaver. Manage beaver populations to restore riparian habitat function and create wetland habitats.
  - Develop a better understanding of native fish habitat requirements in the watershed.
  - Conduct survey of water control structures and potential fish passage barriers. Some barriers may be beneficial to native fish communities by blocking movements of competing non-native species. Promote and establish fish passage and screening solutions at irrigation diversions.
  - Investigate and develop a better understanding of water availability and use in the drainage as it pertains to native fish habitat.
  - Promote livestock grazing management practices to maintain or restore riparian habitat function.
- **Additional Information:**
  Patton, T.M. 1997. Distribution and status of fishes in the Missouri River Drainage in Wyoming: implications for identifying conservation areas. Ph.D. Dissertation. University of Wyoming, Laramie, Wyoming.

Sage Grouse Core Areas (Goal 1 Terrestrial Crucial Area)

- **Habitat Value:** Sage-grouse core areas.
- **Reason Selected:** Sage-grouse core areas designated by the Governor's Office are described as those areas capable of maintaining habitats and viable populations of sage-grouse where they are most abundant. On a statewide basis, they include habitats and existing populations for at least two-thirds of the sage-grouse in Wyoming.
- **Primary species or assemblages of species:**
  Mule deer, pronghorn, elk, sage thrasher, sage sparrow, and Brewer's sparrow.
- **Solutions or actions:**
  - Maintain the functionality and integrity of sage-grouse core areas.
  - Seek opportunities for habitat enhancement, preservation and protection through partnerships and agreements with USFS, BLM, State Land Board and private landowners to maintain these areas. Possible actions include protecting and maintaining core area values through conservation easements, public/private land exchanges and federal land management agency management plans.

- Habitat preservation and enhancement through management of WGFC property rights and implementation of existing management goals and objectives found in the Managed Land and Access Summaries for the WHMAs identified above.

- **Additional Information:**
  Many natural or human-caused impacts can impact or even eliminate the functionality of these habitat components. These include wildfire, livestock grazing, invasive plants, and energy development. The core areas primarily reflect breeding habitats characterized by sagebrush communities associated with high lek densities.

Mixed Mountain Shrub (Goal 2 Terrestrial Enhancement Area)

- **Habitat Value:**
  The southern portion of the Laramie Range foothills encompass a mixture of mountain shrub species including sagebrush species, true mountain mahogany, skunkbrush sumac, rabbitbrush and antelope bitterbrush. These mixed shrub habitats serve as important seasonal ranges for mule deer, and other browse dependent species. Historic overutilization by big game, persistent drought, livestock grazing, current elk populations, and most importantly a lack of disturbance in these communities (i.e. wildfire / prescribed fire), has resulted in declining shrub conditions, lack of regeneration, and lack of forage quality and quantity to support mule deer numbers in the population densities that the public and private landowners desire in this region. Invasive non-native plants, particularly cheatgrass, are increasing becoming more common in the understory in some communities.
- **Reason Selected:**
  Many of the shrub communities are intact and do not have a high composition of invasive weeds, namely cheatgrass in the understory. Based on recent history of treatments, this means that properly timed prescribed fires can still be conducted with a relative certainty of improved habitat conditions post-treatment. Private landowners, state, and BLM are interested in continuing the prescribed burn program in this particular region that was initiated in 2001.

  Many landowners in this area are currently, or have expressed interest in improving livestock grazing management through planned grazing and installing infrastructure (i.e. water, fencing) needed to result in improvements in herbaceous quality and quantity.

  Energy development, most likely wind, could occur. Installation of wind turbines and necessary associated infrastructure may result in fragmentation of preferred big game habitats. Wind energy development may also complicate the ability to perform land management treatments, such as prescribed fire.
- **Primary species or assemblages of species:**
  Mule deer, pronghorn, bighorn sheep, and the following SWAP Tier 1 species: Bald Eagle, Boreal Toad, Burrowing Owl, Common Loon, Ferruginous Hawk, Greater Sage-grouse, Mountain Plover, Northern Goshawk, Townsend's Big-eared Bat, Wyoming Toad

- **Solutions or actions:**
    - o prescribed burning and/or natural fire planning in mixed shrub habitats;
    - o brush mowing or other mechanical treatments of shrubs;
    - o herbicide application to control cheatgrass post-fire (wild or prescribed);
    - o progressive livestock grazing management; and
    - o riparian area enhancement thru livestock grazing management.
- **Additional Information:**
  Presence of T&E species such as the Preble's Meadow Jumping Mouse has the potential to limit/restrict habitat enhancement projects resulting in temporary ground disturbance (i.e. prescribed fire).

Note that some of the sections above have been truncated. Individual priority area narratives were downloaded, and a complete version can be found in the Digital Library delivered with this report or online at the link mentioned above. Wildfire Recovery, Land Protection, and Big Game Goal 1 Crucial Terrestrial Areas, as well as the Waterfowl, Upland Game, Shortgrass Prairie Terrestrial Goal 2 Enhancement Area are also in the watershed, but individual priority area narratives were unavailable for these areas at the time of this report.

WGF also maintains Wildlife Habitat Management Areas (WHMA) which provide permanent access for sportsmen and sportswomen to fish, hunt, trap, boat, view wildlife, picnic, and hike except during seasonal closures. They can provide crucial wintering habitat and important production areas for birds and mammals, or benefit native plants, watersheds, and wildlife corridors. There are three WHMAs in the Lower Laramie watershed.

- **Tom Thorne / Beth Williams WHMA**- Provides hiking access, recreational days for deer hunters, and angling opportunities in Johnson Creek Reservoir. The Tom Thorne/Beth Williams Wildlife Research Center focuses on threated and endangered wildlife management. Elk, mule deer, bighorn sheep, a variety of birds and other wildlife can be seen all year.
- **Laramie Peak WHMA** - The land was purchased for the management of all wildlife species with emphasis on fisheries, bighorn sheep, elk and pronghorn antelope. While closed during the winter months to avoid disturbance to wintering wildlife, the area is open the remainder of the year for recreational opportunities.
- **Cottonwood Draw WHMA** – Offers access to the Grayrocks Reservoir which provides quality habitat for a variety of wildlife. Many species of ducks and Canada geese use these waters, especially during migration periods and some winter months. Pheasants, doves, wild turkey, white pelicans, and sharp-tailed grouse reside here. Squirrels, cottontail rabbits, mule deer, white-tailed deer and pronghorn antelope roam this area, and walleyes can be found in the reservoir.

An interactive map of WGF Wildlife Habitat Management Areas can be found here:
https://wgfd.wyo.gov/Public-Access/WHMA

Management Implications:

While there may be regulations related to timing stipulations on activities within habitat priority areas (ex: no human disturbance November 15th to April 30th), the fact that a project proposed in Chapter 6 is within these priority areas does not preclude it from development. The priority areas are not so much a regulatory delineation, but more of a way for WGFD to determine the best locations to spend their money, time and energy. In fact, if a proposed project in a priority area enhances wildlife habitat, funding through WGFD Trust Fund and the Wyoming Wildlife and Natural Resource Trust (WWNRT) might be available.

4.3.2.4 Sage Grouse

The most recently identified Core Sage Grouse Population Areas within the study area are delineated in Figure 4.3-14. According to WGFD, the overall goal of the Core Area delineations is to protect as many birds as possible while encompassing the least amount of acreage. This can cause occupied leks to fall outside of the identified Core Areas. As is evident in this figure, the Sage Grouse Core Areas affect only a small western portion of the Lower Laramie watershed. In total there are 107,065 acres of Sage Grouse Core Area located within the study area, making up 7.2% of the total watershed area. According to the 2017 lek data received from WGFD, there are a total of 15 occupied leks, 13 unoccupied leks, and 1 undetermined lek within the Lower Laramie river watershed study area. The regulations related to these leks are explained in Attachment B of Executive Order 2019-3 (included in the digital library of this report).

The US Department of Interior decided in September of 2015 that the Greater Sage Grouse (Centrocercus urophasianus) does not require federal protection under the Endangered Species Act. However, it is still recognized as a sensitive species by the BLM and a Species of Greatest Conservation Need (SGCN) by WGFD. The sage grouse is 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 and recommendations to help protect the sage grouse.

In June 2008, Executive Order 2008-2 was signed by then Governor Freudenthal which stresses additional management consideration for sage grouse and sage grouse habitat statewide. This original executive order has been extended most recently by Executive Order 2019-3 signed by Governor Gordon in August of 2019. The Order includes requirements of state agencies to encourage development outside of the Core areas and to focus management, to the greatest extent possible, on the maintenance and enhancements of habitat within them.

These regulations do not prevent project development within Core Areas. Core Area project developments could potentially have some restrictions to fall within the core area guidelines presented in Executive Order 2019-3, but the areas are not precluded from water development projects. Included in the Executive Order is a list of exemptions to core area regulations. Many of the water projects

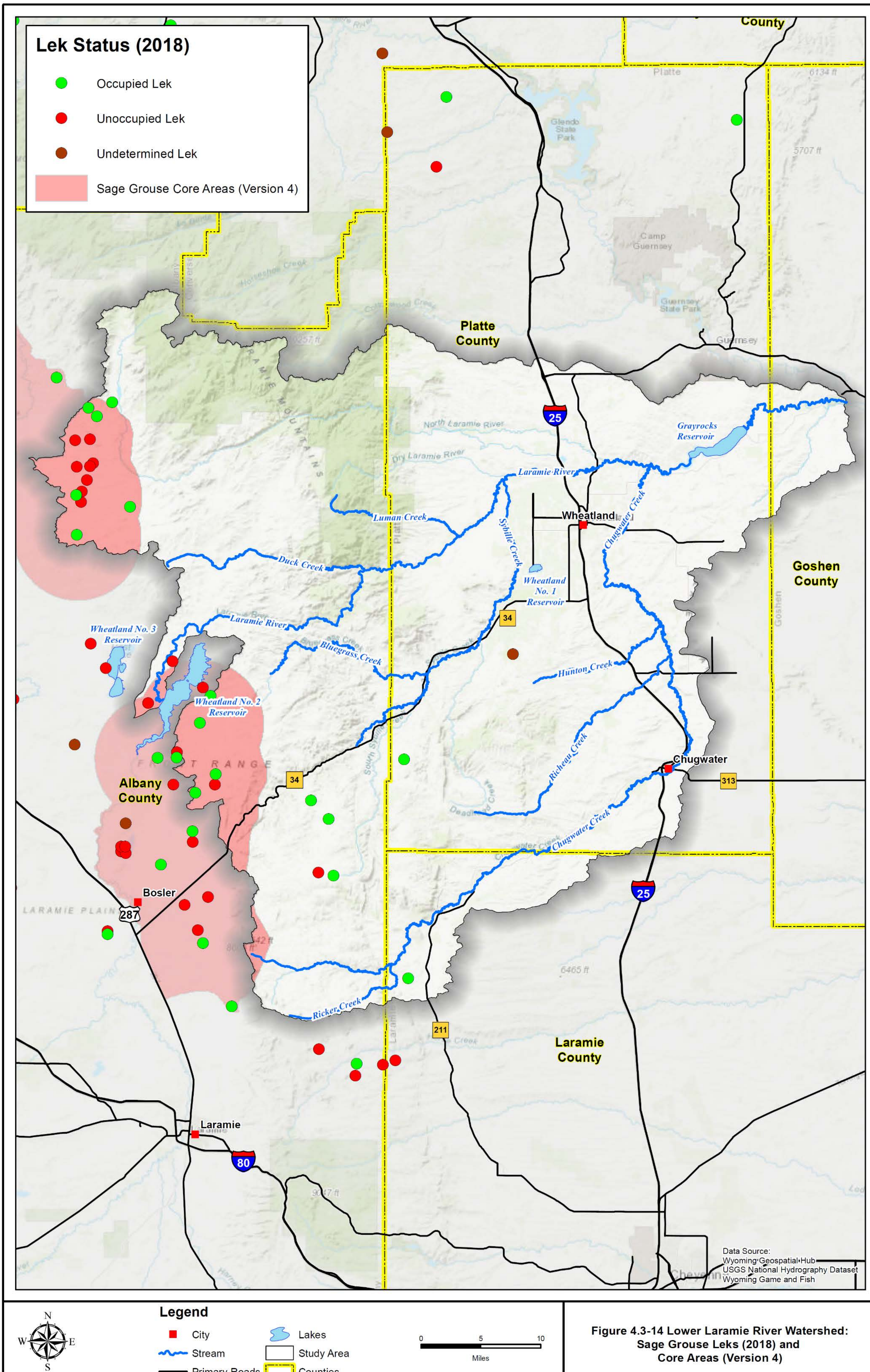


Figure 4.3-14 Lower Laramie River Watershed: Sage Grouse Leks (2018) and Core Areas (Version 4)

presented in this report fall under the exempted project types, with only minor seasonal construction restrictions if within proximity to an occupied lek. Exemptions pertinent to this study were extracted from Executive Order 2019-3 and are listed below:

- *Drilling and outfitting of agricultural or residential water wells (including tank installation, pumps, and agricultural water pipelines) more than 0.6 miles from the perimeter of an occupied lek. Construction within 0.6 miles is allowed from July 1 through March 14, after a habitat evaluation has occurred, and provided development does not occur on the lek. New tanks shall have escape ramps.*
- *Construction of agricultural reservoirs, less than 10 surface acres and more than 0.6 miles from the perimeter of an occupied lek. Construction within 0.6 miles is allowed from July 1 through March 14, after a habitat evaluation has occurred, and provided that development does not occur on the lek.*
- *Construction of aquatic habitat improvements, less than ten wetland or water surface acres, more than 0.6 miles from the perimeter of an occupied lek. Construction within 0.6 miles is allowed from July I through March 14, after a habitat evaluation has occurred, and provided development does not occur on the lek.*
- *Spring development; if the spring is protected with fencing and enough water remains at the site to provide mesic (wet) vegetation. Fences should be constructed to be highly visible to Greater sage-grouse (i.e., buck-and-rail, steeljack, etc.) and/or marked to minimize collision potential.*

4.3.2.5 Sensitive Wildlife Species

The Wyoming Natural Diversity Database (WYNDD) lists numerous non-game species of concern within the watershed, including amphibians, birds, fish, mammals, mollusks, and reptiles. Originally initiated by the Nature Conservancy, the WYNDD became a research and service unit of the University of Wyoming in 1998. Appendix 4E presents the results of a database query conducted by the WYNDD for the watershed. Included in this list are all species of concern or species of potential concern which have been documented in the study area. The WYNDD database is a historic accumulation of information related to sightings within the study area. It lists several endangered species as being sighted within the watershed.

1. There was only one sighting of the black footed ferret in 1933. According to the WYNDD data collected this species is classified as “Listed Endangered – Nonessential Experimental Population (LEXN)”. This status is given to species that have been reintroduced at some point at these locations. The regulations related to activities within areas with LEXN species are less stringent than within areas containing “Listed Endangered” species.
2. There were two sightings for the Least Tern (in 2005 and 2012) which is the only species that is “Listed Endangered” in the watershed.
3. The Preble's Meadow Jumping Mouse, which is “Listed Threatened”, has been spotted 91 times between 1999 and 2014.

Many of the SOC or SOPC are also identified by the Wyoming BLM as a Sensitive Species. 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 FWS/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 refuge or other unique habitats*

The table also indicates whether the species is characterized by the USFS Sensitive Species in USFS Region 2 (USFS-R2), or Region 4 (USFS-R4), or both. Region 2 includes the Bighorn, Black Hills, Medicine Bow, and Shoshone National Forests, and Thunder Basin National Grassland. Region 4 includes the Bridger-Teton, Caribou, Targhee, Wasatch-Cache, and Ashley (including Flaming Gorge National Recreation Area) National Forests.

The WGFD Native Species status is defined in the 2017 State Wildlife Action Plan (SWAP), which is included in the digital library.

The Global Heritage Rank and State Heritage rank are based on a system developed by the Nature Conservancy. It uses a 1-5 scale with 1 indicating that the species is critically imperiled due to extreme rarity or vulnerable to extinction, and 5 indicates that it is demonstrably widespread, abundant, and secure. Different ranks are developed for different ranges. The Global Rank is denoted with a "G" and the State Rank is denoted with an "S".

Data Sources:

U.S. Fish and Wildlife Service: https://www.fws.gov/
Wyoming Game and Fish Department: https://wgfd.wyo.gov/
Wyoming Natural Diversity Database: http://www.uwyo.edu/wyndd/
Wyoming BLM: http://www.blm.gov/wy/st/en/field_offices/Rawlins.html
Wyoming Wildlife Federation: https://wyomingwildlife.org/

4.4 Anthropogenic Systems

4.4.1 Agricultural Water Use

4.4.1.1 Irrigated Lands

The most current irrigated lands mapping publicly available at the time this report consists of mapping completed in conjunction with the WWDC North Platte River Basin Plan Update (2016). This dataset was generated using aerial photography obtained in 2012 (a "dry" year). In conjunction with this watershed study, the project team used aerial photography obtained in 2017 (a “normal” year) to delineate irrigated lands NOT mapped in the 2016 study but that were irrigated in 2017. Table 4.4-1 displays the results of this effort.

Irrigation activities within the study area are primarily associated with the Wheatland Irrigation District (WID) and located in the vicinity of Wheatland, as indicated on Figure 4.4-1. The irrigated acres are distributed along Chugwater Creek, Sybille Creek, Laramie River and their tributaries. The total irrigated acreage within the study area is approximately 74,028; less than 6% of the watershed.

Typically, the full growing season in most of the study area extends from mid-May to late September, with the period from mid-July to the end of September defined as late-season when irrigation water shortages frequently occur. Water supplies are more abundant in April, May and June in typical years because of high volumes of snow melt runoff. The supply of irrigation water in the basin is substantially reduced during late July, August, and September as snowmelt slows and ceases.

As presented in the Platte River Basin Plan in a discussion of irrigation practices in the Lower Laramie River watershed (Wenck, 2016):

- *Alfalfa has typically been cultivated on an average of about 30 percent of* [Lower Laramie River] *subbasin irrigated acreage.*
- *Grass hay has typically been cultivated on an average of about 27 percent of* [Lower Laramie River] *subbasin irrigated acreage.*
- *Irrigated pasture has covered an average of about 21 percent of* [Lower Laramie River] *subbasin irrigated acreage.*
- *Corn has been cultivated on an average of about 8 percent of* [Lower Laramie River] *subbasin irrigated acreage.*
- *Dry beans and sugar beets have each been cultivated on an average of about 5 percent of* [Lower Laramie River] *subbasin irrigated acreage.*
- *Other crops particularly barley and oats, have been cultivated on smaller average portions of the Lower Laramie subbasin.”*

Table 4.4-1 Irrigated Lands Evaluation.

HUC 10 Number	HUC 10 Name	Irrigated Acres 2012 Ground Condition	Additonal Irrigated Acres 2017 Ground Condition	Total Irrigated Acres (2012, 2017)
1018001103	Bluegrass Creek	86	6	92
1018001101	Laramie River-Dry Laramie River	1,514	995	2,509
1018001105	Laramie River-Wheatland Creek	34,367	988	35,355
1018001109	Lower Chugwater Creek	7,797	1,070	8,867
1018001107	Lower North Laramie River	6,579	1,105	7,684
1018001104	Lower Sybille Creek	8,778	541	9,319
1018001108	Upper Chugwater Creek	2,205	2,254	4,458
1018001106	Upper North Laramie River	1,968	2,206	4,174
1018001102	Upper Sybille Creek	587	984	1,571

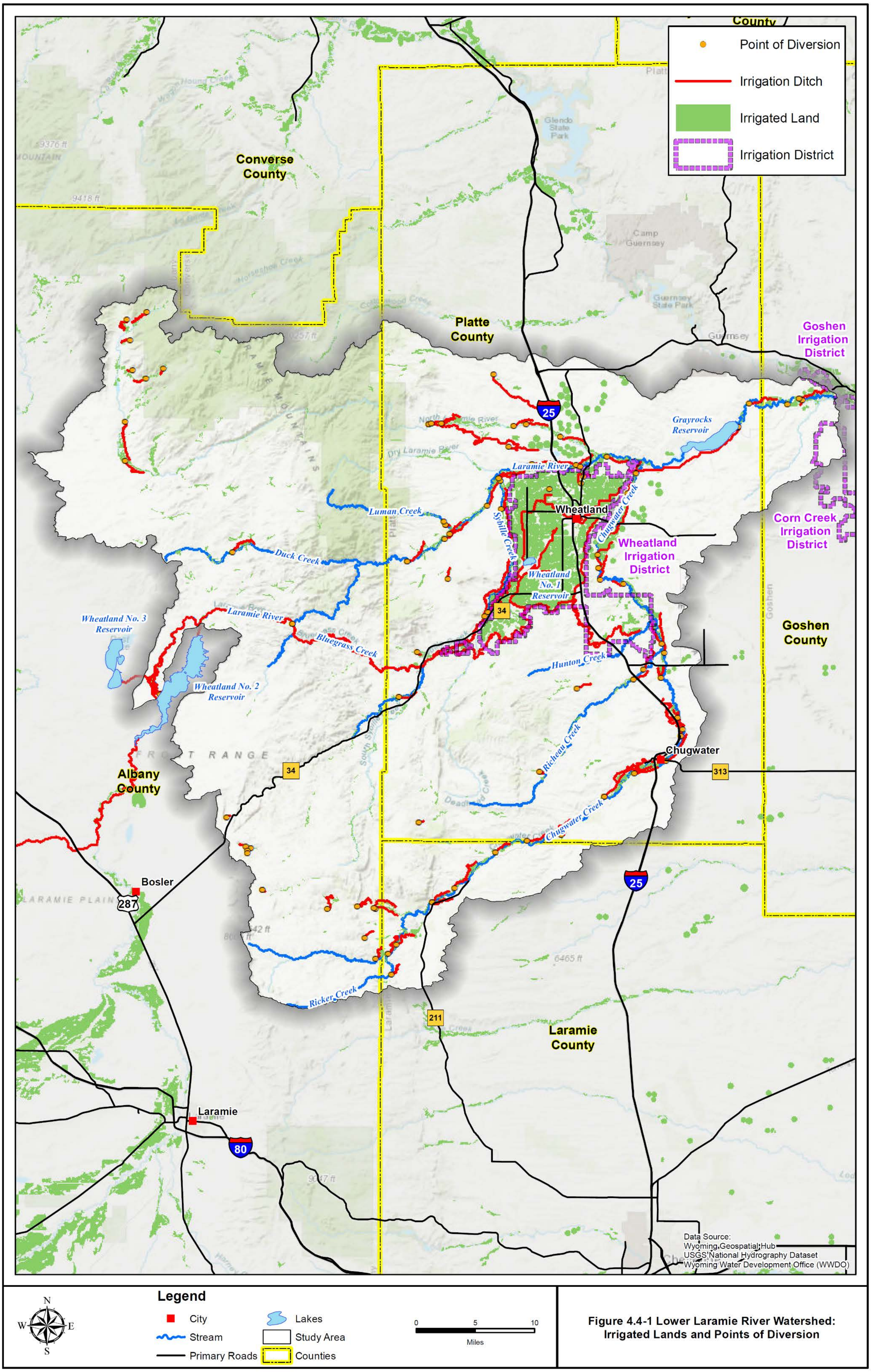


Figure 4.4-1 Lower Laramie River Watershed: Irrigated Lands and Points of Diversion

4.4.1.2 Irrigation Systems

There are 112 individual points of diversion with 2 cubic feet per second or more adjudicated water rights according to the Wyoming State Engineers Office's ePermit database (Figure 4.4-1). In addition, the WWDC's 2017 Wyoming Irrigation Systems Survey reports three irrigation districts within the study area (Table 4.4-2). The larger is the Wheatland Irrigation District (WID). The WID irrigates approximately 54,100 acres and has 825 individual operators/water users. The WID has 120 miles of conveyance via dirt and concrete ditches and has a diversion capacity of 710 cfs. The WID owns 11 reservoirs and has a total storage capacity of 190,000 acre-feet. The WID is described in the Platte River Basin Plan (Wenck, 2016):

> *"The [Wheatland Irrigation] District diverts water from the Laramie River at the Laramie River Diversion Dam through the Wheatland Tunnel and into Bluegrass and Sybille Creeks. District Canals No. 1 and No. 2 convey water to District irrigators from Sybille Creek and WID No. 2 Reservoir, respectively. Canal No. 3 flows from Sybille Creek into WID No. 1 Reservoir. The WID has experienced water shortages throughout its existence. Construction of WID Reservoirs No. 1 and No. 2 in 1895 and 1901, respectively, was an early attempt to address these shortages. The District continued to cope with shortages, which led to the enlargement of Reservoir No. 2 in the late 1950s, followed by the enlargement of Reservoir No. 1 and construction of Reservoir No. 3."*

According to the 2017 Wyoming Irrigation Systems Report provided by the Wyoming Water Development Commission (WWDC), the Gunbarrel Lateral Ditch Company irrigates approximately 2,601 acres and serves 16 individual operators/users. This company diverts from the WID Lateral No 1 and has approximately 10 miles of conveyance via pipe and lined ditch. The capacity of diversion is 35 cfs (WWDC, 2017).

The Toltec Reservoir Watershed Improvement District irrigates approximately 1,728 acres and serves 7 individual operators/users. This district diverts up to 160 cfs from the North Laramie River, and stores up to 2945 acre-ft in the Toltec Reservoir (WWDC, 2016).

Table 4.4-2 Irrigation Systems in the Lower Laramie River Watershed.

Subbasin: Horse Creek	Surface Source	Irrigated Acres	Number of Users	Storage (ac-ft)	Storage Reservoirs
Wheatland Irrigation District	Laramie River	54,100	825	190,000	11 Reservoirs, the largest of which being Wheatland Reservoir Nos. 1-3
Gunbarrel Lateral Ditch Company	Wheatland Irrigation District Lateral No. 1	2,601	16	NA	NA
Toltec Reservoir Watershed Improvement District	North Laramie River	1,728	7	2,945	Toltec Reservoir

Wyoming water law normally allows the diversion of 1 cfs per 70 acres of irrigated land, although 2 cfs per 70 acres may be diverted during surplus water conditions subject to priority dates governing surplus water. When the water supply is insufficient, water right priorities restrict diversions for junior priority ditches.

Water diverted from a stream for irrigation may:

1) return to the stream as return flow,
2) be lost to the groundwater system through canal and field losses, or
3) be consumptively used by vegetation.

Because of return flows, the total volume of diversions along a stream can exceed the stream's natural flow, since the water is being reused. Irrigation also directly affects a stream's hydrologic regime by reducing flows at times through diversions and increasing flows at other times with delayed irrigation returns.

Data Sources:

Wyoming State Engineers Office (WSEO): *http://seo.wyo.gov/home*
Wyoming Water Development: Office (WWDO): *http://wwdc.state.wy.us/*

4.4.2 Domestic, Municipal, and Industrial Water Use

4.4.2.1 Potable Water Systems

The municipal and domestic water use of the Lower Laramie watershed is described in the Platte River Basin Plan as follows (Wenck, 2016):

> *All municipal and community public water supply systems within this subbasin utilize groundwater. The City of Wheatland operates the largest public municipal water supply system. During the winter months, Wheatland typically returns approximately 0.5 mgd of treated wastewater into the North Platte River via Rock Creek. Since 2004, the City has not discharged treated wastewater to Rock Creek during the summer months. The City is working with the WDEQ to eliminate municipal wastewater discharge during the summer months by applying treated wastewater to irrigated lands. Four non-community public water systems are located within the Lower Laramie subbasin, serving about 860 people. Based on an estimated water usage rate of 75 gpcpd, total average demand from these systems is about 64,500 gpd. All of these systems utilize groundwater. Approximately 1,455 permitted rural domestic wells are located in the Lower Laramie subbasin, serving approximately 3,539 people. Total estimated domestic water use is 1,126,200 gpd.*

According to the 2016 Wyoming Public Water System Survey Report provided by the Wyoming Water Development Commission (WWDC), the town of Chugwater obtains its water from three groundwater wells, has a total system capacity of 583,200 gpd, and has a treated water storage capacity of 190,000 gallons. The water is treated by chlorination, serving 212 people. The Chugwater system uses 15,910,000 gallons annually with a peak day water use of 143,000 gallons. In August 1998, a Level II water supply study was performed by States West Water Resources Corporation for the Town of Chugwater. Two alternatives were explored so that the production capacity of the wells could meet demands and water storage could meet the fire protection and emergency storage requirements. This document has been included in the Digital Library.

The town of Wheatland uses eight groundwater wells in the Arikaree Formation and has a total system capacity of 5,760,000 gpd. Wheatland treats their water by chlorination and has a total treated water storage of 3,060,000 gallons. It serves 3,600 people, with a total annual use of 358,117,600 gallons and a peak day use of 2,356,261 gallons (WWDC, 2016). In November 2010, Wester Wetstein & Associates completed a Level I Master Plan for the Town of Wheatland. This master plan reviewed the current water system, forecasted future demands, and determined improvements necessary to mitigate deficiencies. This document has been included in the Digital Library.

4.4.2.2 Industrial and Mining

According to the Platte River Basin Plan (Wenck, 2016), the Lower Laramie subbasin comprises approximately 13.3 percent of permitted industrial water use in the Wyoming Platte River Basin. The power generation industry is the largest industrial water user in the subbasin, and 98 percent of industrial permitted water use is surface water. As described in the basin plan (Wenck, 2016):

> *"Basin Electric Power Cooperative (BEPC), owner and operator of the Laramie River Station, is permitted to use the largest amount of water for industrial purposes within the Lower Laramie subbasin. The majority of water consumed by BEPC is surface water from Grayrocks Reservoir. This reservoir is the principal water source for the plant and provides water to produce steam and supply cooling water demands at the power plant.*
>
> *Information regarding historical BEPC water use for years 1981 through 1999 indicates that average groundwater use has been approximately 15.8 gallons per minute (0.035 cubic feet per second) and average surface water use has been approximately 10,320 gallons per minute (22.99 cubic feet per second)."*

Other industrial uses include mining and mine reclamation, road and bridge construction and maintenance, aggregate processing and cement production, and miscellaneous uses. Exxon Company holds two groundwater permits for uranium mining, with a combined yield of 160 gpm. Great Western Sugar Company is permitted to use 294 gpm for sugar beet processing, obtained from a single groundwater well north of Wheatland, WY.

Data Sources:

Wyoming Water Development: Office (WWDO): *http://wwdc.state.wy.us/*

4.4.3 Water Storage

4.4.3.1 Reservoirs

A reservoir database was constructed by downloading reservoir storage rights from the Wyoming State Engineers ePermit system. The database was then incorporated into the project GIS for evaluation. Figure 4.4-2 displays the results of the effort. Included in this figure are all permitted reservoirs except stock reservoirs which are evaluated in Section 4.4.3.2 of this report.

Several major reservoirs are located within the watershed. Table 4.4-3 summarizes information tabulated by the WSEO pertaining to major reservoirs within the watershed (defined as having a storage capacity greater than 1,000 acre-feet). Figure 4.4-3 displays their locations.

Table 4.4-3 Major reservoirs in the Lower Laramie River Watershed.

Structure Number	Permit Number	Reservoir Name	Applicant Name	Priority Date	Source	Use	Year Completed	Active Capacity (acre-ft)
1	P7649R	Grayrocks Reservoir	Basin Electric Power Co.	4/24/1973	Laramie River	Fish Propagation, Industrial [Drilling], Irrigation, Recreation, Wildlife	1981	101,551
2	P79R	Wyoming Development Company No. 1 Reservoir	Wyoming Development Co.	4/20/1897	Sybille Creek	Irrigation	1897	5,360
	P5387R	Wyoming Development Company No. 1 Reservoir, Enlargement	Wheatland Irrigation District	8/18/1938	Laramie River	Irrigation	1941	1,795
	P6470R	Wyoming Development Company No. 1 Reservoir, 2nd Enlargement	Wheatland Irrigation District	7/10/1958	Sybille Creek	Domestic, Irrigation	1959	2,214
3	P1515R	North Laramie Land Co. No. 1 Reservoir	W. H. & Mattie Johnson	5/1/1909	North Laramie River	Domestic, Irrigation, Stock	1912	1,909
4	P1517R	North Laramie Land Co. No. 3 Reservoir	W. H. & Mattie Johnson	5/1/1909	North Laramie River	Domestic, Fish Propagation, Irrigation, Recreation, Stock	1912	3,156
5	P7252R	Toltec Reservoir	Toltec Watershed Improvement District	3/27/1967	North Laramie River	Irrigation, Recreation, Stock	1984	2,945
6	P7810R	MBPP Ash Pond Reservoir	Basin Electric Power Co.	11/16/1976	Seepage Water Hole Draw	Industrial [Pollution Control]	1982	0

Below are descriptions of major reservoirs in the Lower Laramie watershed. Some of the information was extracted directly from the Platte River Basin Plan Technical Memorandum 2.6 (Wenck, 2016).

Wyoming Development Co. No. 1 Reservoir (Wheatland Irrigation District No. 1 Reservoir)

Wyoming Development Company No. 1 Reservoir (more commonly referred to as Wheatland Irrigation District No. 1 Reservoir) is located in Platte County, about 5 miles southwest of Wheatland, WY. Permitted for irrigation, stock, and domestic use, the Wyoming Development Company No. 1 Reservoir and its enlargements have a permitted capacity of 9,369.75 acre-feet. The reservoir is filled through the enlargement of the Wyoming Development Company No. 1 and No. 3 Canals, which have a carrying capacity of 500 and 1,500 cubic feet per second, respectively (Wenck, 2016).

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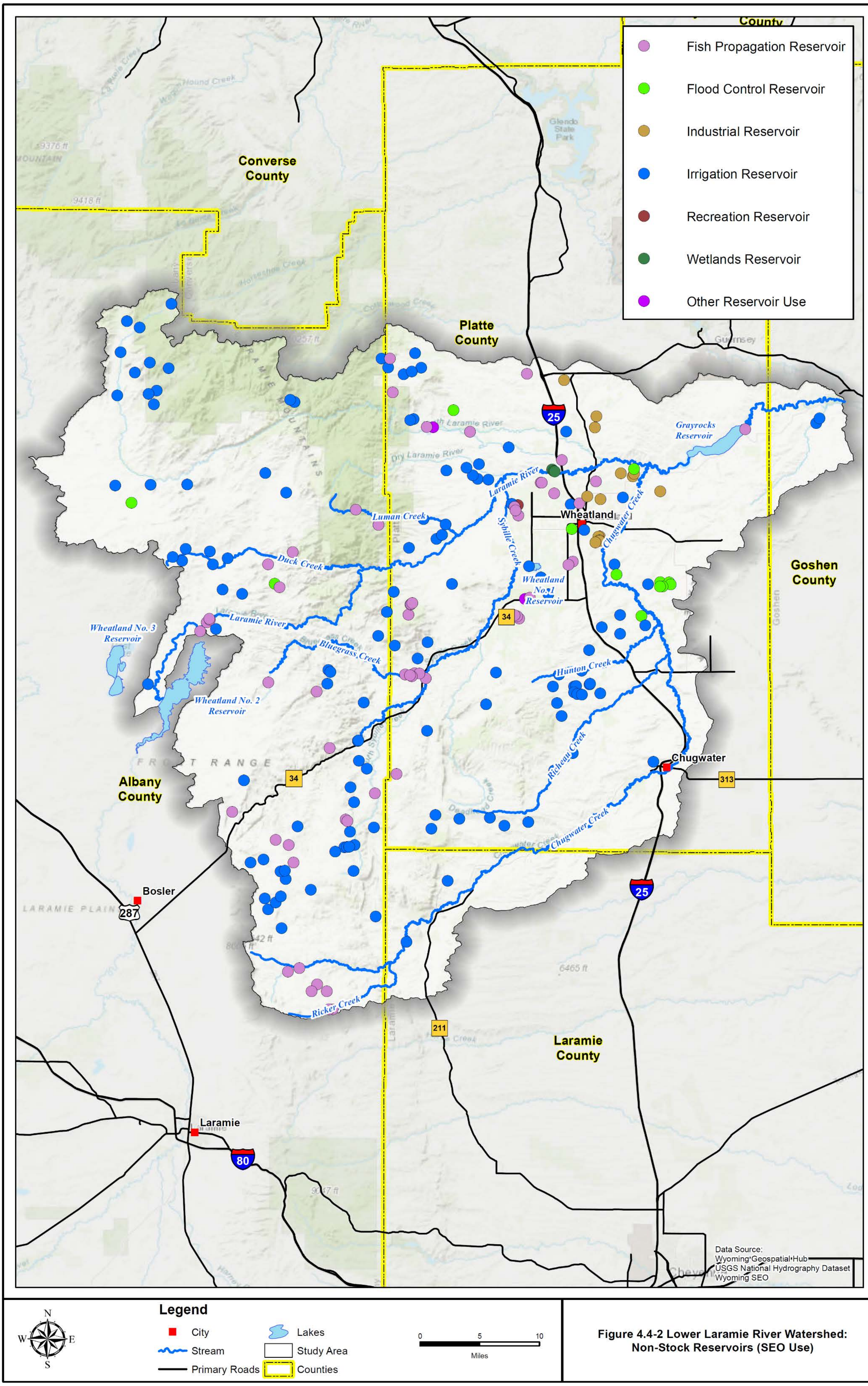


Figure 4.4-2 Lower Laramie River Watershed: Non-Stock Reservoirs (SEO Use)

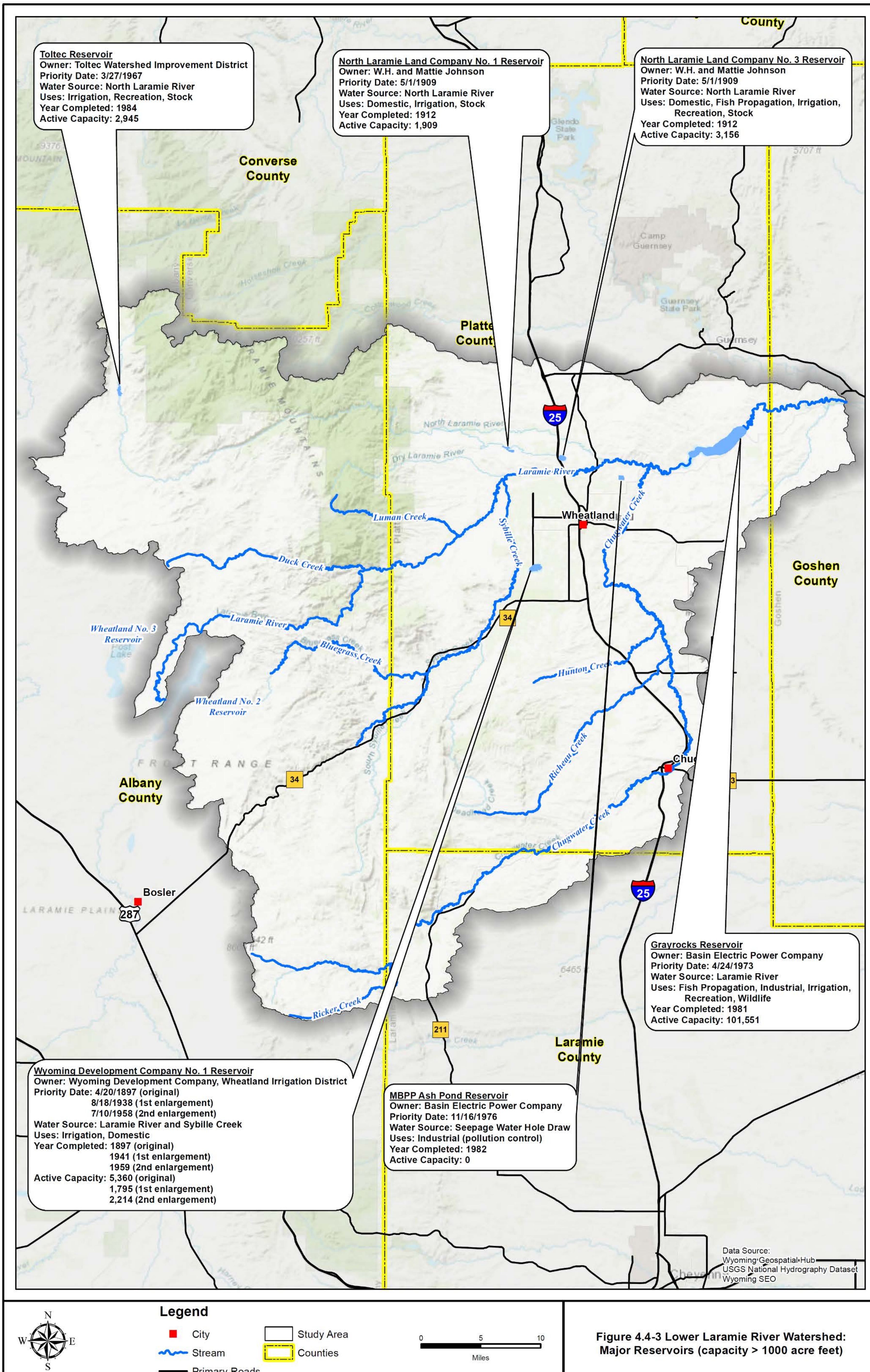


Figure 4.4-3 Lower Laramie River Watershed: Major Reservoirs (capacity > 1000 acre feet)

Grayrocks Reservoir

Grayrocks Reservoir is owned by the Basin Electric Power Cooperative, and located in Platte County, between Wheatland and Fort Laramie, WY. The reservoir is along the Laramie River and is permitted for fish propagation, irrigation, wildlife, industrial, and recreational uses. Grayrocks Reservoir is a zoned earthfill structure with a permitted capacity of 104,109.6 acre-feet. The dam is 94 feet high with a crest length of 2,555 feet. The upstream embankment slope is 3:1, and the downstream embankment slope is 2.5:1. The upstream slope is also protected by riprap (Wenck, 2016).

Grayrocks Reservoir has both a principal spillway or outlet works and an emergency spillway. The principal spillway is constructed of reinforced concrete and has a discharge capacity of 13,500 cubic feet per second at the maximum high-water surface elevation of 4,415 feet. The principal spillway or outlet works is located close to the right abutment of the dam. This principal spillway's location was chosen to reduce foundation subsidence under the spillway. From the principal spillway, water discharges directly into the Laramie River (J.T. Banner & Associates, 1975). The emergency spillway is an unlined fuse plug structure with a discharge capacity of 131,000 cubic feet per second at the maximum reservoir high-water line (Wenck, 2016).

Toltec Reservoir

Toltec Reservoir is located on the channel of the North Laramie River, about 9 miles northwest of the community of Garrett in Albany County, WY. This reservoir is permitted for irrigation, recreation, and stock water. The total permitted capacity of the reservoir is 2,945 acre-feet, and the surface area of the reservoir at the high-water elevation is 227.68 acres. The dam is an earthfill structure with a concrete core, with the upstream face of the dam protected by rock riprap (Wenck, 2016).

N. Laramie Land Co. No. 1 Reservoir

The North Laramie Land Company No. 1 Reservoir is permitted for irrigation, stock, and domestic purposes. The reservoir is located in a draw and a swale that are connected by an open channel, about 9 miles northwest of Wheatland, WY. The reservoir is filled through the North Laramie Land Company Canal and discharges to the North Laramie Land Company No. 2 Reservoir. The dam outlet is a 24-inch cast iron pipe, and the reservoir has a permitted capacity of 1,910 acre-ft (Wenck, 2016)

N. Laramie Land Co. No. 3 Reservoir

The North Laramie Land Company No. 3 Reservoir is used for recreation and fish propagation. The reservoir is located in a natural basin, along I-25, about 6 miles north of Wheatland, WY. The No. 3 Reservoir is filled by the North Laramie Land Company Canal. The No. 3 Reservoir outlet is through an 18-inch cast iron pipe and the reservoir has a permitted capacity of 3,065 acre-ft. The spillway crest width ranges from 600 feet to 1,000 feet (Wenck, 2016).

MBPP Ash Pond Reservoir

The MBPP Ash Pond is permitted solely for pollution control purposes by the Basin Electric Power Cooperative in Platte County (northeast of Wheatland). The reservoir consists of three cells, in which the total permitted capacity is 2,111.1 acre-feet. Located in the Seepage Water Hole Draw, the reservoir is filled through a pipeline from the Laramie River Power Station (Wenck, 2016).

4.4.3.2 Upland Water Storage

An evaluation of upland water storage was completed to provide a database of existing livestock / wildlife reservoirs and their apparent condition. To complete this task, the following steps were completed:

1. Mapping of existing livestock/wildlife reservoirs was obtained from the Casper Field Office of the BLM.
2. Mapping of reservoirs permitted with the Wyoming State Engineer's Office was generated by downloading permit data for all reservoirs within the project study area with "stock" listed as a beneficial use.
3. Using multiple years of aerial photography, each mapped reservoir was evaluated in an effort to determine its functionality.
    - Reservoirs with visible physical breaches or choked with sediment were classified as "non-functional".
    - Reservoirs visibly holding water in multiple years of imagery were classified as "functional".
    - Reservoirs not holding water and with no visible breach were classified as "potential" since a definitive declaration of functionality could not be made.

    Figure 4.4-4 displays an example of this process.

The results of this effort indicated that:

- There is an estimated total of 755 stock reservoirs/ponds in the watershed.
- A minimum of 635 reservoirs appear to be "functional" water sources,
- There are 47 are "potential" water sources (functionality could not be determined), and
- A minimum of 73 reservoirs are "nonfunctional" water sources. These reservoirs displayed physical breaches or other failures.

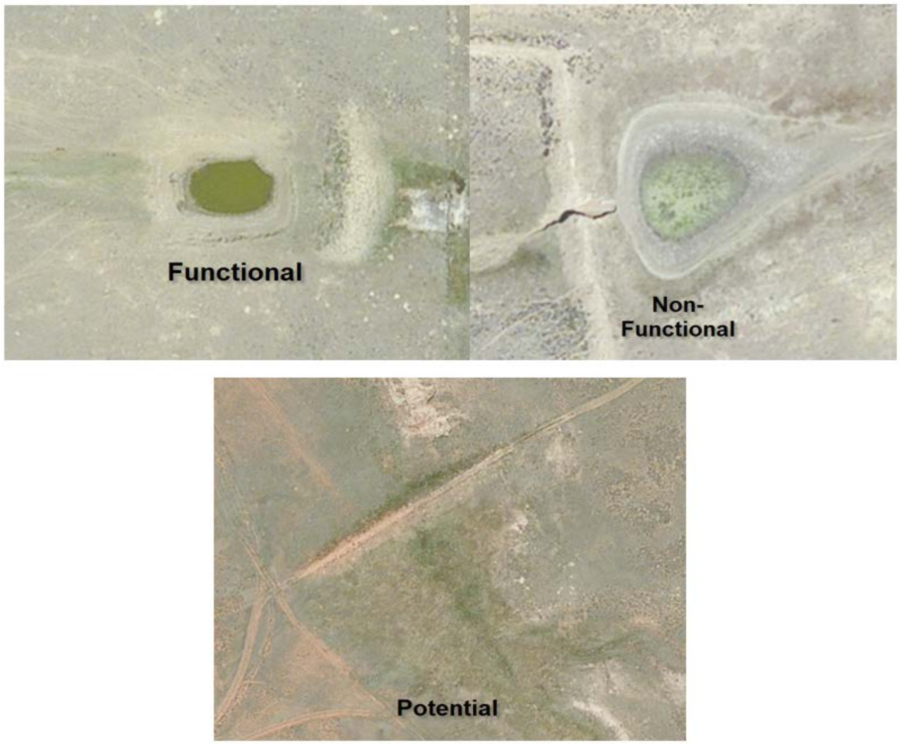


Figure 4.4-4 Evaluation of Stock Reservoirs within the GIS Environment.

Figure 4.4-5 displays the general locations of the “functional” livestock/wildlife reservoirs while Figure 4.4-6 displays those reservoirs classified as “potential” and “nonfunctional”. Appendix 4F presents the results in a tabular format.

4.4.4 Land

4.4.4.1 Land Use

Mine Permits

At the time of this report, there were eighteen active mines within the study area on record with the WDEQ Land Quality Division (Table 4.4-4). Most of the active permits are associated with sand and/or gravel operations (16 permits). In addition to these, one limestone and one stone mine are currently active within the study area. Figure 4.4-7 displays the locations of these mines.

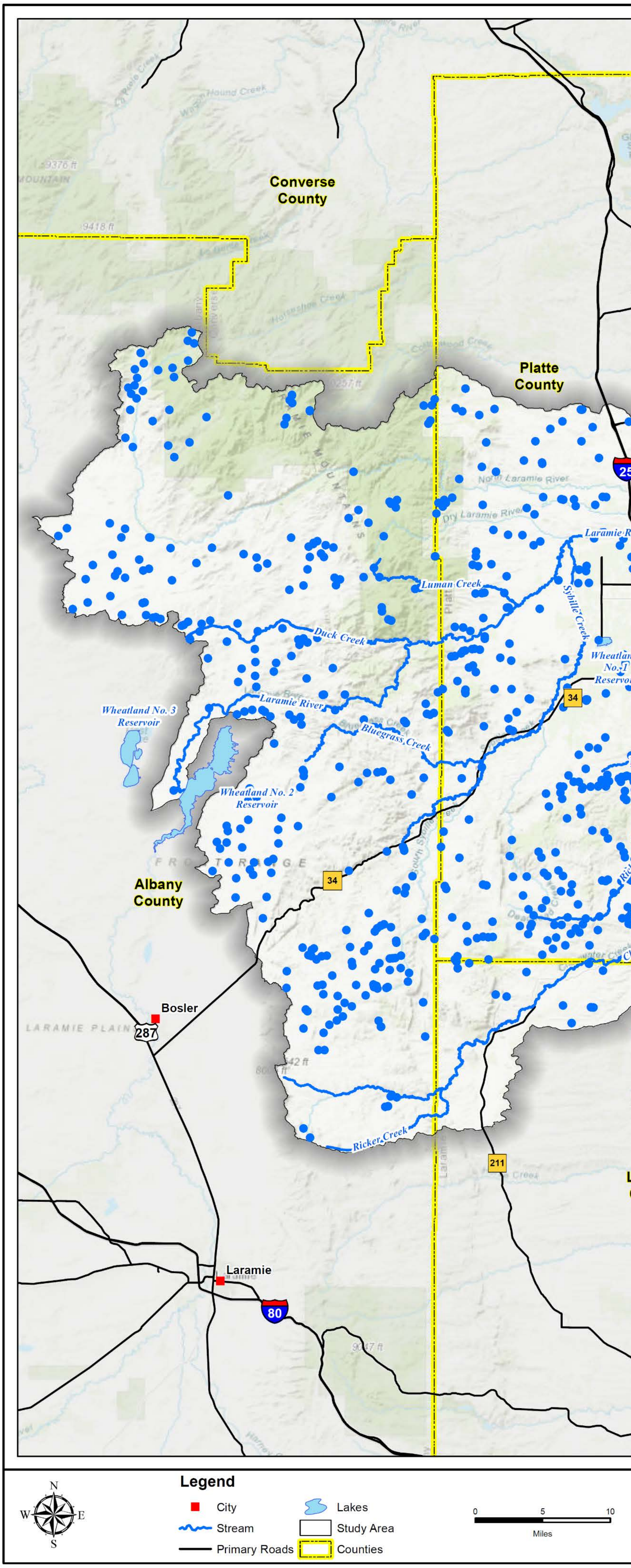


Figure 4.4-5 Lower Laramie River Watershed: Existing Functional Water Sources

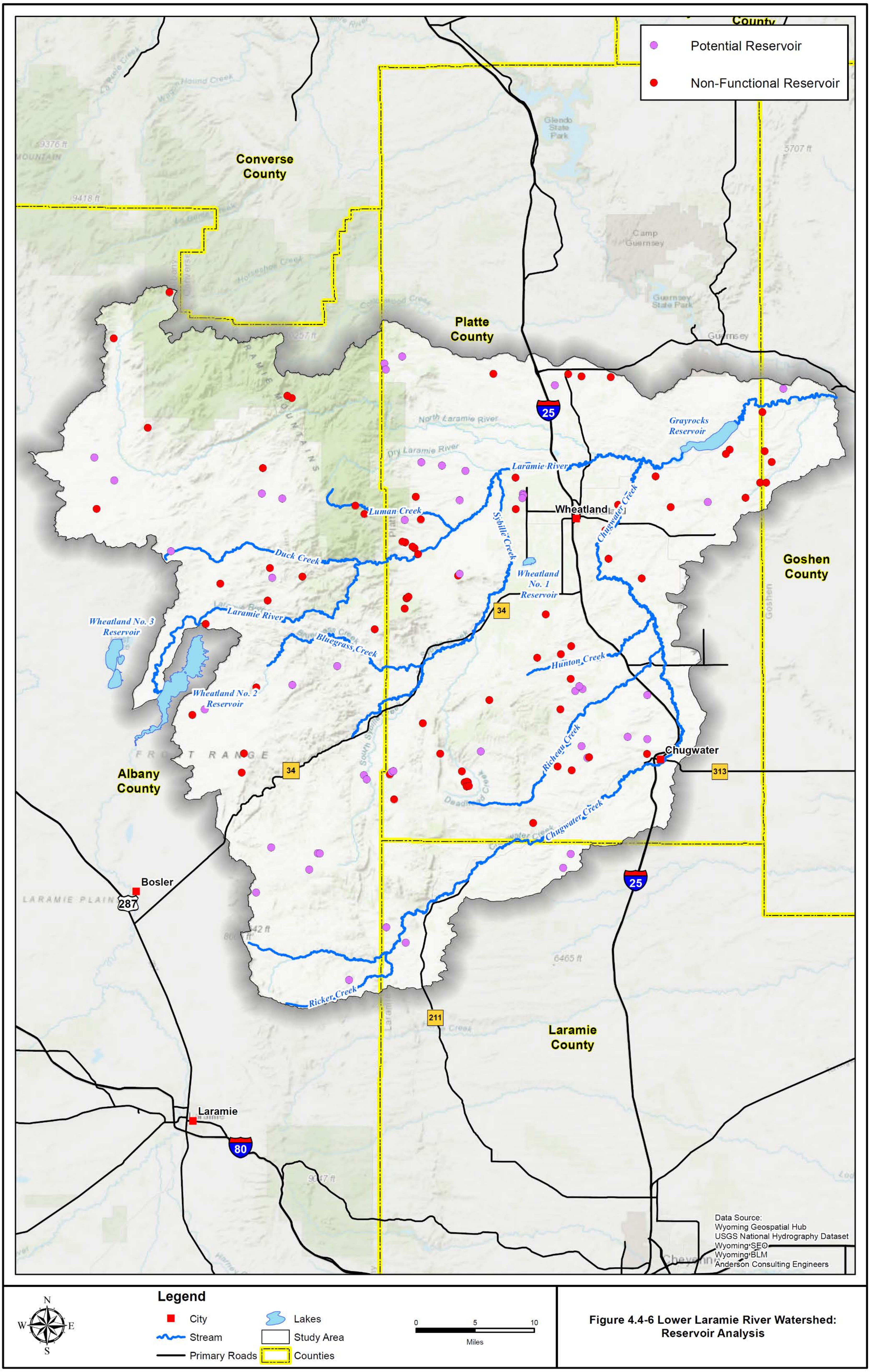


Figure 4.4-6 Lower Laramie River Watershed: Reservoir Analysis

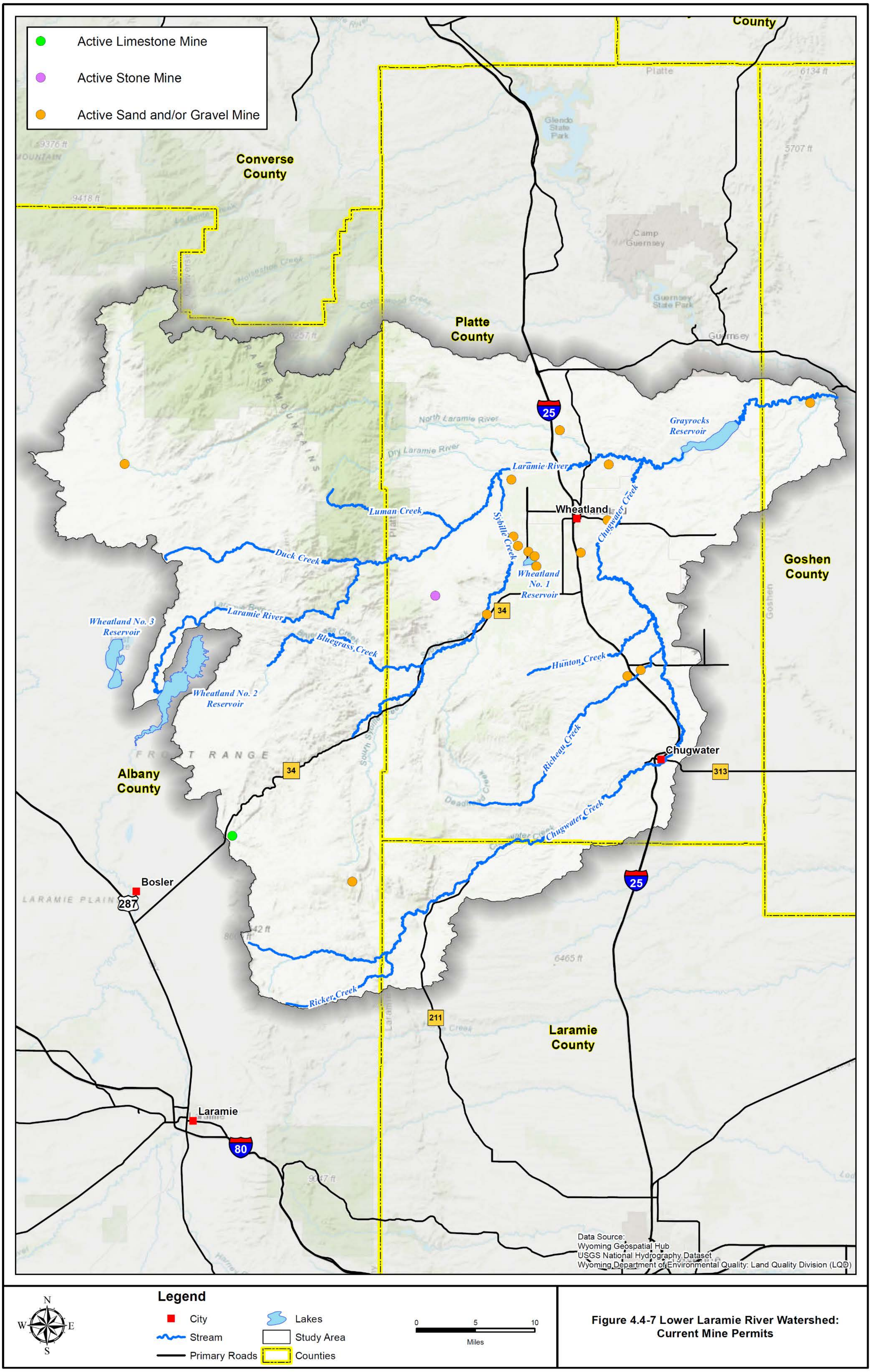


Figure 4.4-7 Lower Laramie River Watershed: Current Mine Permits

Table 4.4-4 Tabulation of Existing Mine Permits (WDEQ, 2016).

Permit Number	Company Name	Mine Name	Mine Type	Mineral	Acres	Status
ET0936	TITAN IRON ORE CORP	IRON MTN	Sand & Gravel	Limited Mine Operation (ET)	9	Active
SP0722	MCMURRY READY MIX CO	PLUMBAGO CREEK	Limestone	Small Mine (SP)	34.9	Active
ET0961	TYLER DODGE	DODGE	Sand & Gravel	Limited Mine Operation (ET)	10	Active
SP0809	ALEXANDER CONST CO	WEST PIT	Sand & Gravel	Small Mine (SP)	10	Active
ET1506	ALEXANDER CONST CO	FINNERTY	Sand & Gravel	Limited Mine Operation (ET)	10	Active
SP0813	OFTEDAL CONST INC	MULESHOE PIT #1	Sand & Gravel	Small Mine (SP)	10	Active
ET1528	QUALITY AGG & CONST INC	HADLEY PIT	Sand & Gravel	Limited Mine Operation (ET)	10	Active
PT0284	CROELL REDI MIX INC	JONES PIT	Sand & Gravel	Large Mine (PT)	48.1	Active
SP0565	BASIN ELECTRIC POWER COOP	BASIN ELECTRIC	Sand & Gravel	Small Mine (SP)	42.11	Active
SP0781	CROELL REDI MIX INC	MCGUIRE PIT	Sand & Gravel	Small Mine (SP)	60	Active
SP0823	STONE WHOLESALE INC	BLACK BEAUTY MINE	Stone	Small Mine (SP)	80	Active
PT0318	GOSHEN COUNTY OF	#15 - GID/Ft. Laramie - Shared with GID	Sand & Gravel	Permit	N/A	Active
PT0260	PLATTE, COUNTY OF	Artery Pit	Sand & Gravel	Permit	N/A	Active
PT0260	PLATTE, COUNTY OF	Abbot Pit	Sand & Gravel	Permit	N/A	Active
PT0260	PLATTE, COUNTY OF	Norris Pit	Sand & Gravel	Permit	N/A	Active
PT0260	PLATTE, COUNTY OF	Britton Pit	Sand & Gravel	Permit	N/A	Active
PT0260	PLATTE, COUNTY OF	County Pit	Sand & Gravel	Permit	N/A	Active
SP0696	ALBANY, COUNTY OF	Robins Pit	Sand & Gravel	Small Mine (SP)	N/A	Active

Management Implications:

Mining and mineral extraction operations produce economic value to a community and region but can also contribute to ecological and environmental impacts. It is important to consider the locations of such disturbances for assignment of impairment load allocation and when assessing and evaluating current natural resource condition for design and implementation of conservation practices
Data Sources:

Wyoming Department of Environmental Quality Land Quality Division: http://deq.wyoming.gov/lqd/

Transportation, Energy and Communications Infrastructure

Primary paved transportation routes traversing the study area are shown on Figure 4.4-8. Interstate 25 (I-25) intersects the east portion of the watershed, running north to south through the towns of Chugwater and Wheatland. Wyoming State Route 34 travels southwest from the Wheatland, along Sybille Creek. Wyoming State Routes 211 intersects the southeastern portion of the watershed, travelling along Chugwater Creek.

Figure 4.4-8 also shows the railroad corridors within the watershed. The main active line is the Burlington Northern Railroad that runs north from Cheyenne along Chugwater Creek, then up through the town of Guernsey.

Communication towers are located throughout the watershed; however, they are clustered around Wheatland and Chugwater, which are the major population centers within the study area.

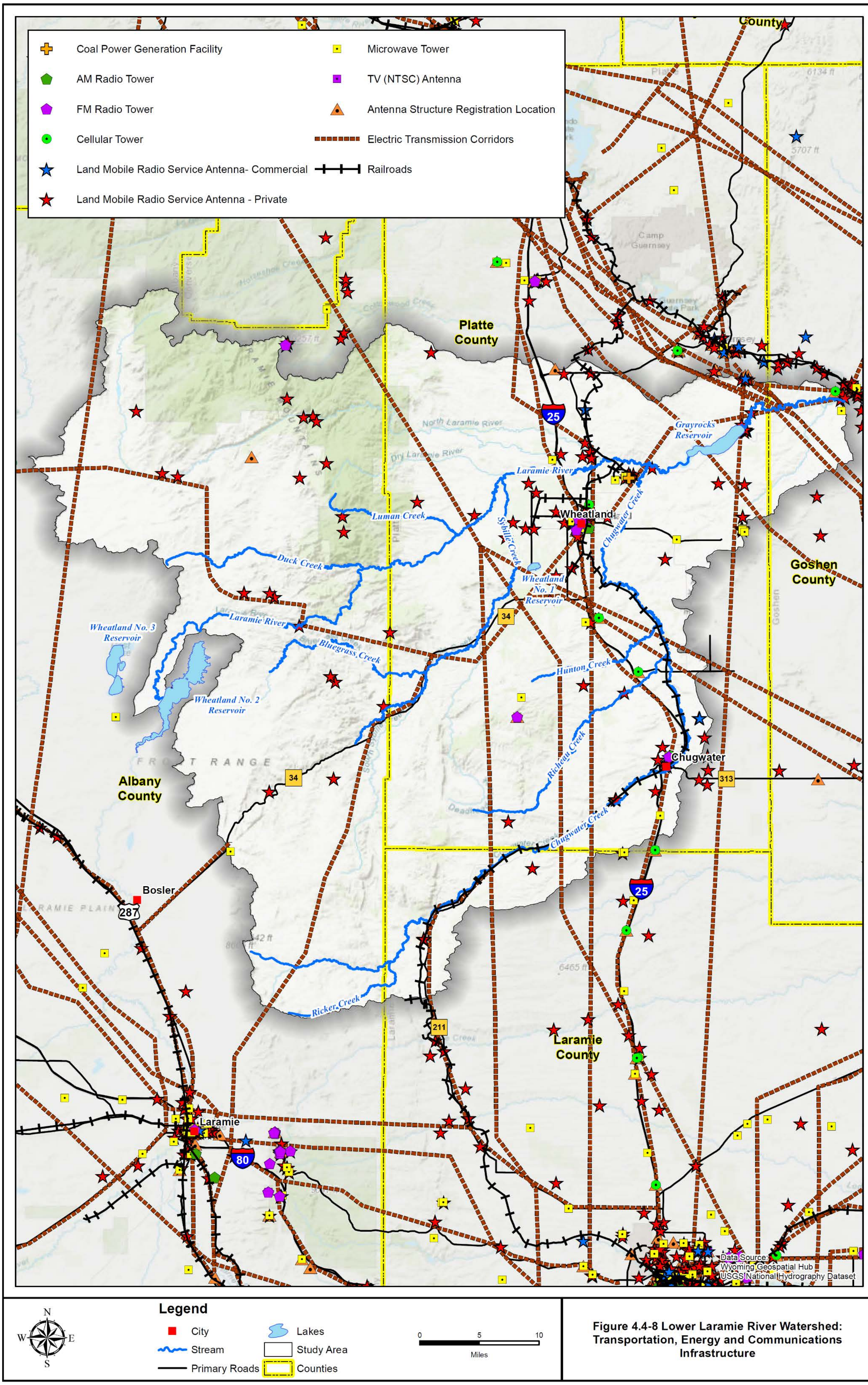


Figure 4.4-8 Lower Laramie River Watershed: Transportation, Energy and Communications Infrastructure

There is only one power generation facility in the watershed. The Laramie River Station is a is a coal power plant owned by Basin Electric Power Coop that can generate 1,710 megawatts per hour with three units.

Several electric transmission corridors are located within the study area, primarily located in the eastern portion of the watershed. Mapping of the lines provided by WyGISC is intentionally coarse in nature with poor accuracy; presumably for security reasons. Consequently, the lines indicated on Figure 4.4-8 are approximations of alignment only.

Management Implications:

Coordination with WYDOT and/or County Road and Bridge Departments could be required for implementation of many watershed plan components. Crossing existing roads with pipelines or other improvements can be problematic with respect to permitting and can potentially add significant costs to a project. Coordination would be required to determine costs and methods of construction (i.e., trenching, boring, etc.).

Whenever possible, project conceptual designs have been developed with the intention of avoiding road and energy transmission line crossings to minimize costs and permitting issues. However, there will be cases where the greater effort and costs associated with crossing a road or a pipeline could provide significant benefits to the project owner.

Data Sources:

Wyoming Geographic Information Science Center (WyGISC- Geospatial Hub): *http://geospatialhub.org/*
Wyoming State Geological Survey (WSGS): *http://www.wsgs.wyo.gov/pubs-maps/gis*
Federal Communications Commission: *https://catalog.data.gov/dataset/fcc-geographic-information-systems*

Oil and Gas Production and Resources

There are numerous pipelines within the study area for natural gas and other fuel products. As shown on Figure 4.4-9, many of the pipelines are roughly parallel to the main transportation route I-25. These include multiple crude oil pipelines and natural gas liquid pipelines, one product pipeline (refined), and one natural gas pipeline. There are also several crude oil pipelines which cross the northeast potion of the watershed, and one that travels along the northern portion of the watershed. Also, one natural gas pipeline crosses the western portion of the watershed.

The locations of all active and permanently abandoned oil and gas wells were obtained from the Wyoming Oil and Gas Conservation Commission (WOGCC). Active wells and permanently abandoned wells within the study area are shown on Figure 4.4-10. Most of the wells are in the eastern portion of the watershed, and only 6 wells are still active.

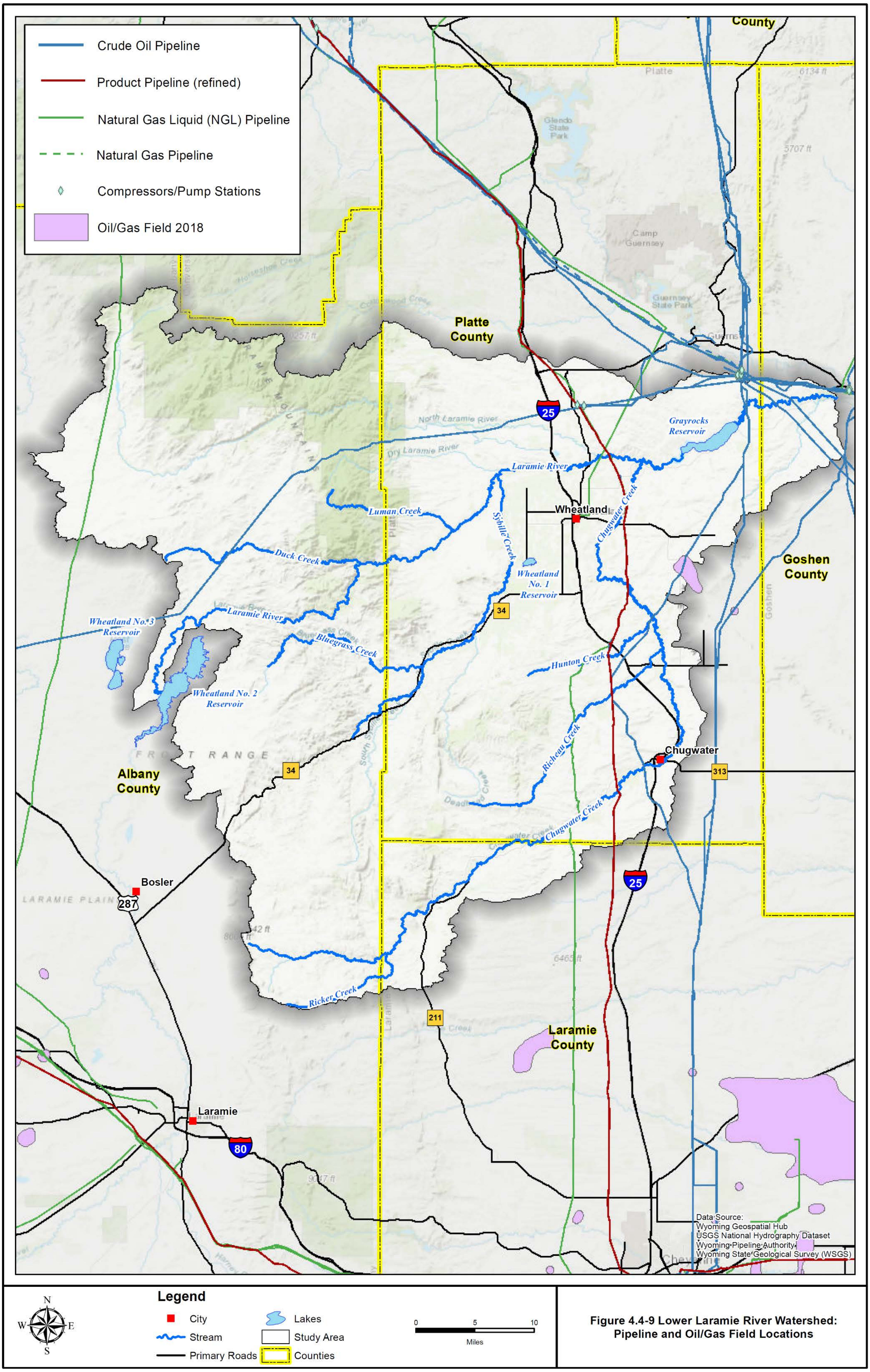


Figure 4.4-9 Lower Laramie River Watershed: Pipeline and Oil/Gas Field Locations

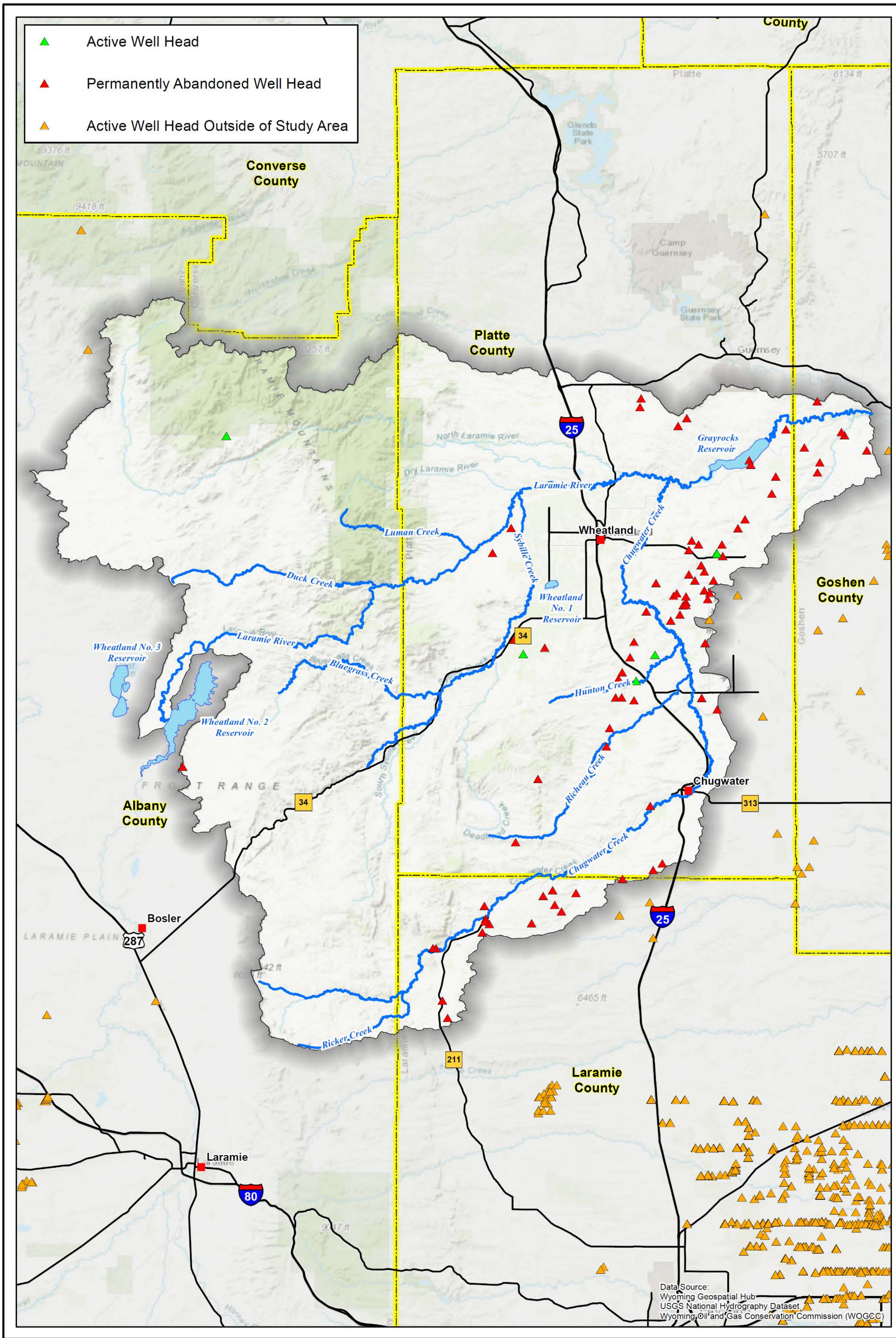


Figure 4.4-10 Lower Laramie River Watershed: Oil and Gas Wells as of 12/31/18

Data Sources:

Wyoming Oil and Gas Conservation Commission: *http://wogcc.state.wy.us/*
Wyoming State Geological Survey (WSGS): *http://www.wsgs.wyo.gov/*

4.4.4.2 Land Ownership

The total land area within the project study area is approximately 1,492,969 acres (2,333 square miles). Figure 4.4-11 presents a map indicating the various land ownership categories within the watershed. The study area spans Albany, Laramie, Platte, and Goshen Counties. As indicated in Figure 4.4-12, Platte County comprises 48.1 percent (1,122 square miles) of the study area, Albany County comprises 44.4 percent (1,037 square miles), Laramie County comprises 5.2 percent (121 square miles), while Goshen County comprises the remaining 2.3 percent (53 square miles).

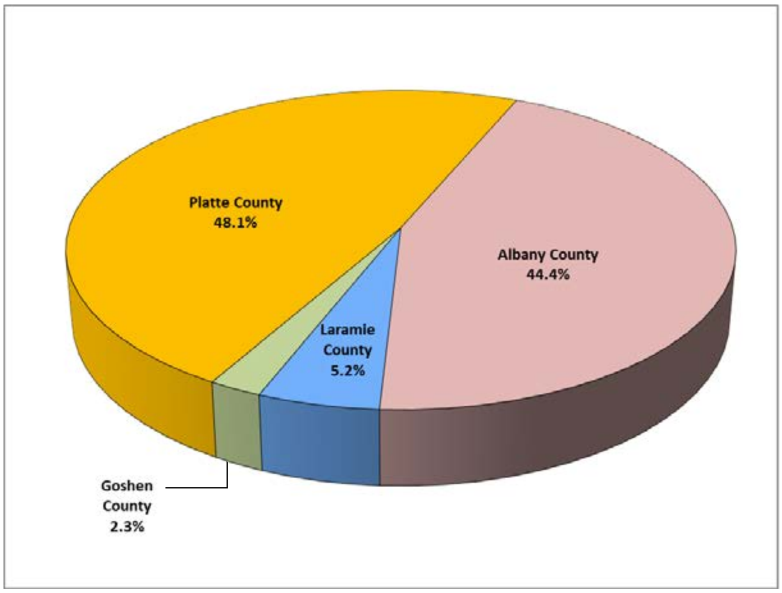


Figure 4.4-12 Distribution of Ownership Among Counties.

Land ownership information was obtained from the Bureau of Land Management (BLM) and the assessor's offices of the counties involved and incorporated into the project GIS. According to this data, privately owned lands dominate the ownership profile (Figure 4.4-13):

- Private Lands: 1,776 square miles (76.1 percent of the study area),
- Bureau of Land Management: 254 square miles (10.9 percent of the study area),
- State of Wyoming: 210 square miles (9.0 percent of the study area),
- United States Forest Service: 75 square miles (3.2 percent of the study area),
- Department of Defense: 15 square miles (0.6 percent of the study area),
- Water bodies: 1.5 square miles (<0.1 percent of the study area),
- National Park Service: 1.1 square miles (<0.1 percent of the study area),
- Bureau of Reclamation: 0.2 square miles (<0.1 percent of the study area).

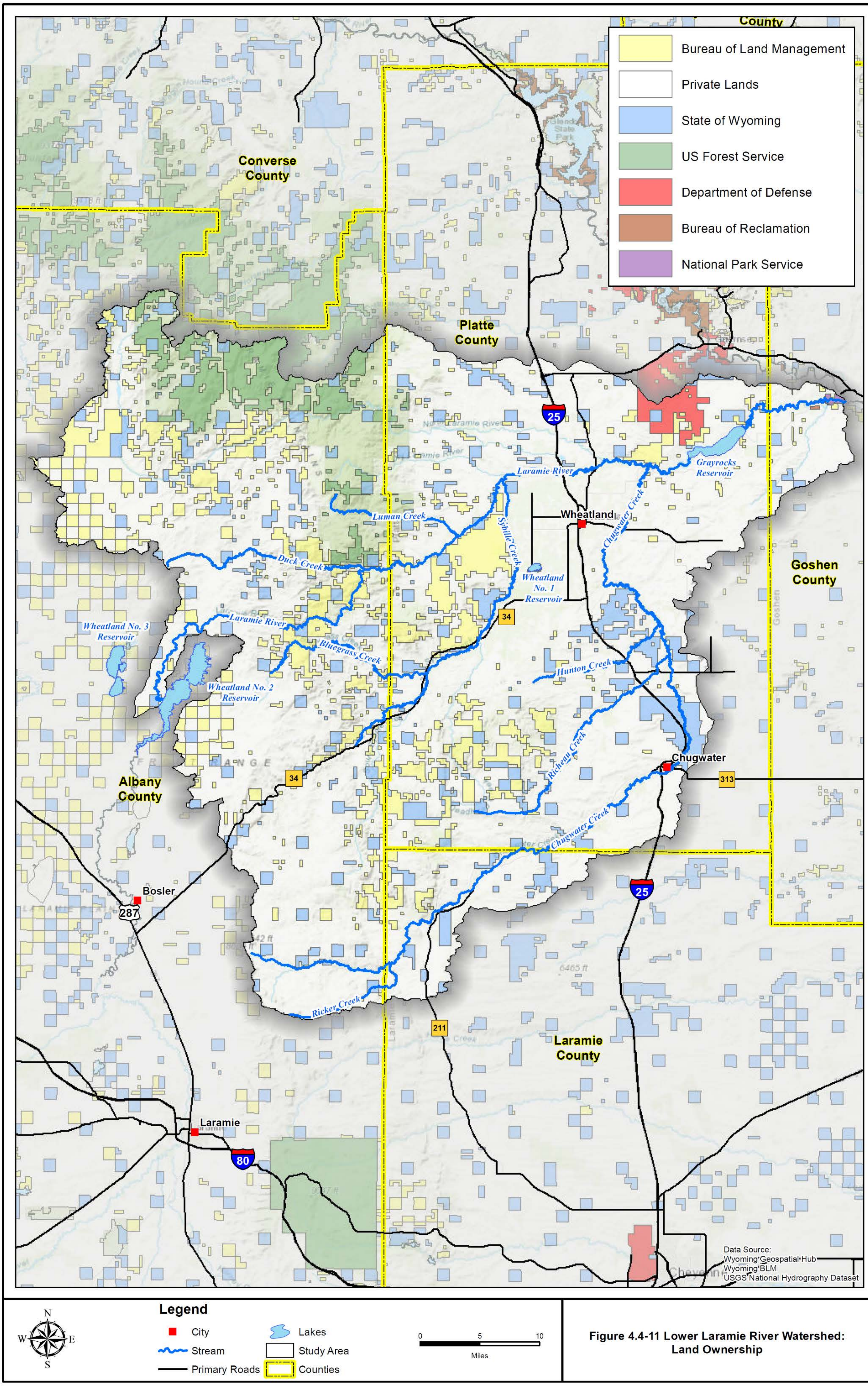


Figure 4.4-11 Lower Laramie River Watershed: Land Ownership

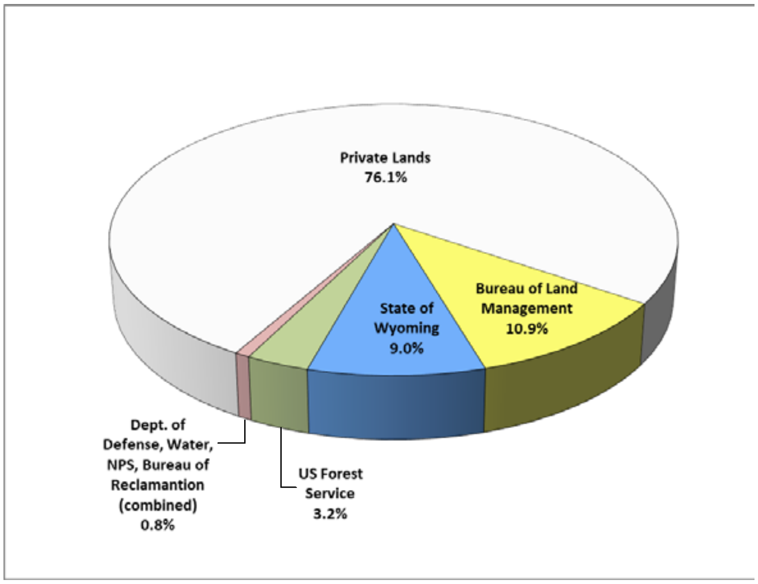


Figure 4.4-13 Distribution of Land Ownership within the Lower Laramie Study Area.

Management Implications:

Land ownership has direct implications to the watershed study and implementation of proposed watershed improvements. Unlike much of the State, the project study area is dominated by privately owned properties (greater than 70 percent). Consequently, permitting efforts will be greatly simplified on those lands. On federally owned lands, project implementation will require coordination with the BLM, USFS, or USFW for permitting and easements. Depending upon the nature of the proposed project or management activity, the NEPA process may be initiated. Likewise, project implementation on State lands will require permitting through the Wyoming Board of State Lands and Investments. Chapter 9: Permitting provides descriptions of potential permitting requirements, application information, and agency contact tabulations

Data Sources:

Albany County Assessors Data: *http://www.co.albany.wy.us/gis-map-property-data-download.aspx*
Goshen County Assessors Data (Must contact assessor): *https://goshencounty.org/maps/*
Laramie County Assessors Data (Must contact assessor): http://www.laramiecounty.com/_officials/CountyAssessor/index.aspx
Platte County Assessors Data (Must contact assessor): http://plattecountywyoming.com/Assessor/Default.aspx

4.4.4.3 Land Management and Upland Water Resources

Land Management

Of the approximately 1.35 million acres within this study area, over 1.03 million acres are privately owned, over 201,500 acres under Federal management, and 121,500 acres managed by the State. Significant portions of this land base are devoted to livestock grazing which in turn provides a major contribution to the local ranching and farming industry. Livestock grazing on BLM and USFS lands is managed under allotments as shown in Figure 4.3-4. There are 190 BLM allotments and 17 Forest Service allotments. Federal land grazing is managed under the Federal Land Policy and Management Act of 1976 and the Taylor Grazing Act of 1934.

Grazing activities on BLM lands are required to meet Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands as established in 1997. These Standards and Guidelines are to support infiltration, maintain soil moisture, stabilize soils, and provide sufficient water to maintain system function and soil permeability; restore, maintain, or improve riparian plant communities to sustain adequate residual plant cover for sediment capture and groundwater recharge; implement riparian improvements to maintain or enhance stream channel morphology; develop springs, seeps, reservoirs, wells, or other water development projects in a manner that protects watershed ecological and hydrological functions; implement range improvements away from riparian areas to avoid conflicts in achieving or maintaining riparian function; and adopt management practices and implement range improvements that protect vegetative cover and thereby maintain, restore, or enhance water quality.

In addition to the BLM allotments within the watershed, the USFS administers 17 grazing allotments.
The Medicine Bow - Routt National Forest is the administrative unit of the US Forest Service located in eastern Wyoming. Each forest and grassland is guided by a unique Land and Resource Management Plan (available on the Forest web site at http://www.fs.usda.gov/land/mbr/landmanagement) that outlines desired conditions, goals, objectives, standards, and guidelines for the Plan area. Each Plan also provides direction to monitor resources to determine if the Forest or Grassland is moving toward or maintaining the desired conditions of the Plan area.

The USFS conducts resource monitoring that pertains to maintenance and improvement of watershed health. Included are reviews of roads and trails, riparian area grazing use by livestock and wildlife, and recreation. Data collection and information gathered is used to understand the maintenance or improvement of watershed condition and how management being applied to the resource area is maintaining a healthy watershed condition. Specific interest is directed toward proper functioning condition of riparian areas and wetlands and how management is affecting those habitat environs.

State lands within the watershed are generally leased to private landowners for agriculture production, including livestock grazing. These permits are obtained through the Office of State Lands and Investments as approved by the State Board of Land Commissioners. Management practices, including infrastructure improvements on state leases, are usually determined and implemented by the lessee. Refer to the land ownership map for state land locations as shown in Figure 4.4-11 above.

Ecological Site Descriptions

Discussion of private land grazing within this watershed is centered on the presentation of the potential for forage plant production within an “ecological site”. The actual condition of that ecological site, including the existing plant diversity and community, can be a representation of past and current management. The ecological site description associated with a specific location within the watershed therefore can provide a reference from which current grazing management can be compared, measured and adjusted.

Rangelands are classified as ecological sites based on soils, topography, and climate that create each site’s unique characteristics. An ecological site is a conceptual division of the landscape defined by the BLM, USFS, and NRCS as the following: A distinctive kind of land based on recurring soil, landform, geological, and climate characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its ability to respond similarly to management actions and natural disturbances. Ecological sites incorporate environmental factors such as climate, soils, landform, hydrology, vegetation, and natural disturbance regimes that together define the site and its relationships between these factors and how they influence plant community composition [Caudle et al., 2013].

The characteristics differentiating ecological sites and their features are documented as an ecological site description (ESD), which includes the following:

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

An ESD includes interpretations about the land uses that a specific ecological site can support and management alternatives for achieving objectives. ESDs are valuable tools that can be used to help landowners and managers make decisions through evaluating the condition or health of a range or forest site and comparing the current vegetation composition to the type of plants the site is capable of growing.

The ecological sites and associated descriptions were developed over many years of data collection and range site monitoring and are dependent on the location of a site within defined precipitation zones and existing soil characteristics. ESDs available from the NRCS describe the following for each ecological site:

- Site characteristics—physiographic, climate, soil, and water features
- Plant communities—plant species, vegetation states, and ecological dynamics

- Site interpretations—management alternatives for the site and its related resources
- Supporting information—relevant literature, information, and data sources.

ESDs are available from the NRCS at:
https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=%20ESD

ESDs are also available through an interactive tool provided by New Mexico State University at:
https://edit.jornada.nmsu.edu/page?content=catalog&catalog=3

In practical application, ESDs can be used to compare what is growing on the rangeland with what each site is capable of growing. By comparing the present vegetative composition to the potential compositions, the relative health of the range resource can be evaluated. Production of each site is closely related to the ecological condition of the site. Ecological Sites are defined based upon their location within defined Ecological Precipitation Zones and soil characteristics. Figure 4.4-14 displays the ecological precipitation zones found in the watershed.

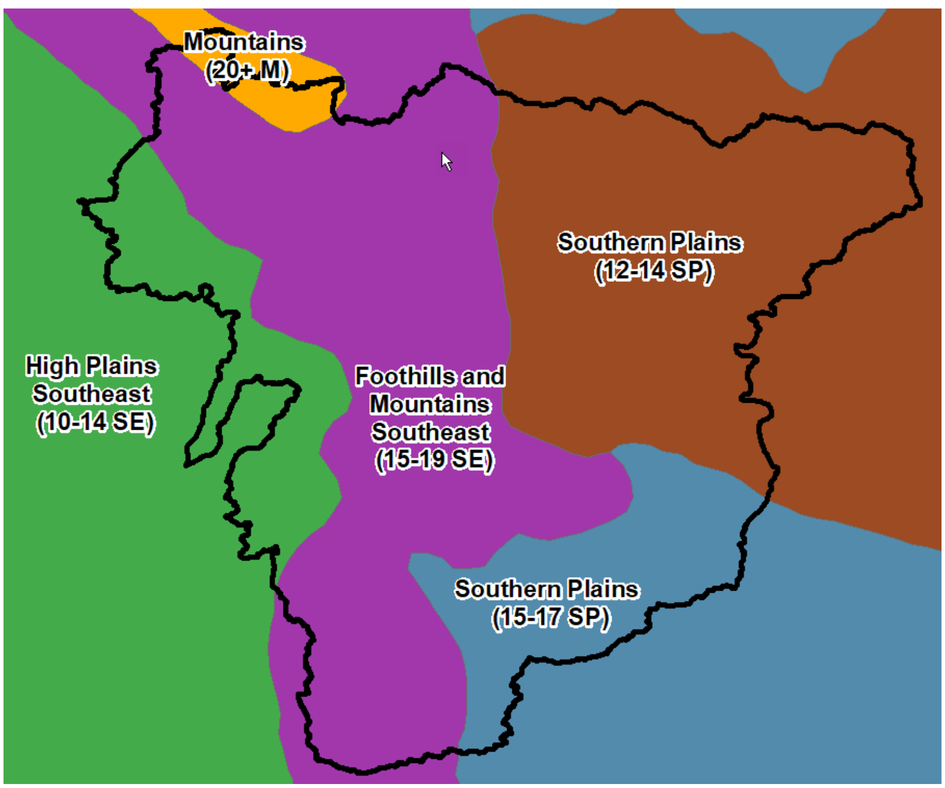


Figure 4.4-14 Ecological Precipitation Zones.

Using database tools provided by the NRCS, the available soils mapping was evaluated, and Ecological Sites defined within the study area. Also, please note that even if there are soils data available there may not be an associated ESD that can be calculated. For example, rock outcrop, mines, dumps, urban land,

and water are all soil map unit values in the soils data for which ESD's cannot be calculated. Table 4.4-5 displays the ecological sites in the watershed.

Table 4.4-5 Ecological Site Descriptions within the Lower Laramie River Watershed.

Ecological Site ID	Ecological Site Name	Acres	Percent of Watershed
N/A	No ESD Available	453,342	30.37%
R067AY150WY	SANDY (12-17SP)	294,695	19.74%
R049XA160WY	SHALLOW IGNEOUS (15-19SE)	212,135	14.21%
R034AY322WY	LOAMY (10-14SE)	110,131	7.38%
R067AY122WY	LOAMY (12-17SP)	86,320	5.78%
R067AY222WY	LOAMY (15-17SP)	46,572	3.12%
R049XA122WY	LOAMY (15-19SE)	39,985	2.68%
R067AY234WY	ROCKY HILLS (15-17SP)	36,688	2.46%
R067AY166WY	SHALLOW SANDY (12-17SP)	30,564	2.05%
R049XA174WY	SUBIRRIGATED (15-19SE)	22,975	1.54%
R067AY152WY	SANDY LOWLAND (12-17SP)	19,347	1.30%
R067AY174WY	SUBIRRIGATED (12-17SP)	16,166	1.08%
R067AY176WY	VERY SHALLOW (12-17SP)	16,151	1.08%
R067AY212WY	GRAVELLY (15-17SP)	12,471	0.84%
R067AY178WY	WETLAND (12-17SP)	9,212	0.62%
R067AY266WY	SHALLOW SANDY (15-17SP)	8,677	0.58%
R067AY262WY	SHALLOW LOAMY (15-17SP)	8,579	0.57%
R049XA134WY	ROCKY HILLS (15-19SE)	7,936	0.53%
R034AY362WY	SHALLOW LOAMY (10-14SE)	7,744	0.52%
R034AY376WY	VERY SHALLOW (10-14SE)	6,280	0.42%
R034AY334WY	ROCKY HILLS (10-14SE)	5,353	0.36%
R067AY114WY	GRAVELLY LOAMY (12-17SP)	4,628	0.31%
R067AY146WY	SANDS (12-17SP)	4,295	0.29%
R067AY204WY	CLAYEY (15-17SP)	3,722	0.25%
R034AY338WY	SALINE LOWLAND (10-14SE)	3,464	0.23%
R034AY336WY	SALINE LOAMY (10-14SE)	3,316	0.22%
R034AY366WY	SHALLOW SANDY (10-14SE)	2,910	0.19%
R034AY350WY	SANDY (10-14SE)	2,345	0.16%
R067AY250WY	SANDY (15-17SP)	2,190	0.15%
R067AY112WY	GRAVELLY (12-17SP)	1,624	0.11%
R034AY304WY	CLAYEY (10-14SE)	1,577	0.11%
R049XA116WY	IGNEOUS (15-19SE)	1,456	0.10%
R067AY274WY	SUBIRRIGATED (15-17SP)	1,433	0.10%
R067AY138WY	SALINE LOWLAND (12-17SP)	1,333	0.09%
R058BY150WY	SANDY (10-14SE)	1,280	0.09%
R034AY342WY	SALINE SUBIRRIGATED (10-14SE)	1,079	0.07%
R034AY374WY	SUBIRRIGATED (10-14SE)	1,013	0.07%
R067AY228WY	LOWLAND (15-17SP)	817	0.05%
R034AY344WY	SALINE UPLAND (10-14SE)	753	0.05%
R067AY120WY	LIMY UPLAND (12-17SP)	747	0.05%
R049XA162WY	SHALLOW LOAMY (15-19SE)	491	0.03%
R034AY358WY	SHALLOW CLAYEY (10-14SE)	453	0.03%
R067AY124WY	LOAMY LOWLAND (12-17SP)	262	0.02%
R067AY142WY	SALINE SUBIRRIGATED (12-17SP)	225	0.02%
R049XA108WY	COARSE UPLAND (15-19SE)	112	0.01%
R034AY318WY	IMPERVIOUS CLAY (10-14SE)	48	0.00%
R072XY100KS	LOAMY TABLELAND	37	0.00%
R058BY176WY	VERY SHALLOW (10-14SE)	27	0.00%
R067AY276WY	VERY SHALLOW (15-17SP)	5	0.00%
R067AY126WY	LOAMY OVERFLOW (12-17SP)	2	0.00%

Three predominant ESDs cover approximately 40 percent of the watershed and are listed below:

1. **Sandy (Sy) 12 – 17-inch Central High Plains**, **Northern Part** (R067AY150WY) is the largest zone and covers approximately 295,000 acres (19.7%) of the study area.

2. **Shallow Igneous (SwIg) 15 – 19-inch Southern Rocky Mountain Foothills** (R049XA160WY) covers approximately 212,000 acres (14.2%) of the study area.

3. **Loamy (Ly) 10 – 14-inch Cool Central Desertic Basins and Plateaus** (R034AY322WY) covers approximately 110,000 acres (7.4%) of the study area.

Figure 4.4-15 displays the locations of the major ecological sites where the 1:24,000 soils mapping was available. Appendix 4G contains the plant community descriptions for each of the ESDs listed above.

4.4.4.4 Cultural Resources

The Wyoming State Historic Preservation Office (SHPO) maintains an in-progress database of inventoried historic sites within the state. A determination of each site's eligibility for inclusion in the National Register of Historic Places (Register) is included in the database. SHPO also has created a spatial data file which "generalizes" the cultural resource inventory. This "location fuzzing" of the historically significant data is to protect the sites from unauthorized disturbance. The attributes recorded for each section of the Public Land Survey System include site count, inventory acres, report numbers, and eligible site number. Figure 4.4-16 displays the results of the database retrieval in a graphical format. Each square mile section within the study area has been color coded based upon the number of sites within it determined to be eligible for inclusion on the Register.

The National Register of Historic Places (National Register) is the nation's official list of cultural resources worthy of preservation. It is administered on a federal level by the National Park Service and managed locally by the Wyoming State Historic Preservation Office (SHPO). The National Register is part of a program to coordinate and support both public and private efforts to identify, evaluate, and protect historic and archeological resources. The National Register recognizes the accomplishments of those who have contributed to the history and heritage of the United States, the state, and local communities.

Listing a property on the National Register of Historic Places is a form of acknowledgment and prestige, which places no restraints on the property. This classification does not restrict the rights of property owners to use, develop, or sell the property. Although placing a property on the National Register is intended to neither stop alterations to a building nor require owners to provide the public access to the property, it can provide the owner with eligibility for certain financial incentives (NPS, 2016 at *https://www.nps.gov/nr/national_register_fundamentals.htm*).

To date, 8 sites within the study area have been included in the National Register (see Table 4.4-6). Full descriptions of these sites are available from the National Park Service website located at: *http://npgallery.nps.gov/nrhp/*.

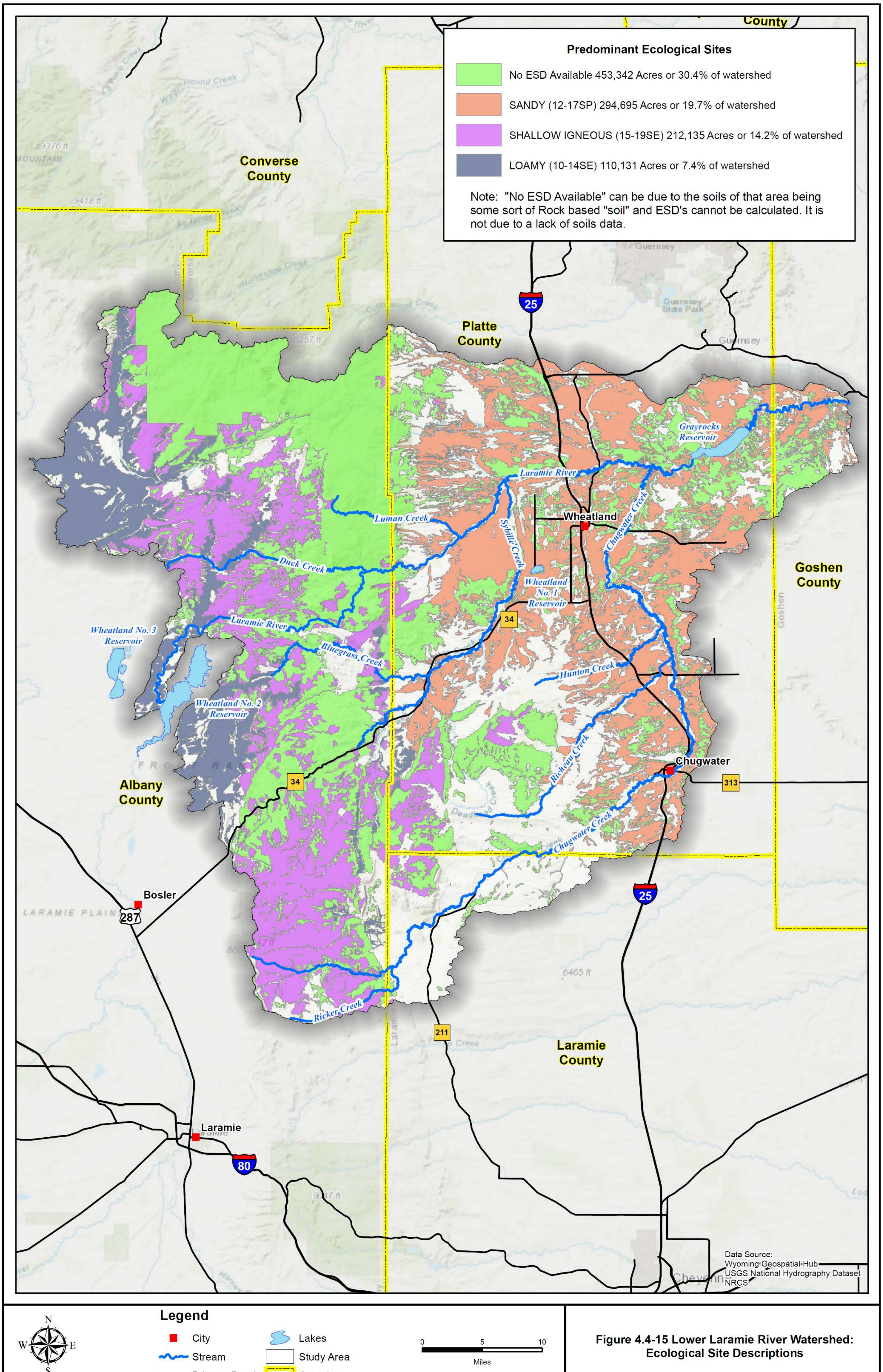


Figure 4.4-15 Lower Laramie River Watershed: Ecological Site Descriptions

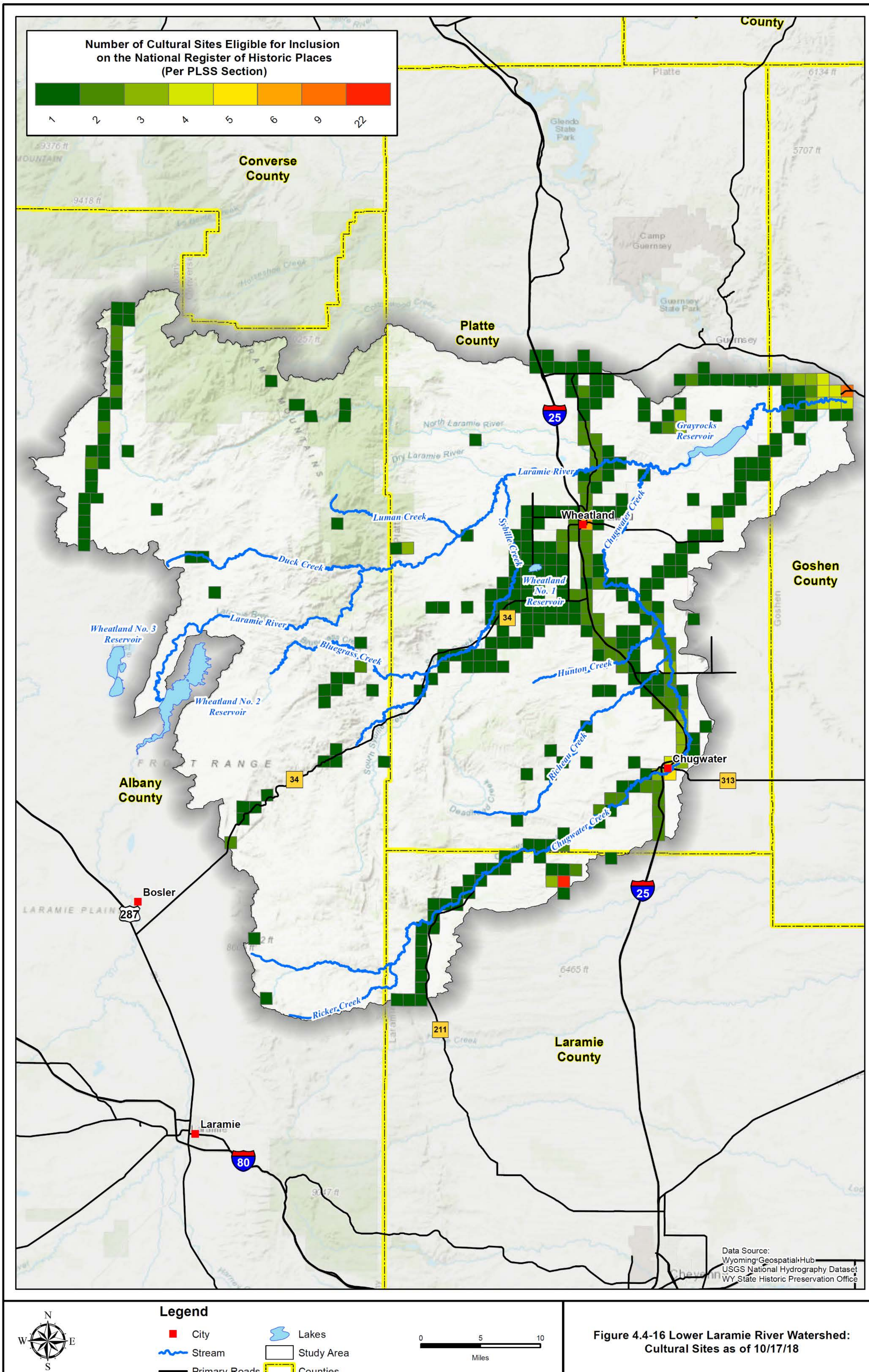


Figure 4.4-16 Lower Laramie River Watershed: Cultural Sites as of 10/17/18

In addition to the historic places mentioned in Table 4.4-6, BLM has mapped the historic trails in Wyoming. Figure 4.4-17 displays the historic trails and sites listed on the National Registry of Historic Places within the study area. The Cheyenne-Deadwood State Road runs along the eastern edge of the watershed, passing through the towns of Chugwater and Fort Laramie. The Rock Creek – Fort Fetterman Stage Road passes through the western portion of the watershed. The Oregon/California/Mormon/Pony Express Trail passes through the northeast corner of the watershed near the confluence of the Laramie River and the North Platte.

Table 4.4-6 National Register of Historic Places within the Lower Laramie River Watershed.

Historic Place Name	National Registry Reference Number
Diamond Ranch	84003696
EWZ Bridge over East Channel of Laramie River	85000431
Fort Laramie National Historic Site	66000755
Fort Laramie Three-Mile Hog Ranch	75001901
Grant, Robert, Ranch	95001073
McDonald Ranch	84003696
Platte County Courthouse	08001004
Swan Land and Cattle Company Headquarters	66000760
Wheatland Railroad Depot	96000077

Management Implications:

The data presented above is only the data that is open to the public; there is also "sensitive data" that was not made available for this study. The Wyoming State Historic Preservation Office (SHPO) should be contacted before proceeding with any proposed project to obtain more detailed site-specific information.

If the BLM is involved in a proposed project and the project is within ¼ mile of a historic trail or within the visual horizon of the trail, stipulations put forth in the Rawlins or Casper Resource Management Plans would be imposed. Most issues related to projects proposed in this report could be mitigated by following best management practices suggested by the BLM, such as low-profile water tanks and low-contrast paint to blend into the surroundings.

Data Sources:

Wyoming Bureau of Land Management (BLM): *http://www.blm.gov/wy/st/en.html*
Wyoming State Historic Preservation Office (SHPO): *http://wyoshpo.state.wy.us/Index.aspx*
National Park Service, National Registry of Historic Places: https://www.nps.gov/nr/

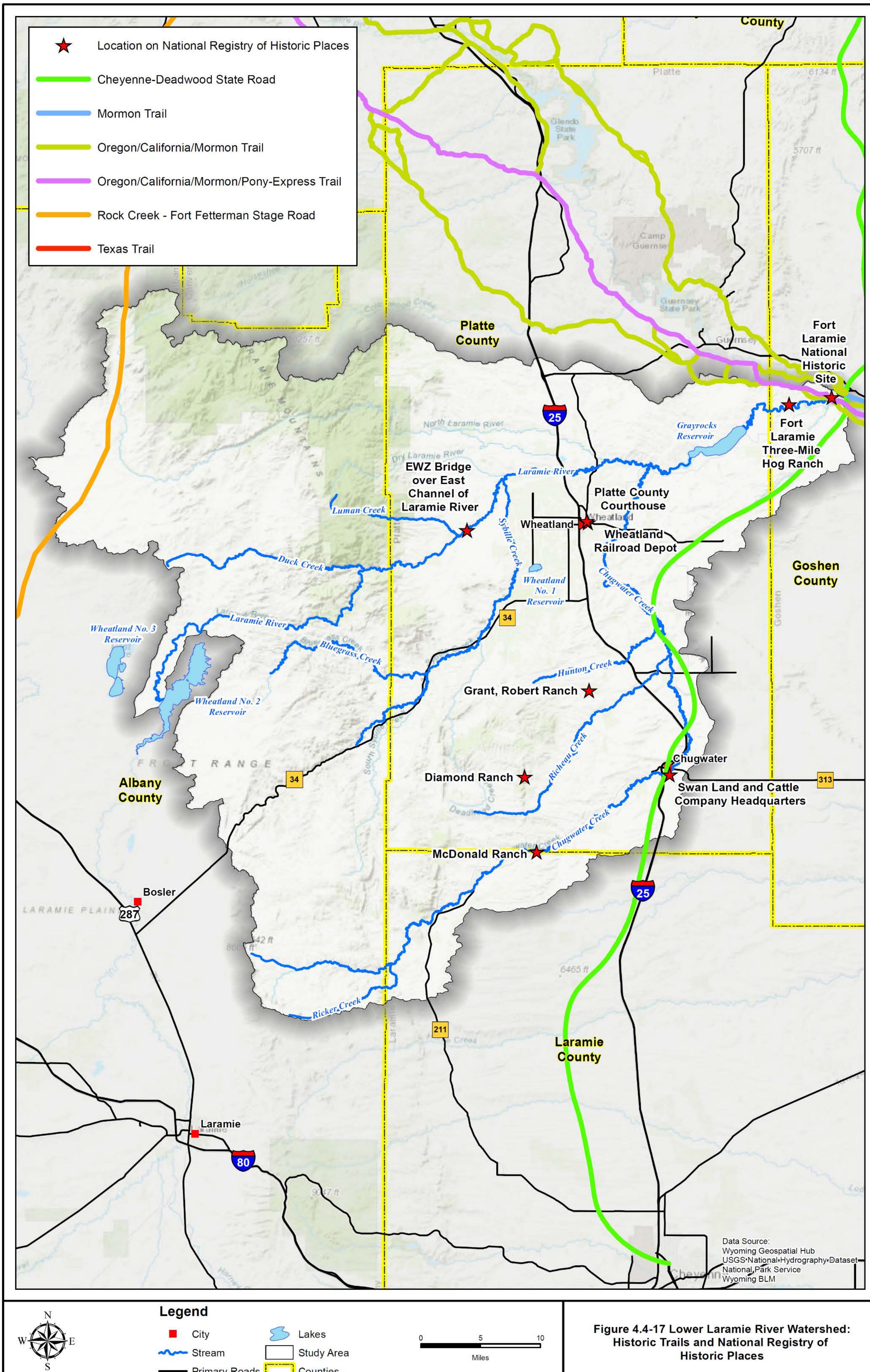


Figure 4.4-17 Lower Laramie River Watershed: Historic Trails and National Registry of Historic Places

V. TASK 4: SURFACE HYDROLOGY

5.1 Overview

The USGS has assigned watersheds in the United States with numeric identifiers called Hydrologic Unit Codes, or HUCs. According to the USGS, "The United States is divided and sub divided into successively smaller hydrologic units which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system."

The first level of classification divides the nation into 21 major geographic areas, or regions. These geographic areas typically contain the drainage area of a major river, such as the Missouri region. Eighteen of the regions make up the land area of the lower forty-eight states. As regions are subdivided, the HUC identifier is extended. At this time, the smallest subdivision is referred to as the Twelfth order HUC due to the fact that the identifier has 12 digits. The following information is provided as an example of the HUC system as it refers to one of the Lower Laramie tributaries: Hunton Creek.

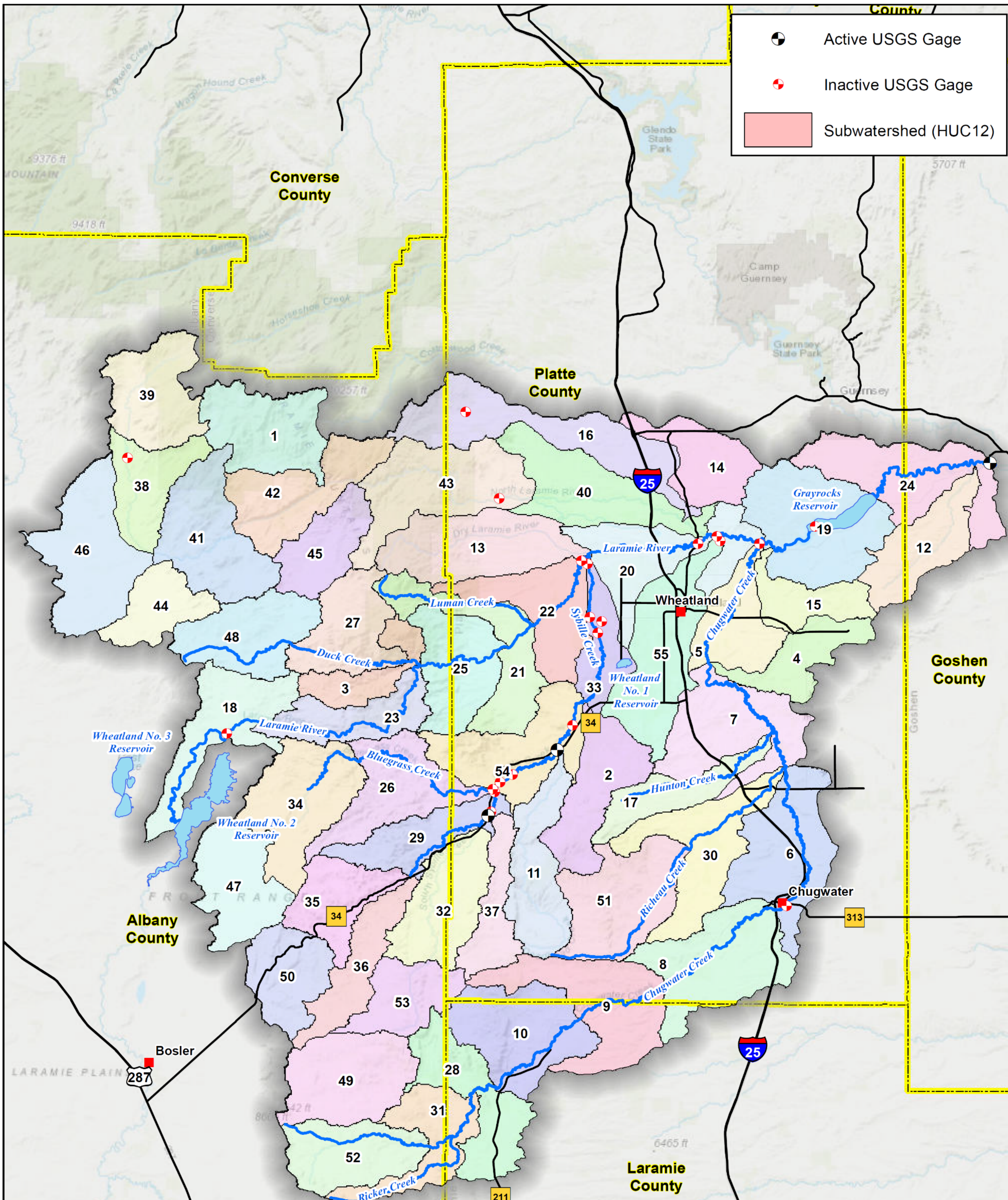
Region:	10 Missouri	(Second order HUC)
Subregion:	1018 North Platte	(Fourth Order HUC)
Accounting Unit:	101800 North Platte	(Sixth Order HUC)
Cataloging Unit:	10180011 Lower Laramie	(Eighth Order HUC)
Sub-basin:	1018001109 Lower Chugwater Creek	(Tenth Order HUC)
Sub-basin:	101800110904 Hunton Creek	(Twelfth Order HUC)

The Lower Laramie watershed study area was defined by the eighth order HUC, 10180011 Lower Laramie. Table 5.1-1 summarizes the HUC system as it pertains to the study area as indicated in Figure 5.1-1.

The stream reaches and tributaries in the study area range from perennial to ephemeral. Ephemeral streams are defined as those streams/reaches that flow only in response to direct precipitation events, and where any groundwater inflows are insufficient to sustain streamflow due to losses from evaporation, transpiration, and seepage. The hydrologic behavior of intermittent streams/reaches is transitional between perennial and ephemeral stream hydrology. Ephemeral streams tend to be extremely 'flashy', displaying very rapid rise to peak followed by a rapid recession in streamflow. Annual runoff is typically low for ephemeral streams.

Table 5.1-1 Lower Laramie Watershed Study: Hydrologic Unit Code Breakdown.

HUC 2 Number / Name	HUC 4 Number / Name	HUC 6 Number / Name	HUC 8 Number / Name	HUC 10		HUC 12	
				Number	Name	Number	Name
Region 10: Missouri	Subregion 1018: North Platte	Accounting Unit 101800: North Platte	Cataloging Unit 10180011: Lower Laramie	1018001101	Laramie River-Dry Laramie River	101800110101	Laramie River-Dodge Creek
						101800110102	Laramie River-Preemption Creek
						101800110103	Cherry Creek
						101800110104	Upper Duck Creek-Lower Duck Creek
						101800110105	Lower Duck Creek-Dry Laramie River
						101800110106	Laramie River-Slate Creek
						101800110107	Laramie River-Luman Creek
						101800110108	Laramie River-Marble Query Spring
						101800110109	Dry Laramie River
				1018001102	Upper Sybille Creek	101800110201	Upper North Sybille Creek
						101800110202	Middle North Sybille Creek
						101800110203	Middle Sybille Creek
						101800110204	Lower North Sybille Creek
						101800110205	Upper South Fork Sybille Creek
						101800110206	Lower South Fork Sybille Creek
						101800110207	Mule Creek-Sybille Creek
				1018001103	Bluegrass Creek	101800110301	Upper Bluegrass Creek
						101800110302	Middle Bluegrass Creek
						101800110303	Lower Bluegrass Creek
				1018001104	Lower Sybille Creek	101800110401	Upper Sybille Creek
						101800110402	Deadhead Creek
						101800110403	Brush Creek-Sybille Creek
						101800110404	Lower Sybille Creek
				1018001105	Laramie River-Wheatland Creek	101800110501	Laramie River-Laramie River Ditch
						101800110502	Wheatland Creek
						101800110503	Laramie River-Grayrocks Reservoir
						101800110504	Eagles Nest Canyon
						101800110505	Laramie River-Sixmile Creek
						101800110506	Deer Creek-Laramie River
				1018001106	Upper North Laramie River	101800110601	Twentytwo Mile Draw
						101800110602	North Laramie River-Bar M Creek
						101800110603	North Laramie River-Antelope Creek
						101800110604	North Laramie River-Cow Creek
						101800110605	Pinto Creek
						101800110606	North Laramie River-Coyote Creek
						101800110607	Bear Creek-North Laramie River
						101800110608	Sturgeon Creek
				1018001107	Lower North Laramie River	101800110701	North Laramie River-Owen Creek
						101800110702	North Laramie River-Big Draw
						101800110703	Fish Creek-North Laramie River
						101800110704	Dwery Cemetary
				1018001108	Upper Chugwater Creek	101800110801	Upper Middle Chugwater Creek
						101800110802	Lower Middle Chugwater Creek
						101800110803	Upper South Chugwater Creek
						101800110804	Lower South Chugwater Creek
						101800110805	Chugwater Creek-Threemile Creek
						101800110806	Chugwater Creek-North Chugwater Creek
						101800110807	Chugwater Creek-Dry Creek-Laramie River
						101800110808	Chugwater Creek-Chugwater
				1018001109	Lower Chugwater Creek	101800110901	Upper Richeau Creek
						101800110902	Lower Richeau Creek
						101800110903	Chugwater Creek-Dry Creek
						101800110904	Hunton Creek
						101800110905	Chug Spring
						101800110906	Chugwater Creek-Antelope Road



Map ID	Subwatershed Name (HUC 12)	Map ID	Subwatershed Name (HUC 12)	Map ID	Subwatershed Name (HUC 12)
1	Bear Creek-North Laramie River	20	Laramie River-Laramie River Ditch	39	North Laramie River-Bar M Creek
2	Brush Creek-Sybille Creek	21	Laramie River-Luman Creek	40	North Laramie River-Big Draw
3	Cherry Creek	22	Laramie River-Marble Query Spring	41	North Laramie River-Cow Creek
4	Chug Spring	23	Laramie River-Preemption Creek	42	North Laramie River-Coyote Creek
5	Chugwater Creek-Antelope Road	24	Laramie River-Sixmile Creek	43	North Laramie River-Owen Creek
6	Chugwater Creek-Chugwater	25	Laramie River-Slate Creek	44	Pinto Creek
7	Chugwater Creek-Dry Creek	26	Lower Bluegrass Creek	45	Sturgeon Creek
8	Chugwater Creek-Dry Creek-Laramie River	27	Lower Duck Creek-Dry Laramie River	46	Twentytwo Mile Draw
9	Chugwater Creek-North Chugwater Creek	28	Lower Middle Chugwater Creek	47	Upper Bluegrass Creek
10	Chugwater Creek-Threemile Creek	29	Lower North Sybille Creek	48	Upper Duck Creek-Lower Duck Creek
11	Deadhead Creek	30	Lower Richeau Creek	49	Upper Middle Chugwater Creek
12	Deer Creek-Laramie River	31	Lower South Chugwater Creek	50	Upper North Sybille Creek
13	Dry Laramie River	32	Lower South Fork Sybille Creek	51	Upper Richeau Creek
14	Dwery Cemetary	33	Lower Sybille Creek	52	Upper South Chugwater Creek
15	Eagles Nest Canyon	34	Middle Bluegrass Creek	53	Upper South Fork Sybille Creek
16	Fish Creek-North Laramie River	35	Middle North Sybille Creek	54	Upper Sybille Creek
17	Hunton Creek	36	Middle Sybille Creek	55	Wheatland Creek
18	Laramie River-Dodge Creek	37	Mule Creek-Sybille Creek		
19	Laramie River-Grayrocks Reservoir	38	North Laramie River-Antelope Creek		

Data Source:
Wyoming Geospatial Hub
USGS National Hydrography Dataset

Legend

- City
- Stream
- Primary Roads
- Lakes
- Study Area
- Counties

0 5 10
Miles

N S E W

Figure 5.1-1 Lower Laramie River Watershed: Hydrologic Units and USGS Stream Gages

5.2 Surface Hydrology

5.2.1 Summary of Existing Data

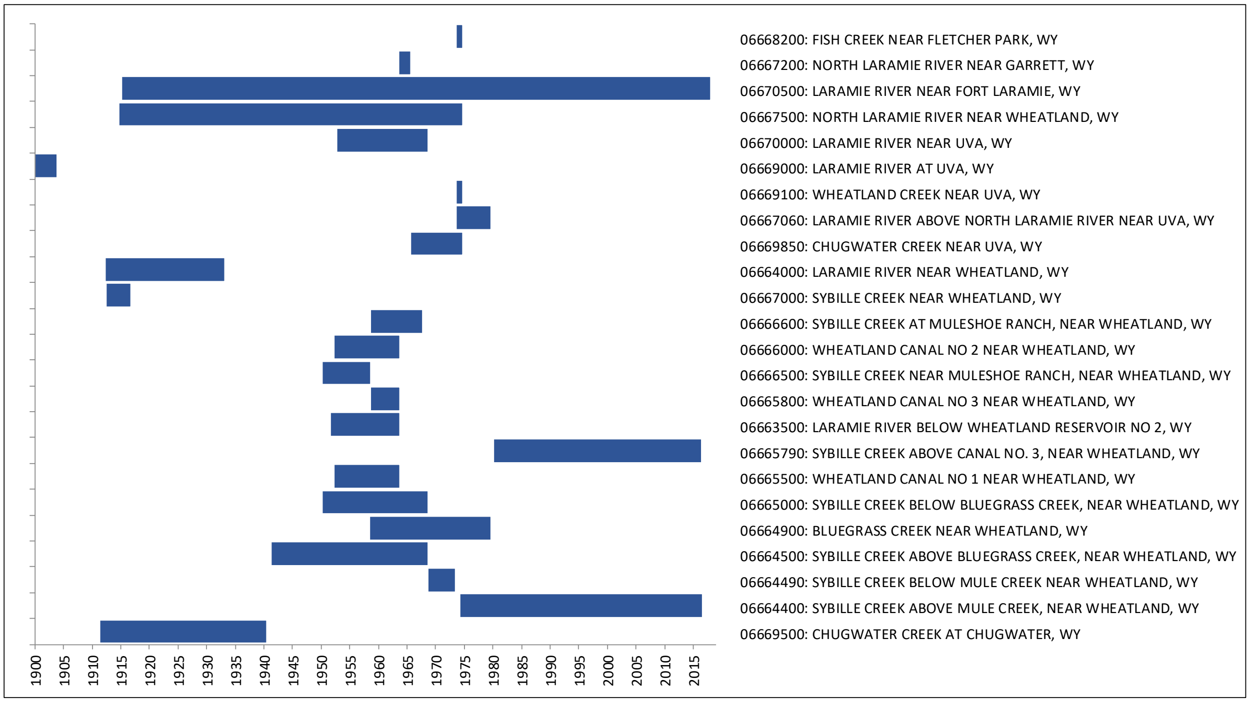
There are currently three active USGS stream gaging stations within the watershed (Figure 5.1-1). As indicated in Figure 5.2-1, historically, twenty-four gages have been active. However, twenty-one of the gages have been discontinued by the USGS (the last one being discontinued in 1979), leaving the basin with only three active gages. In addition, the Wyoming State Engineer's Office maintains gages on streams, irrigation canals/ditches and reservoirs. Table 5.2-1 tabulates the WSEO gages within the study area.

5.2.2 Mean Annual Discharge Estimation

Mean monthly discharges were computed using the available data from the active USGS gages and are presented in Table 5.2-2. The mean annual hydrographs at this gage location reflects typical snowmelt driven runoff patterns. The bulk of the annual runoff occurs between April and July. The late summer through fall months (August through October) see steep declines in streamflow as the streams return to baseflow conditions through the winter. Figure 5.2-2 displays the mean annual hydrograph at the active gage site within the study area.

Mean annual discharge was also computed for each of the 55 subwatersheds (HUC12) within the study area using regional methods described by Lowham (1988). The methodology used to compute these discharges relies upon statistical relationships between basin area, mean annual precipitation and measured stream discharge. Output from the Lowham process represents total annual runoff per square mile. Results of this analysis are presented in Figure 5.2-3.

Using the available climate data, precipitation and mean annual discharge was also estimated for "wet" and "dry" years at each of the subwatersheds. Using the Sybille Research Unit, Double Four Ranch, Wheatland 4 N, and Chugwater climate stations, the annual precipitations recorded within the last 40 years were sorted and divided into "wet" (top 20%), "dry" (bottom 20%), and "normal" (middle 60%) years. Figures 5.2-4 through 5.2-7 show this analysis for each station. Each HUC12 was associated with a climate station based on Thiessen polygons. Then the average "wet" and "dry" annual precipitation values were inserted into the Lowham equations to estimate "wet" and "dry" mean annual flow. Appendix 5A presents the results in a tabular format. These data can be used in planning potential water development projects such as stock reservoirs. Using the mean annual yield per square mile for the appropriate sub-basin, approximate yield can be pro-rated for a specific area.



Site Number	Site Name	Site Status	Beginning	End	Drainage Area (sq. miles)	Gauge Elevation (ft, NGVD29)
06668200	FISH CREEK NEAR FLETCHER PARK, WY	Inactive	10/1/1973	9/30/1974	6.33	N/A
06667200	NORTH LARAMIE RIVER NEAR GARRETT, WY	Inactive	8/1/1963	9/30/1965	46	7230
06670500	LARAMIE RIVER NEAR FORT LARAMIE, WY	Active	4/1/1915	3/15/2018	4564	4220
06667500	NORTH LARAMIE RIVER NEAR WHEATLAND, WY	Inactive	10/1/1914	9/30/1974	370	4840
06670000	LARAMIE RIVER NEAR UVA, WY	Inactive	10/1/1952	9/30/1968	4440	4375
06669000	LARAMIE RIVER AT UVA, WY	Inactive	5/1/1895	10/31/1903	3662	4450
06669100	WHEATLAND CREEK NEAR UVA, WY	Inactive	10/1/1973	9/30/1974	56.7	N/A
06667060	LARAMIE RIVER ABOVE NORTH LARAMIE RIVER NEAR UVA, WY	Inactive	10/1/1973	9/30/1979	3131	N/A
06669850	CHUGWATER CREEK NEAR UVA, WY	Inactive	10/1/1965	9/30/1974	654	N/A
06664000	LARAMIE RIVER NEAR WHEATLAND, WY	Inactive	5/1/1912	2/28/1933	2527	4595
06667000	SYBILLE CREEK NEAR WHEATLAND, WY	Inactive	6/1/1912	10/31/1916	515	4630
06666600	SYBILLE CREEK AT MULESHOE RANCH, NEAR WHEATLAND, WY	Inactive	10/1/1958	9/30/1967	508	4700
06666000	WHEATLAND CANAL NO 2 NEAR WHEATLAND, WY	Inactive	5/1/1952	9/30/1963	N/A	4769
06666500	SYBILLE CREEK NEAR MULESHOE RANCH, NEAR WHEATLAND, WY	Inactive	4/1/1950	9/30/1958	507	4740
06665800	WHEATLAND CANAL NO 3 NEAR WHEATLAND, WY	Inactive	10/1/1958	9/30/1963	N/A	4980
06663500	LARAMIE RIVER BELOW WHEATLAND RESERVOIR NO 2, WY	Inactive	10/1/1951	9/30/1963	2248	6884
06665790	SYBILLE CREEK ABOVE CANAL NO. 3, NEAR WHEATLAND, WY	Active	4/1/1980	6/30/2016	N/A	5040
06665500	WHEATLAND CANAL NO 1 NEAR WHEATLAND, WY	Inactive	5/1/1952	9/30/1963	N/A	5190
06665000	SYBILLE CREEK BELOW BLUEGRASS CREEK, NEAR WHEATLAND, WY	Inactive	4/1/1950	9/30/1968	366	5220
06664900	BLUEGRASS CREEK NEAR WHEATLAND, WY	Inactive	8/1/1958	9/30/1979	139	5250
06664500	SYBILLE CREEK ABOVE BLUEGRASS CREEK, NEAR WHEATLAND, WY	Inactive	4/1/1941	9/30/1968	225	5246
06664490	SYBILLE CREEK BELOW MULE CREEK NEAR WHEATLAND, WY	Inactive	10/1/1968	7/31/1973	219	5325
06664400	SYBILLE CREEK ABOVE MULE CREEK, NEAR WHEATLAND, WY	Active	4/1/1974	10/1/2016	194	5340
06669500	CHUGWATER CREEK AT CHUGWATER, WY	Inactive	5/1/1911	6/30/1940	349	5270

Figure 5.2-1 Period of Record for Study Area Stream Gages.

Table 5.2-1 Wyoming State Engineers Office Gages in the Project Study Area.

Station ID	Station Name	WSEO Division / District	Start of Record
014AWO	Wheatland Reservoir No. 2 Outflow	Division 1 / District 04A	7/6/2009
014AWR	Wheatland Reservoir No. 2 Reservoir	Division 1 / District 04A	10/7/2008
014CSMUL	Sybille Creek above Mule Creek (USGS COOP)	Division 1 / District 04C	7/6/2009
014AR3SC	Wheatland Reservoir No. 3 Supply Canal	Division 1 / District 04A	4/3/2013
014AR3O	Wheatland Reservoir No. 3 Outflow	Division 1 / District 04A	4/3/2013
014CN1CS	No. 1 Canal Sybille	Division 1 / District 04C	7/6/2009
014CSCN3	Sybille Creek above Canal No. 3	Division 1 / District 04C	7/6/2009
014CWT	Wheatland Tunnel	Division 1 / District 04C	7/6/2009
014CLRBT	Laramie River below Wheatland Tunnel	Division 1 / District 04C	7/6/2009
014CLRCR	Laramie River Above the Cramer Ditch	Division 1 / District 04C	7/6/2009
014CWR1	Wheatland Reservoir #1	Division 1 / District 04C	2/12/2010
014CGRIN	Grayrocks Inflow	Division 1 / District 04C	5/26/2010
014CGROT	Grayrocks Outflow	Division 1 / District 04C	5/26/2010
06670500	Laramie River nr. Fort Laramie, WY	Division 1 / District 14	11/12/2009

Table 5.2-2 Mean Monthly Discharges for Active Stream Gages.

Month	Mean Stream Discharge (cfs)		
	LARAMIE RIVER NEAR FORT LARAMIE, WY	SYBILLE CREEK ABOVE CANAL NO. 3, NEAR WHEATLAND, WY	SYBILLE CREEK ABOVE MULE CREEK, NEAR WHEATLAND, WY
USGS ID	06670500	06665790	06664400
Period of Record	4/1/1915 to Present	4/1/1980 to Present	4/1/1974 to Present
Jan	76		
Feb	83		
Mar	104	26	7.8
Apr	148	55	31
May	422	125	82
Jun	335	84	49
Jul	134	79	23
Aug	66	66	13
Sep	60	33	6.4
Oct	62	29	4.2
Nov	71		
Dec	76		

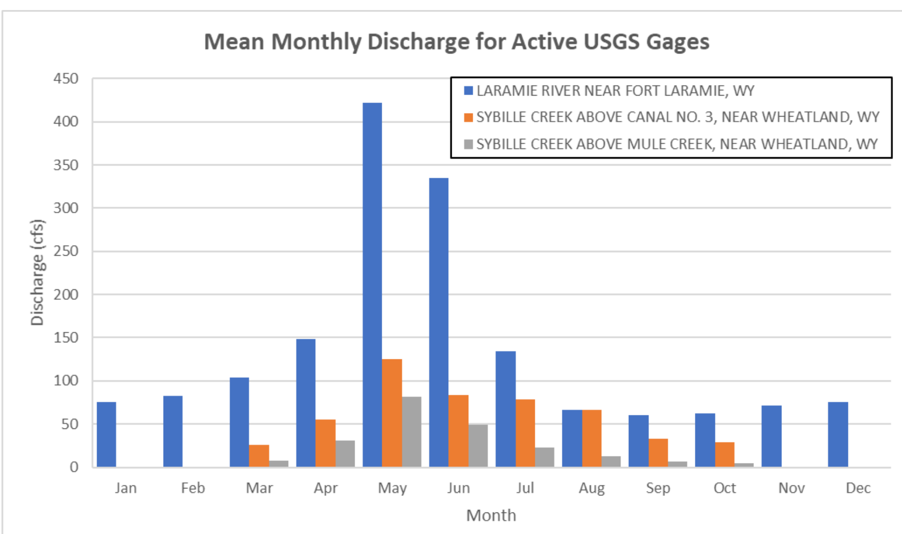


Figure 5.2-2 Mean Monthly Discharge at Selected USGS Stream Gages.

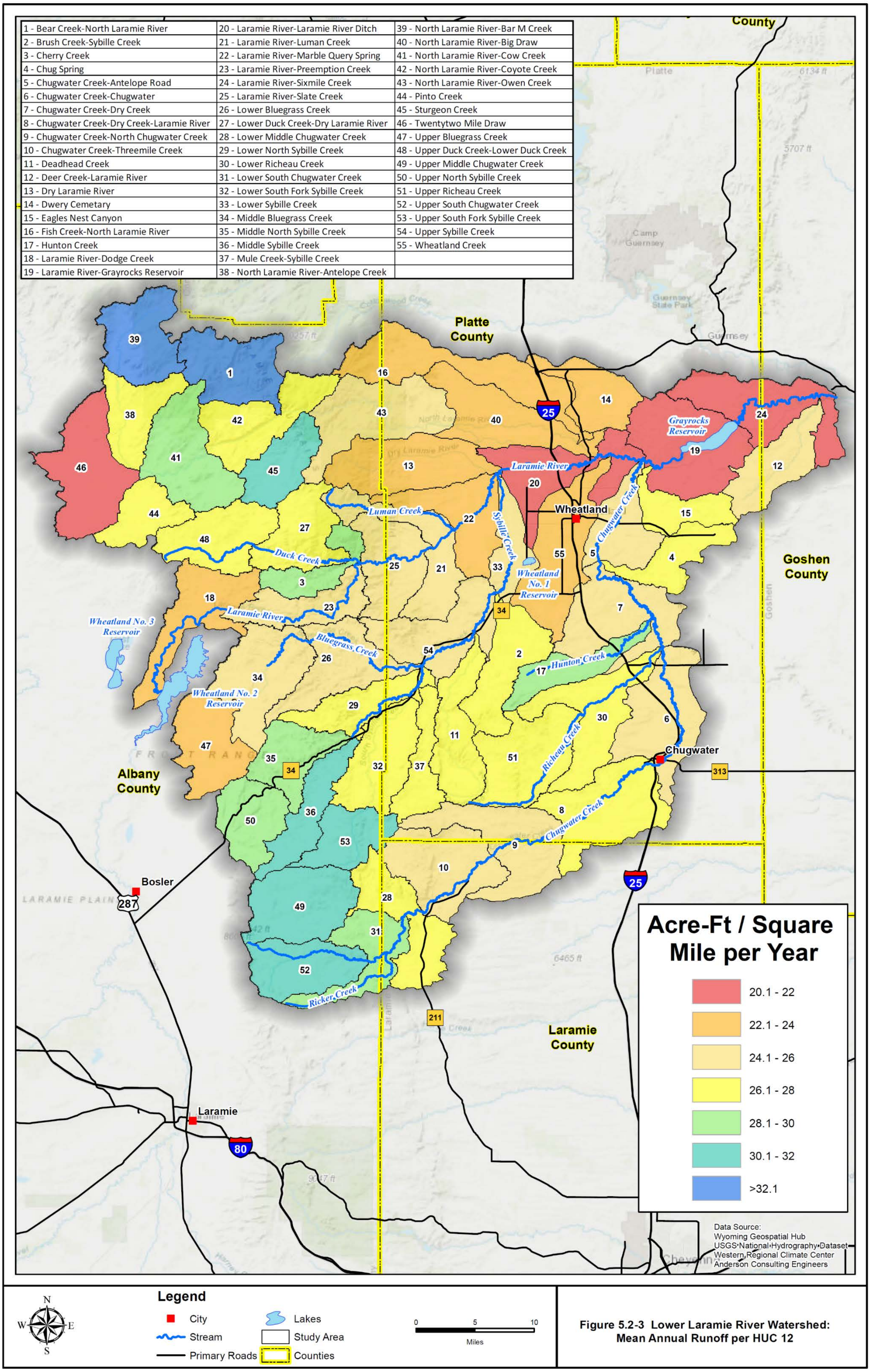


Figure 5.2-3 Lower Laramie River Watershed: Mean Annual Runoff per HUC 12

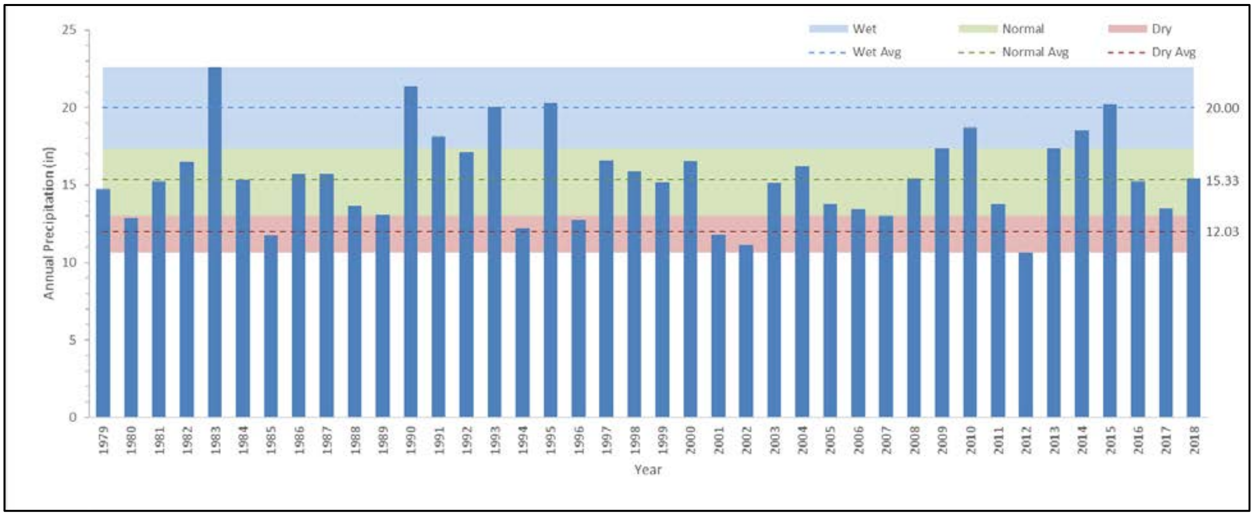


Figure 5.2-4 Sybille Research Unit, WY Station (1979-2018) – Wet/Dry Classification.

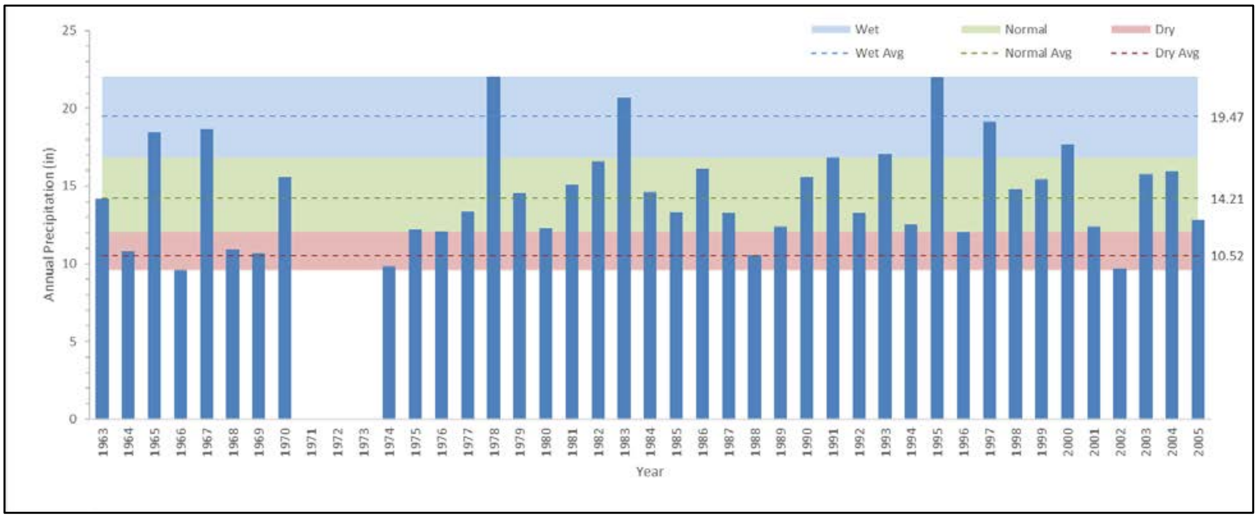


Figure 5.2-5 Double Four Ranch, WY Station (1963-2005)– Wet/Dry Classification.

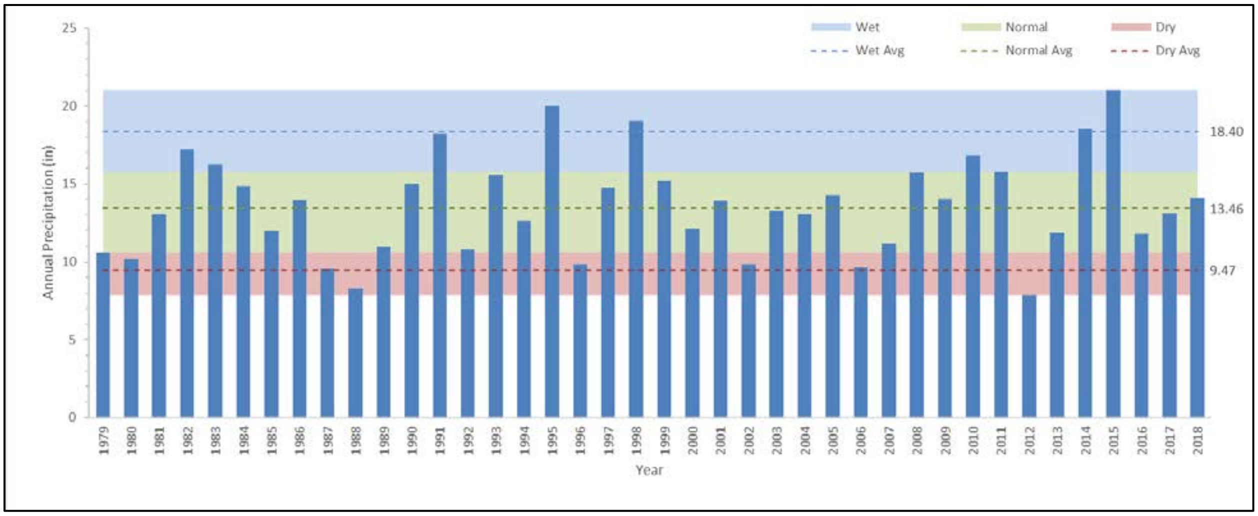


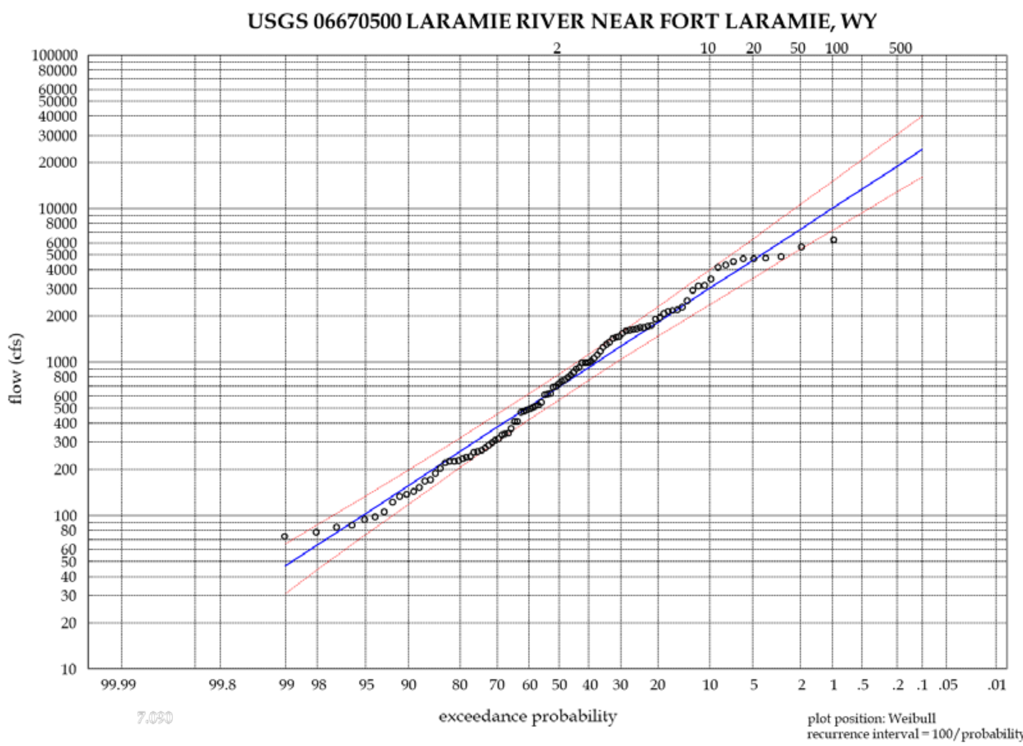
Figure 5.2-6 Wheatland 4 N, WY Station (1979-2018)– Wet/Dry Classification.

Figure 5.2-7 Chugwater, WY Station (1979-2018)– Wet/Dry Classification.

5.2.3 Peak Flow Estimation and Flooding

Using regional methods described by the USGS (Miller, 2003), peak flow characteristics were calculated for each of the 55 subwatersheds (HUC12) within the study area. The methodology used to compute these discharges is based upon regression analyses of gaged data against various basin characteristics. Most of the study area lies in the Eastern Basins and Eastern Plains region, while a few of the higher elevation watersheds lie in the Rocky Mountain region, as designated by Miller (2003). For the Rocky Mountain region, which is mostly forested with some alpine areas and some open woodlands, the peak flow is calculated using basin area, elevation, and longitude. Annual peak flows in this region are driven by snow melt in late spring and early summer. The Eastern Basins and Eastern Plains region is generally characterized as semiarid grassland where peak annual flow is calculated using basin area and mean soil hydrologic index. These estimates are intended to be used for regional planning efforts only. Project-specific estimates would be required before design of future watershed projects (ex. reservoir storage). Appendix 5B presents the results of this effort.

Flood frequency calculations were completed for the USGS stream gages with a sufficient period of record (10 years) to complete the analysis. The Log-Pearson III methodology (Water Resources Council, 1977) was used to estimate peak discharge associated with the 2-year through the 500-year events. Figure 5.2-8 displays the results of the analysis for the USGS Gage 06670500 Laramie River near Fort Laramie, WY. Appendix 5C contains the results of this analysis.



Recurrence (years)	Q (cfs)
500	18,962
200	13,389
100	10,047
50	7,340
25	5,177
20	4,582
10	3,015
5	1,815
2	687

Figure 5.2-8 Flood Frequency Analysis: USGS Gage 06670500.

Areas burned by wildfires can be highly susceptible to erosion and sedimentation, due to the loss of vegetation. The Britania Mountain Fire burned 32,089 acres in September 2018 northwest of Wheatland, and just south of the North Laramie River. Figure 5.2-9 shows a map of the Britania Mountain Fire provided by the Rocky Mountain Incident Management team (last updated on 9/6/18). Seeding and mulching may be used to reduce runoff and erosion from burned areas while silt fences may be used to restrict the transfer of sediment from burned areas into drainageways.

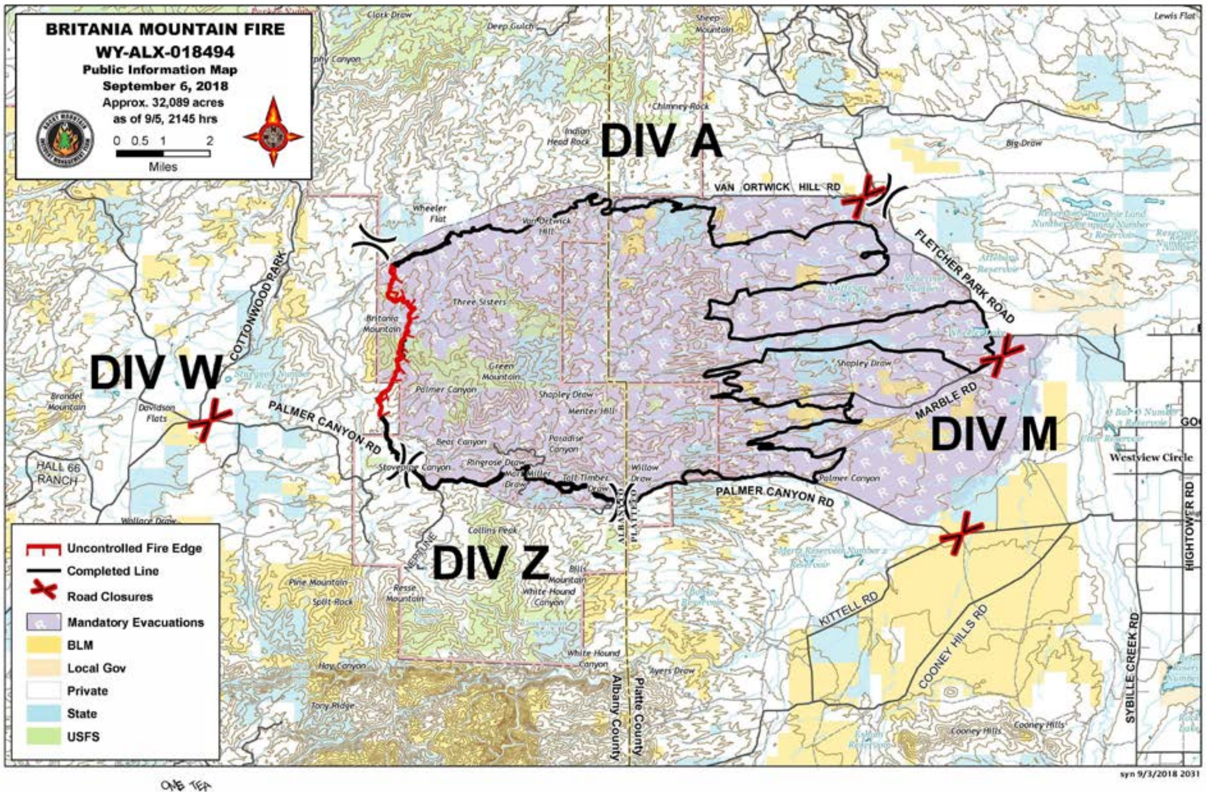


Figure 5.2-9 Britania Mountain Fire (September 6, 2018).

The Federal Emergency Management Agency (FEMA) has mapped floodplains within the Town of Wheatland. Figure 5.2-10 shows a portion of Flood Insurance Rate Map (FIRM) 560043-0005B. Areas designated as Zone A are within the 100-yr floodplain. Areas designated as Zone B are between the limits of the 100-yr and 500-yr floodplains. Flooding from Rock Creek has caused loss of life and damage to property, railways, roadways in Wheatland, such as in May 1935, May 1938, and June 1949. Heavy rains and hail have caused flooding and crop damage to rural areas near Wheatland – notably in July 1962, July 1984, and June 1987 (Water Resources Data System, University of Wyoming). The North Laramie River and its tributaries periodically flood due to heavy rains or snow in the Laramie Mountains (e.g. May 1965, June 1970, June 1987, and June 1995). Flash floods have also been experienced in Palmer Canyon (July 1976), Sybille Canyon (August 1990 and June 1991), Dead Horse Creek (July 1996), and southwest of Chugwater (Sept 1996). In 1969, the west dam of Wheatland Reservoir No. 1 was breached, inundating downstream areas along Sybille Creek. Families were forced to evacuate, and the flood reportedly caused $1 million in damages to crops and livestock.

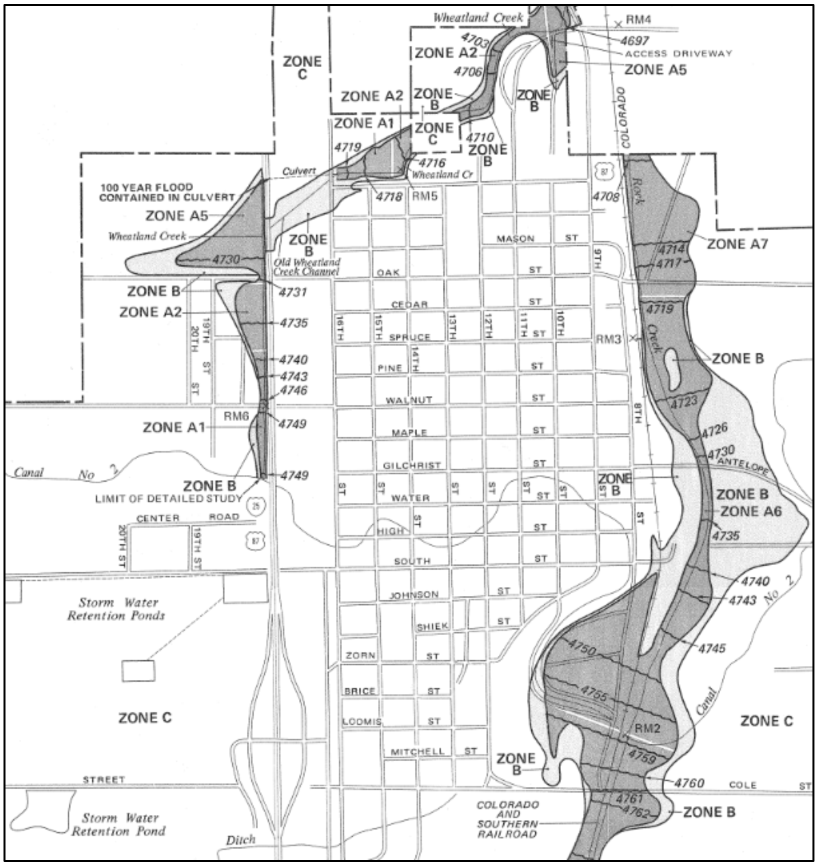


Figure 5.2-10 FEMA Map for the Town of Wheatland.

VI. TASK 5: MANAGEMENT AND REHABILITATION PLAN

6.1 Overview

One of the principal objectives of this Level I study is to generate a watershed management and rehabilitation plan that is technically sound, practical in nature, and economically feasible. During the completion of the watershed inventory and characterization phase of the project, we met with as many landowners/stakeholders at their properties as possible to document their resource-related concerns and to develop the list of projects discussed in this chapter.

Potential improvements were developed and categorized into the following:

- **Irrigation System Conservation and Rehabilitation:** The inventory and evaluation of existing infrastructure was completed and improvements were identified.
- **Livestock/Wildlife Upland Watering Opportunities:** Based upon an evaluation of existing water sources and the condition of upland grazing resources, potential upland water source development projects were identified.
- **Grazing Management Opportunities**: Based upon a review of the pertinent Ecological Site Descriptions (ESDs) and the ambient vegetation and soil conditions, grazing strategies are presented.
- **Environmental Enhancement Opportunities**: Several projects were identified which would fall under the category of stream channel stability and environmental enhancement; including stream bank stabilization, wetland enhancement and fisheries-related opportunities.
- **Aquatic Vegetation Management**: The issue of management of aquatic vegetation was discussed early in the project. Projects identified under this component of the watershed management plan address potential options that could be employed by individuals or entities to manage nuisance aquatic vegetation in irrigation conveyance systems.

Where pertinent, conceptual designs were prepared for the identified projects. These can be found in Appendix 6A of this document. These plans have been prepared to provide an overview of potential improvements that can partially or fully address the key issues identified within the watershed. Figure 6.1-1 displays the locations of the projects.

Disclaimer: It is important to note that all project recommendations presented in this report are conceptual only and are intended to provide sufficient information to initiate projects and to apply for funding through various funding mechanisms; implementation will require engineering analysis and design. Also, there are no requirements that these projects be ultimately implemented; participation is totally voluntary. Furthermore, the South Goshen Conservation District has no obligation to participate as sponsor of projects for potential funding. Decisions to sponsor a project will be made by the SGCD board on a case by case basis.

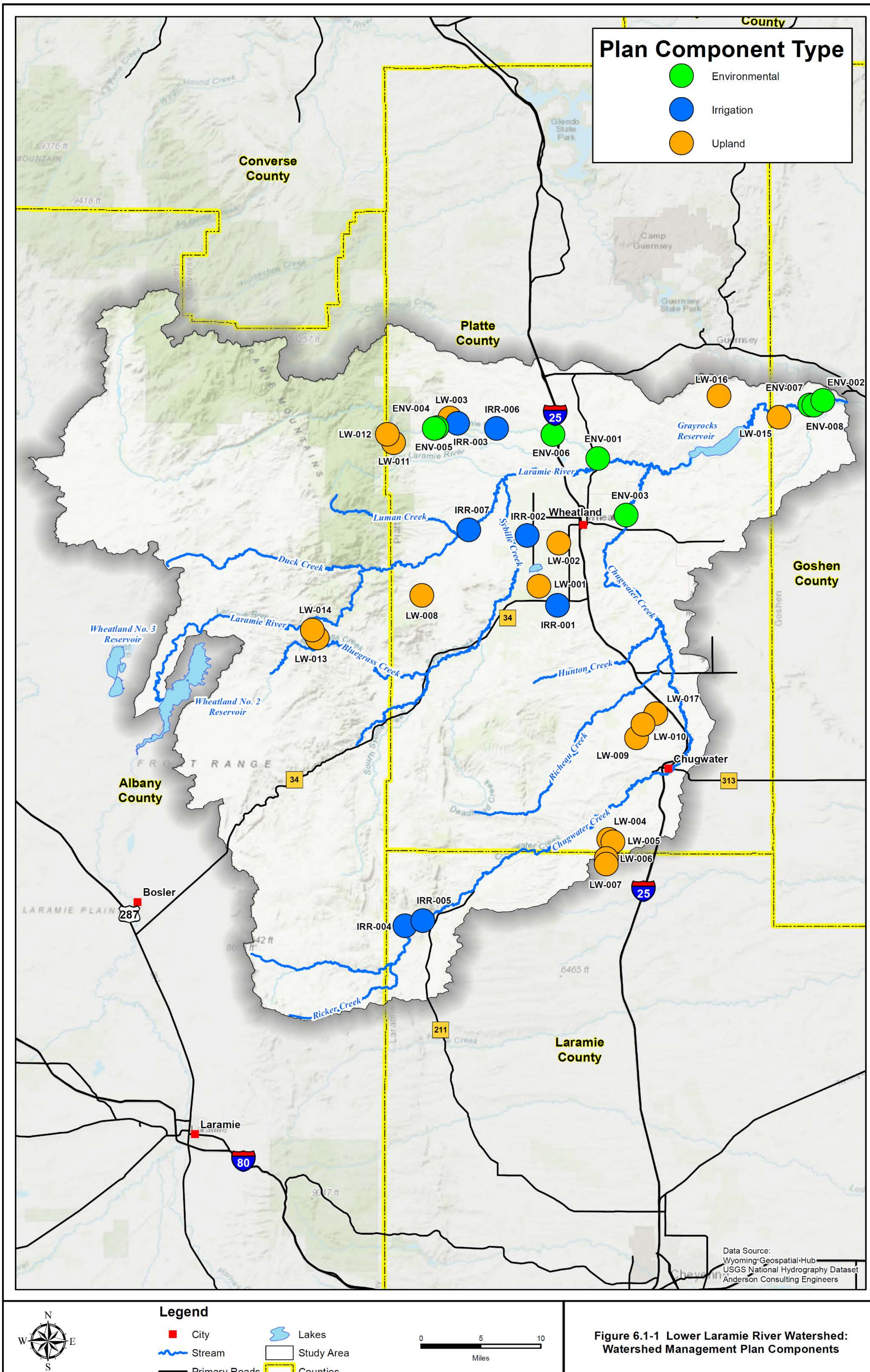


Figure 6.1-1 Lower Laramie River Watershed: Watershed Management Plan Components

6.2 Benefits of Watershed Planning

The Wyoming Water Development Commission's (WWDC) Level I Watershed Study is a fundamental landscape analysis confined to a hydrologically connected drainage area or watershed and is focused on two primary components. The first is an identification of the physical attributes of that analysis area. This is accomplished by conducting a comprehensive inventory of the natural resources and subsequently using that inventory to articulate a description of the current natural resource conditions. The second is a long range plan outlining management and/or rehabilitation opportunities and activities that address ecological enhancement and watershed function.

Best management practices (BMPs) and conservation practices are eligible for grant funding assistance through the WWDC's Small Water Project Program (SWPP). The WWDC's SWPP funds are mainly used for installing BMPs and conservation practices such as stock ponds, water wells, buried water delivery pipelines, stock tanks, spring developments, solar platforms and pumps, wetland enhancement and restoration, windmills, and irrigation diversion and conveyance improvements.

To assist decision makers with the evaluation of various BMPs, the NRCS prepares Network Effects Diagrams, or "NEDs". The NEDs "are flow charts of direct, indirect and cumulative effects resulting from installation of the practices. Completed network diagrams provide an overview of expert consensus on the environmental effects of installing proposed practice installation. They show the potential positive and negative outcomes of practice installation and are useful as a reference point for next steps, and as a communication tool with partners and the public" [Natural Resources Conservation Service, 2014].
The NRCS NEDs are available at the website:
(https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/).

Benefits associated with a particular BMP can be classified as direct, indirect or cumulative. Direct and indirect benefits would be considered measurable or tangible benefits. For example, construction of a reservoir designed to augment late season irrigation water supplies provides the direct or measurable benefit, of providing a supply of water commensurate with its storage capacity. An indirect benefit could be the habitat provided to wildlife. Likewise, the same reservoir could provide the cumulative benefit of increased income to producers and improved health of the local economy. Benefits can be either quantitative or qualitative or both. Benefits can be local or global and specific or surrogate, depending on multiple factors unique and specific to the BMP, ecological site, watershed, or major land resource area. Project benefits can be related to ecological enhancement, water quantity, economic stability, stream corridor or riverine stability, or maintenance of open spaces.
Appendix 6B contains a discussion of the benefits of watershed management planning and the NEDs. This information is included to provide the conservation district with additional information pertinent to their planning and decision-making efforts.

6.3 Water Rights Considerations

Prior to the discussion of any water development projects, an understanding of Wyoming water law as it pertains to the proposed Watershed Management Plan is important.

As with many Wyoming watersheds, the Lower Laramie is subject to a variety of additional water administration issues unique to its water supply characteristics and location with respect to neighboring states. Specifically, the following decrees apply to the area:

- Modified North Platte Decree (2001)
- Laramie River Decree (1922)
- Platte River Recovery and Implementation Program (PRRIP) (2001)

Appendix 6C presents a summary of these decrees and their applicability to the study area. With respect to the types of small water projects contemplated under this Watershed Plan, the implications of the decrees are:

1. All new water uses or changes to existing water uses for which the change involves the type of use, point of diversion, or place of use, or increases the amount of use, require a permit from the Wyoming State Engineer.
2. Permits for stock and domestic wells (<25 gpm) are generally obtained without great difficulty, do not generally require mitigation, and do not require review by the Platte County Control Area Board.
3. Permits for groundwater use within areas that have been designated "not hydrologically connected" (i.e. the "green" areas of Figure 6.3-1 as described in Appendix 6C) are not subject to the limitations of the Modified North Platte Decree or the PRRIP.
4. Permits for which equivalent depletions are being retired, e.g. on the same property or elsewhere, do not require further mitigation under the PRRIP.
5. The degree of scrutiny to which a new water use will be subject and the requirements under which that use will be allowed to proceed are a function of the type, quantity, and season of use. Large, non-irrigation season uses that require new water rights are the least likely to be approved without full mitigation.
6. Any questions about the information necessary to obtain a new water right or to make significant changes to an existing water right should be directed to the North Platte Coordinator in the Wyoming State Engineer's Office in Cheyenne.

6.4 Irrigation System Components (IRR)

As presented in Chapter 4, the irrigation system inventory effort associated with this project consisted of the evaluation of structures and ditch conditions at the request of interested landowners and stakeholders. No ditch systems were inventoried in their entirety. Instead, and at the request of those individuals who came forward with requests to participate in the study, individual irrigation system components were inspected.

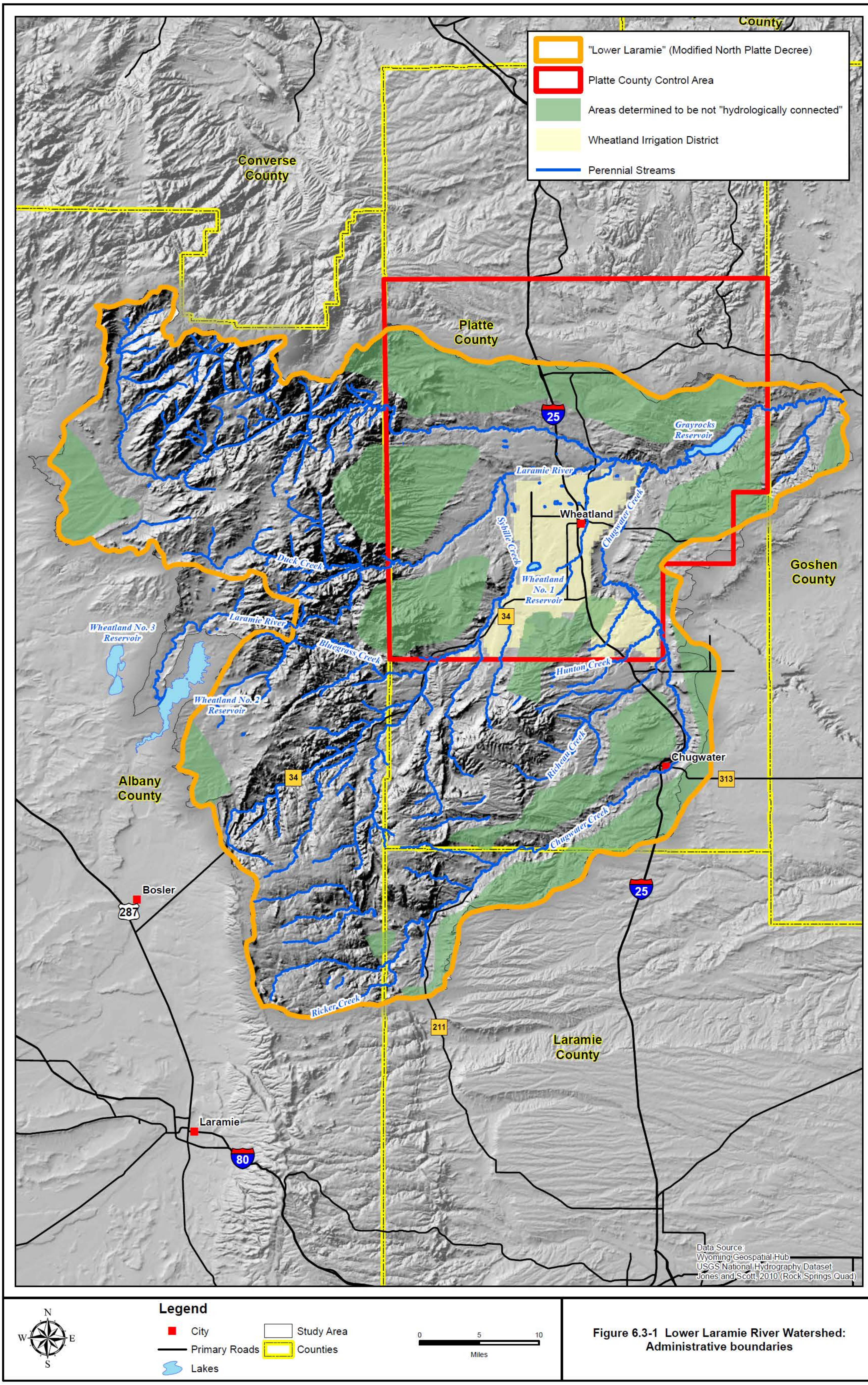


Figure 6.3-1 Lower Laramie River Watershed: Administrative boundaries

Through the project outreach efforts, several individual landowners came forward with requests for the project team to assess existing infrastructure (Appendix 6A). Table 6.4-1 tabulates the specific irrigation projects included in the watershed management plan. Recommendations included herein are not all-inclusive; there will be additional irrigation structures located throughout the watershed in need of rehabilitation or replacement. Potential projects involving those structures may still be considered eligible for application funding through the WWDC Small Water Project Program (SWPP).

Table 6.4-1 Lower Laramie River Watershed Plan: Irrigation Components.

Lower Laramie River Watershed Management Plan			
Watershed Management Plan Component	**Sponsor Reference**	**Project Name**	**Description**
Irrigation Components			
IRR-001	Christinic-001	Christinic Pipeline Conversion Project	Convert Open Ditch to Buried Pipeline
IRR-002	Cochorn-001	Cochorn Pipeline Conversion Project	Convert Open Ditch
IRR-003	Faris-002	Faris Pipeline Project	Install Pipeline within Conveyance System
IRR-004	Farthing-001	Iron Mountain Ditch No. 2 Headgate Replacement Project	Replace Failing Headgate
IRR-005	Farthing-002	Davidson Ditch Headgate Replacement Project	Replace Failing Headgate
IRR-006	Kontour-001	Kontour Headgate Replacement Project	Replace Failing Headgate
IRR-007	Schockley-001	Schockley Headgate Project	Replace Headgate/Ditch Lost to Bank Erosion

The specific types of improvements that comprise this component of the watershed management plan include:

- Rehabilitation/replacement of existing structures
- Mitigation of seepage losses
- Enhanced delivery of water
- Reduction in annual operation and maintenance costs
- Improvement in ditch management and efficiency through water measurement

Many direct and indirect effects and benefits of rehabilitating and improving water conveyance for irrigation systems exist and include the following:

- Water availability for irrigation
- Plant growth and productivity
- Reduced infiltration and evaporation losses
- Increased plant growth and productivity
- Decreased leaching of nutrients

- Reduced erosion associated with practice
- Decreased sediment delivery to surface waters.

6.5 Livestock/Wildlife Water Components (L/W)

6.5.1 Overview

Developing reliable watering facilities in areas that otherwise lack these facilities for livestock and wildlife help to promote improved rangeland conditions in several ways. Water facilities may be associated with wells, springs, streams, ponds, or hauled water. Reliable sources of water are integral aspects of any range management plan that involves distributing livestock.

Placing water facilities typically involves the following strategies:

- Facilitating prescribed grazing-management plans
- Providing alternative water supplies to riparian sources
- Providing a reliable source where no other sources may exist
- Optimizing upland range resources.

Many direct and indirect effects and benefits of providing reliable water facilities for livestock and wildlife exist and include the following:

- Controlled access to streams, ponds, water supplies, and sensitive areas (when combined with proper fencing)
- Decreased loading of pathogens, sediments, and nutrients to existing surface waters
- Improved water quality, quantity, and distribution of livestock and wildlife
- Increased plant productivity
- Improved wildlife habitat
- Increased species diversity
- Increased livestock food sources

Based upon the premise that existing water sources are capable of providing water to livestock within a one-mile radius, buffers were drawn around existing water sources (functional stock reservoirs and developed springs) discussed in Chapter 4 (Figure 6.5-1). Note that this figure does not show buffers around perennial/intermittent streams undeveloped springs or stock tanks. A general objective of this effort was to provide means of providing reliable sources of livestock/wildlife drinking water as alternative water supplies to riparian corridors. As indicated in this figure, portions of the study area appear to be adequately supplied with water sources. However, it is important to note that many of these sources are stock reservoirs located on intermittent/ephemeral channels and are consequently reliant upon uncertain runoff. Long-term or season-long utility is not always certain, consequently, these water sources can be considered somewhat unreliable.

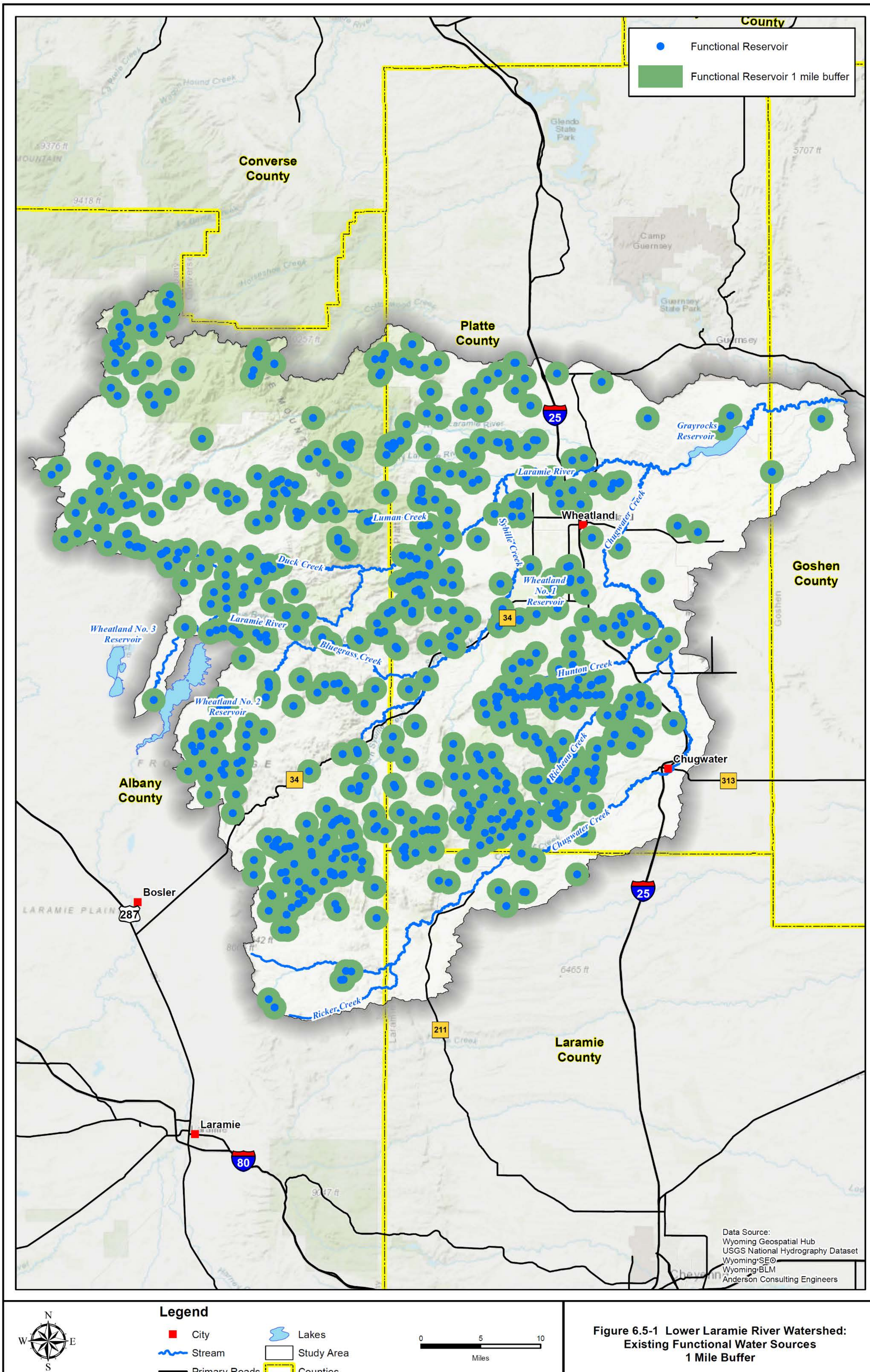


Figure 6.5-1 Lower Laramie River Watershed: Existing Functional Water Sources 1 Mile Buffer

Landowners / stakeholders indicated locations where existing sources could benefit from enhanced or improved infrastructure. Conceptual plans and project descriptions were developed for 38 recommended projects as tabulated in Table 6.5-1. (See Appendix 6A for descriptions and conceptual designs). Typical projects include rehabilitation of existing stock reservoirs, spring developments and construction of pipeline/stock tank systems, and construction of new wells or rehabilitation of existing wells.

As presented in Chapter 4, there are numerous springs scattered throughout the study area. Many of these could conceivably be developed as upland water sources for wildlife and livestock. Prior to the design of any project, site-specific evaluation of the water source would be required to ensure adequate water yield and to develop environmental safeguards. Final design of any upland water projects would consequently require consideration of the yield of the water source and the number of animals the project is anticipated to serve. Appendix 6D contains information pertinent to the design and construction of livestock and wildlife water source improvements.

For the purposes of this project, watering facilities were assumed to consist of rubber tire stock tanks providing approximately 1,200 gallons of storage. This volume would facilitate the water needs of approximately 80 cattle per day assuming a water requirement of 15 gallons per day. A water source capable of providing 1 gallon per minute would be required to supply these facilities. By incorporating closed storage tanks in a project design, greater use of existing water sources could be realized.

In addition, environmental evaluations would be required for the impacts identified with each project involving federal lands. BLM typically conducts these evaluations when BLM lands are involved; however, the WGFD, NRCS or other agencies may provide input, particularly on archaeological or cultural resources issues. Consequently, implementation would be partially contingent upon BLM scheduling and manpower for completion of the requisite evaluation and documentation.

It must be kept in mind that designs presented in this report are conceptual only. The indicated alignments of pipelines and placement of livestock / wildlife watering facilities are general and intended to represent the concept behind the alternatives. If implemented, detailed design would be required.

6.5.2 Well Siting and Design Considerations

Many of the Livestock/Wildlife water supply components of the Lower Laramie River Watershed Management Plan include either construction of new groundwater wells or rehabilitation/enhancement of existing wells. As previously discussed in Chapter 4.2, while one can make generalizations about the availability and quality of groundwater in various formations, groundwater development is inherently both site specific and use specific. Because both the availability and quality of groundwater and the specific requirements of a specific project with respect to these parameters vary widely, generic identification of suitable and unsuitable locations for development are difficult. Any significant commitment of groundwater development funds should be preceded by an appropriate level of site-specific investigation.

Table 6.5-1 Lower Laramie River Watershed Plan: Livestock/Wildlife Water Supply Components.

Lower Laramie River Watershed Management Plan			
Watershed Management Plan Component	Sponsor Reference	Project Name	Description
Livestock/Wildlife Water Supply Components			
L/W-001	Brant-001	Brant Stock Reservoir Rehabilitation Project	Rehabilitate Existing Sediment-Filled Stock Reservoir
L/W-002	Brown-001	Brown Well and Stock Tank Project	Construct New Well, Pipeline, and Stock Tank
L/W-003	Faris-001	Faris Well Replacement Project	Rehabilitate Existing Well System
L/W-004	Gillaspie-001	Gillaspie Spring Development Project 1	Replace Existing Spring Development/Pipeline/Tank
L/W-005	Gillaspie-002	Gillaspie Spring Development Project 2	Replace Existing Spring Development/Pipeline/Tank
L/W-006	Gillaspie-003	Gillaspie Solar Project 1	Install Solar Platform/Pump in Existing Well
L/W-007	Gillaspie-004	Gillaspie Solar Project 2	Install Solar Platform/Pump in Existing Well
L/W-008	Irvine-001	Irvine Stock Reservoir Rehabilitation	Rehabilitate Existing Stock Reservoir
L/W-009	Langseth-001	Langseth Well Construction Project 1	Construct New Well, Pipeline, and Stock Tank
L/W-010	Langseth-002	Langseth Well Construction Project 2	Construct New Well, Pipeline, and Stock Tank
L/W-011	Preston-001	Preston Stock Reservoir Rehabilitation Project	Rehabilitate Existing Stock Reservoir
L/W-012	Preston-002	Preston Stock Reservoir Construction Project	Construct New Stock / Wildlife Reservoir
L/W-013	Purdy-001	Purdy Spring Development Project 1	Construct New Spring Development/Tank
L/W-014	Purdy-002	Purdy Spring Development Project 2	Construct New Spring Development/Tank
L/W-015	Watson-001	Watson Pipeline Project 1	Construct New Pipeline/Tank System From Existing Well
L/W-016	Watson-002	Watson Pipeline Project 2	Construct New Pipeline/Tank System From Existing Well
L/W-017	West-001	West Well and Pipeline Construction Project	Construct New Well, Pipeline, and Stock Tank

Evaluation of the aquifers, groundwater use history, and groundwater administration for the Lower Laramie watershed provides the following general guidance:

- The most productive aquifer in the Lower Laramie watershed is created by the alluvial deposits along the lowest part of the Laramie River, particularly as it joins the alluvial aquifer along the North Platte River. This aquifer is of quite limited extent, however, only present beneath a narrow strip along the river.
- Similar deposits, although thinner and narrower, are present along the lower reaches of the perennial streams of the watershed and may support significant groundwater production in select areas.
- Over the wider area of the watershed, the highest potential for development of high-capacity wells is in the Arikaree Formation and the overlying stream terrace deposits. However, depths on the order of 500 feet may be necessary to obtain the desired yield, and long screened sections should be anticipated to accumulate sufficient permeable material to support production.
- Opportunities for development of high-capacity wells may be available in the older, carbonate and sandstone formations, but these are likely feasibly accessible only to wells in select areas adjacent to the mountain uplifts of the study area.
- Development of groundwater through most of the Lower Laramie watershed is subject to the special restrictions of the Modified North Platte Decree, which sets a cap on total irrigated acreage in the watershed, and the Platte River Recovery Implementation Program, which requires mitigation of all net depletions beyond 1997 baseline levels.
- Certain areas of the watershed, commonly termed “green areas” have been exempted from the provisions of those jurisdictions, and thus provide potentially less-encumbered development opportunities.
- Opportunities for development of small supplies of groundwater for uses without severe water-quality restrictions are widely available across the watershed, but cannot be specifically evaluated without site-specific data.

6.5.3 Site Specific Studies

Site specific studies were conducted for projects included in the Watershed Management Plan that involved construction of new wells or rehabilitation of existing wells. Reports of these efforts are incorporated directly into the individual project descriptions included as Appendix 6A. These reports are intended for inclusion with Small Water Project Program applications as supplemental information and to assist the PCRD with planning and prioritization efforts. The general strategies and approach used by the hydrogeologist is discussed in the following paragraphs.

As previously described, while one can make generalizations about the availability and quality of groundwater in various formations, groundwater development is inherently both site specific and use specific. For a surface water source, the availability of 5 cfs at point A can be approximately translated, minus intervening diversions, as 5 cfs at downstream point B. In contrast, a well at point A may produce 500 gpm of high quality water, whereas a well at point B, in a different formation nearby, may produce less than 10 gpm of poor-quality water.

Because both the availability and quality of groundwater vary widely, and because the requirements of a specific project with respect to quantity, quality, seasonality, etc. are unique to each proposed use, generic identification of "suitable" and "unsuitable" locations for development is virtually impossible. Any significant commitment of groundwater development funds should be preceded by an appropriate level of site-specific investigation.

The following guidelines may be helpful in that process:

- Best performance from any bedrock aquifer will be where whatever intrinsic permeability present is enhanced by fractures. In many cases, useful levels of fracturing may be associated with folds and faults that can be mapped at the surface (e.g. those previously presented in Chapter 4 on Figure 4.2-6 or on more detailed geologic mapping of specific areas).
- Groundwater quality limitations vary widely depending on the intended use; groundwater unsuitable for one use may be fully adequate for another. Less productive aquifers tend to have lower overall water quality, but groundwater quality, like quantitative productivity, can be critically site-specific
- Well siting should always look to take advantage of the experience of those who have gone before. The GIS products associated with this report contain information on permits developed through the Wyoming State Engineer's Office (SEO). Once a well is completed, the owner is required to file a Statement of Completion, which are now available electronically from the SEO website (https://sites.google.com/a/wyo.gov/seo/) under the groundwater permit number (listed for existing wells in the accompanying electronic files). In addition to basic information on owner, use, and depth, many of these statements describe the geologic materials encountered, at what depths groundwater was found, how the well was constructed, basic aquifer productivity test data and, sometimes, limited water-quality data
- Proximity to successful wells is always a valuable assessment approach, but should be tempered by consideration of whether or not the basic geology changes significantly between the reference and target locations.
- The classifications of Figure 4.2-11 provide a first-cut on the potential productivity of a specific area. Groundwater development in locations in the major aquitard classification (e.g. the granitic rocks of the Laramie Range) should be approached with the most caution.
- The geology of both Figures 4.2-6 and 4.2-11 has been generalized to a degree appropriate to the scale at which the referenced maps were published. While digital copies of mapping products are amenable to presentation at much larger scales, doing so cannot create detail unsupported by the original mapping. Figure 4.2-6 was compiled from the best-available mapping at a watershed scale, but more detailed geologic investigations may be available for specific areas. Where the underlying geology is unclear, the most detailed sources should be consulted for site specific evaluations. The US Geological Survey has published 1:24,000-scale geologic mapping for select quadrangles in the study area. These, and the smaller-scale geologic mapping used to compile Figure 4.2-6 are shown on Figure 6.5-2. These maps do not address groundwater conditions specifically, but provide additional local detail on the distribution and character of the geologic

strata present. Many of these individual maps are available for download from the USGS website at:
https://ngmdb.usgs.gov/ngm-bin/ngm_search_dbi.pl?bc_ul=41.795401%2C-109.882043&bc_lr=40.850721%2C-107.643579

- Throughout the Lower Laramie watershed, younger strata are underlain by older strata (i.e. in order is listed in Appendix 4A, although all formations are not present at all locations). For example, a well drilled through the Arikaree Formation would at most locations encounter the underlying and more extensive Brule and Chadron Formations, but beyond that could find any one or all of the Appendix 4A formations. In most cases, in this watershed, drilling beyond the bottom of the Arikaree is unlikely to encounter dramatically better individual water-bearing strata, but deeper drilling at most locations may gradually accumulate production simply through the penetration of additional material. However, this approach may be compromised not only by the expense involved, but by the common deterioration in water-quality with depth and the potential diminution of aquifer permeability absent the active groundwater circulation near outcrop areas.

6.6 Storage Components (STO)

Construction of new water storage facilities in the watershed would be possible to complete within the framework of Wyoming water laws; however, constraints imposed by those laws would present significant and potentially insurmountable hurdles. As discussed previously in Section 6.2, the Modified North Platte Decree (2001), the Laramie River Decree (1922) and the Platte River Recovery and Implementation Program (2001) all impose limits on what can and cannot be done with respect to water use in the basin.

No storage projects were incorporated into the watershed management plan.

6.7 Environmental Components (ENV)

Environmental components of the watershed management plan include stream stabilization projects and projects involving potential modifications to existing irrigation diversions to facilitate fisheries management objectives.

With respect to the stream stabilization projects, the general condition of the principal stream channels and primary tributaries were evaluated during the geomorphic investigation which included:

- Classification of approximately 795 miles of stream channel within the GIS environment
- Field reconnaissance to verify the classifications.

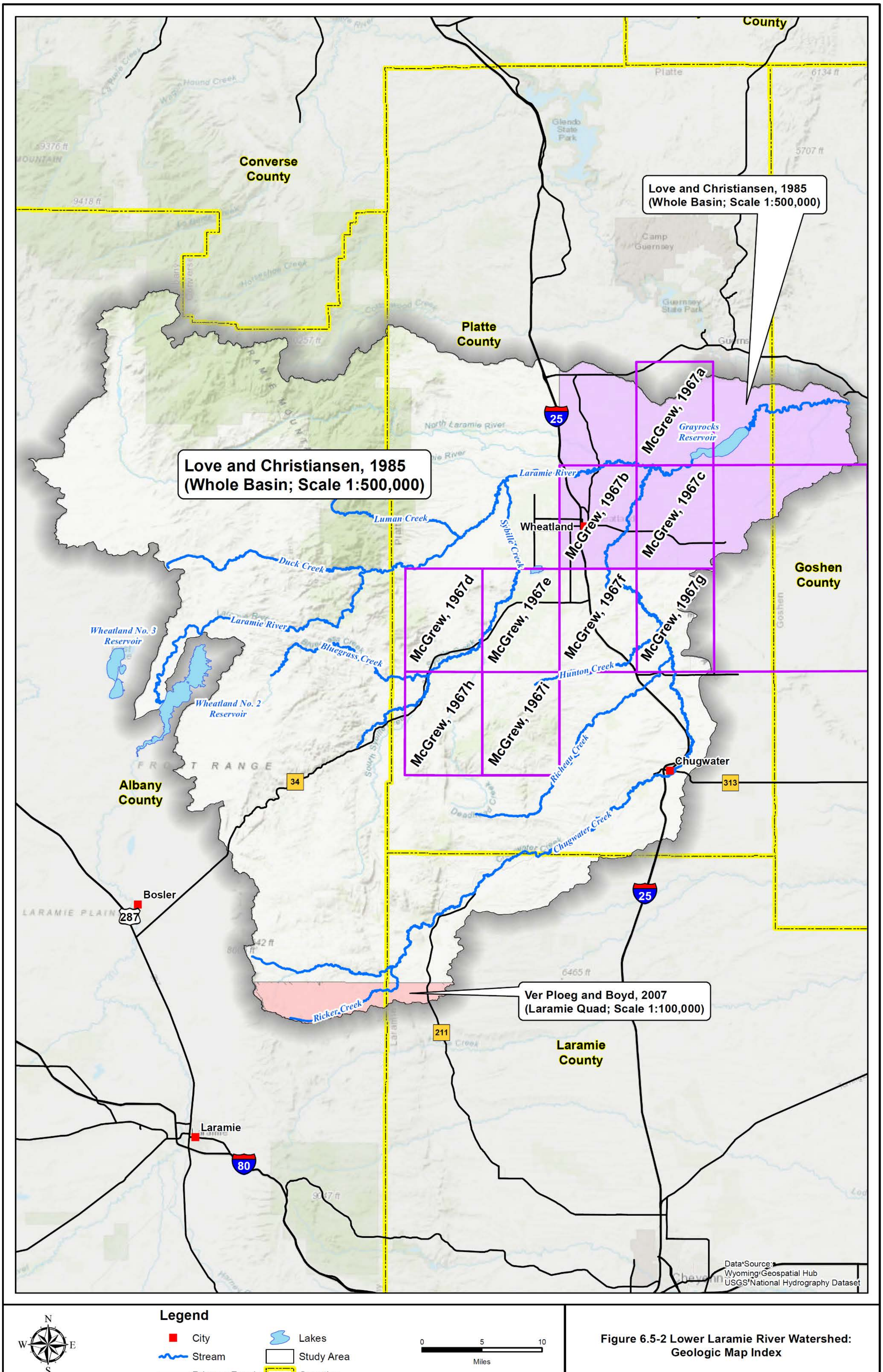


Figure 6.5-2 Lower Laramie River Watershed: Geologic Map Index

These efforts and their results are presented in Chapter 4. During the evaluation of existing channel conditions, general classes of impairment were noted:

- Riparian Vegetation Degradation: Impaired riparian condition and habitat, and
- Riparian Degradation: Generally bank erosion and physical disturbance of stream banks.
- Imbalance of Sediment Supply: Imbalance between stream capacity and sediment supply can lead to channel degradation or aggradation

The scope of this Level I investigation precludes an in-depth evaluation of stream channel conditions. Locations where stability issues exist were documented largely through project workshops and word of mouth. Consequently, only a limited number of specific locations where stream channel or bank stabilization projects may be beneficial were noted. Given the magnitude of the extent of the study area, the complexity of the stream system, and the variety of land uses encompassed within it, there are certainly additional locations where further investigation may be warranted. The specific projects recommended in this watershed management plan, however, serve as examples of the types of local projects which could be completed and provide benefit to landowners and watershed health. Table 6.7-1 tabulates the specific stream channel rehabilitation projects identified in this study. Appendix 6A contains descriptions of each.

Table 6.7-1 Lower Laramie River Watershed Plan: Environmental Components.

Lower Laramie River Watershed Management Plan			
Watershed Management Plan Component	**Sponsor Reference**	**Project Name**	**Description**
Environmental Components			
ENV-001	deRyk-001	Lower Laramie River Bank Stabilization Project 1	Realign Streambank and Stabilize Erosive Banks
ENV-002	Lanier-001	Lower Laramie River Bank Stabilization Project 2	Stabilize Erosive Streambank
ENV-003	Nockels-001	Chugwater Creek Bank Stabilization Project 1	Stabilize Erosive Streambank
ENV-004	WGF-001	Wilson No. 2 Ditch Diversion Fish Passage Project	Enhance Fish Passage Capabilities
ENV-005	WGF-002	North Laramie Land Company Canal Fish Passage Project	Enhance Fish Passage Capabilities
ENV-006	WGF-003	Burger Ditch Diversion Structure Fish Barrier	Increase Fish Barrier Opportunity
ENV-007	Freeborn-001	Lower Laramie River Stabilization Project 3	Stabilize Erosive Streambank
ENV-008	Freeborn-002	Lower Laramie Wetland Rehabilitation Project	Restore Wetland Functionality

6.7.1 Channel Stabilization Strategies

Various approaches can be taken during channel restoration and stabilization efforts, including both "hard" engineering and "soft" approaches and combinations of the two.

Examples of "hard" approaches would include construction of channel structures or reconstruction of channels themselves. The selection of the appropriate mitigation/restoration technique depends upon site-specific information and critical review of hydrologic and hydraulic data. Installation of an inappropriate type of structure or improper installation could exacerbate conditions.

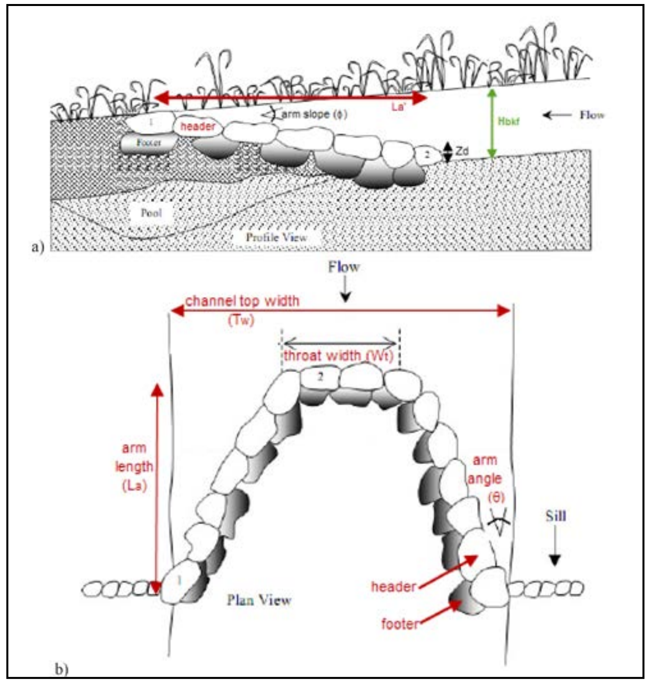


Figure 6.7-1 Rock Vortex Weir Structure Diagram (Adapted from Rosgen, 2006).

For instance, methods of restoring incised channels may include construction of gradient restoration facilities (i.e., drop structures, check structures) within the incised channel. Figure 6.7-1 displays a diagram of a typical stream channel stabilization strategy for a small channel experiencing minor downcutting or bank erosion. A vortex weir can be placed within a problematic reach to serve as a grade control structure as well as directing and centralizing streamflow. Weir configuration can be varied to provide additional functions such as facilitating irrigation diversions. Figure 6.7-2 displays a photograph of a typical installation.

Figure 6.7-2 Stream Stabilization Structure: Rock Vortex Weir.

Re-establishment of pre-incision channel elevations can be accomplished by means of check dams. Figure 6.7-3 displays a photo of a large-scale check dam on Muddy Creek in the Little Snake River watershed near Baggs, Wyoming. This structure serves as a good example of how gradient restoration strategies can be utilized to restore diversion capabilities at irrigation headgates rendered inoperable by changes in channel configuration.

Figure 6.7-3 Channel Gradient Restoration Feature on Muddy Creek near Baggs, WY. Photo on left is viewed Downstream from the Dam at Incised Channel. Photo on the right is viewed Upstream at Restored Gradient.

Figure 6.7-4 Stream Stabilization Measure: Willow Fascine Installation.

Examples of "soft" approaches include a variety of Best Management Practices (BMPs). Examples of potentially applicable BMPs designed for channel restoration activities include those that result in reducing or, at least temporarily excluding wildlife and livestock from accessing designated riparian zones, establishment of riparian buffers, etc. The proposed wildlife/livestock water developments discussed previously (and others that may be identified in the future) can be considered elements of a range management BMP that will help restore, over time, those areas of channel impairment that have resulted from overutilization of riparian areas or adjacent upland range. Figure 6.7-4 displays a photo of willow fascine installation. This strategy could be employed on many of the perennial channels or intermittent where sufficient flow exists to support the vegetation, in an effort to restore riparian habitat and stabilize streambanks.

These examples of "hard" and "soft" approaches represent both extremes of the continuum of channel restoration strategies that exist. In practice, it must be kept in mind that it is generally a combination of strategies, integrated into a cohesive plan, that provides the most effective solution. Table 6.7-2 presents a summary of some of these channel restoration strategies which can be employed during future restoration efforts. Development of more specific projects and BMPs was beyond the scope of this Level I study. Such projects can be identified and developed on the basis of more detailed geomorphic analysis of impaired stream reaches.

Table 6.7-2 Summary of Potential Stream Channel Stabilization/Restoration Techniques.

Flow-Redirection Techniques	**Biotechnical Techniques**
Vanes	Woody Plantings
Groins	Herbaceous Cover
Buried Groins	Soil Reinforcement
Barbs	Coir Logs
Engineered Log Jams	Bank Reshaping
Drop Structures	**Internal Bank-Drainage Techniques**
Porous Weirs	Subsurface Drainage Systems
Structural Techniques	**Avulsion-Prevention Techniques**
Anchor Points	Floodplain Roughness
Roughness Trees	Floodplain Grade Control
Riprap	Floodplain Flow Spreaders
Log Toes	**Other Techniques**
Roughened-Rock Toes	Channel Modifications
Log Cribwalls	Riparian-Buffer Management
Manufactured Retention Systems	Spawning-Habitat Restoration
	Fish Ladders/bypass structures
	Fish Screens/entrainment prevention

As would be recommended with any similar project, monitoring of the success of the project(s) is highly recommended. At a minimum, monitoring should include visual inspection of rehabilitation features to determine the effectiveness and ability of the rehabilitation to withstand high flow events. Evidence of existing or induced erosion, movement of rehabilitation features (rock, root wads, etc.), sedimentation, vegetation establishment, etc. should be noted. In addition, long term monitoring of rehabilitation sites should include:

- Photographic documentation
- Cross sections
- Longitudinal profiles
- Bank surveys
- Bank erosion pins
- Scour chains
- Pebble counts

6.8 Grazing Management Opportunities (Watershed Management Plan Component)

In Chapter 4, the ecological sites found within the watershed were presented and the concept of the ecological site description (ESD) was introduced. The ESD for a given ecological site contains a wealth of information pertaining to the site and its community. Within each ESD is a State and Transition model.

State and transition models describe the patterns, causes, and indicators of transitions between communities within an ecological site based upon the ecological site description (ESD). In a graphical form, they display information obtained from literature supplemented by the knowledge and experience of range scientists and managers. Basically, they display the response of a given ecological site to various range management practices or disturbances. They help to distinguish changes in vegetation and soils that are easily reversible versus changes that are subject to thresholds beyond which reversal is costly or unlikely. By being aware of the predicted response of a given ecological site to a treatment, the land manager can use this knowledge to best prescribe land management practices or treatments to direct the transition in a desirable direction. For instance, land management strategies can be prescribed which could result in restoration of the Historic Climax Plant Community (HCPC) under the right circumstances.

Based upon the assumptions presented in Chapter 3, the three dominant ecological sites found within the mapped portions of the Upper Laramie River Watershed study area are likely to be the following:

- Sandy 12 - 17-inch Central High Plains, Northern Part ESD (R067AY150WY) is the largest zone and covers approximately 271,000 acres (18.2percent) of the study area.

- Igneous 15 - 19-inch Southern Rocky Mountain Foothills (R049XA116WY) covers approximately 212,000 acres (14.2%) of the study area.

- Loamy (Ly) 15 - 19-inch Southern Rocky Mountain Foothills (R049XA122WY) covers approximately 110,000 acres (7.4%) of the study area.

It is important to note that other ecological sites will be encountered and that the list above is provided as an initial point for prescription of grazing practices. Prior to prescription of a grazing management plan, local site-specific conditions must be considered and the appropriate ESD determined.

As an example of ESD utilization, the management strategies for the Sandy 12-17 inch site is provided below:

"The Reference State is characterized by cool-season mid bunchgrasses (needle and thread), warm-season mid rhizomatous grasses (prairie sandreed), and warm-season mid bunchgrass (little bluestem). Secondary grasses are warm-season tall bunchgrass (sand bluestem), and warm-season shortgrass (blue grama). Other grasses and grass-likes include western wheatgrass, Indian ricegrass, prairie Junegrass, sand dropseed, and threadleaf sedge. A minor component of forbs and shrubs are also present. The Sod-bound State is characterized by warm-season shortgrass (blue grama) and grasslikes (threadleaf sedge). The Increased Bare Ground State is characterized by annual grasses (sixweeks fescue), forbs (spreading buckwheat and annuals), and shrubs (broom snakeweed, and pricklypear). Invasives include cheatgrass.

The degree of grazing has a significant impact on the ecological dynamics of the site. This region was historically occupied by large grazing animals such as bison and elk, along with pronghorn and mule deer. Grazing by these large herbivores, along with climatic fluctuations, had a major influence on the ecological *dynamics of this site. Deer and pronghorn are widely distributed throughout the MLRA. Secondary influences of herbivory by species such as small rodents, insects and root-feeding organisms have impacted the vegetation and continues today.*

Historically, it is believed that, due to the migratory nature of the herds of large ungulates, herbivory consisted of very short grazing events followed by long rest/recovery periods lasting several months or longer. In addition to natural grazing and rest periods, these migrating herds significantly impacted the ecological processes of nutrient and hydrologic cycles. Herd behavior and movements were likely affected by water and forage availability, fire, drought, and predators. Prescribed grazing that typically mimics the historic grazing of herds of migratory herbivores has been shown to result in desired improvements based on management goals for this ecological site.

This is an important site for livestock grazing, especially beef cattle. Today the management of livestock grazing by humans has been a major influence on the ecological dynamics of the site. This management, coupled with the effects of annual climatic variations, largely dictates the plant communities for the site.

Recurrent drought has historically impacted the vegetation of this region. Changes in species composition and production, will vary depending upon the duration and severity of the drought cycle, and prior grazing management.

This site developed with occasional fire as part of the ecological processes. Historic fire frequency (pre-industrial), is estimated at 10-12 years (Guyette, 2012), randomly distributed, and started by lightning at various times throughout the growing season. It is thought that early human inhabitants also were likely to start fires for various reasons (deliberate or accidental). It is believed that fires were set as a management tool for attracting herds of large migratory herbivores (Stewart, 2002). The impact of fire over the past 100 years has been relatively insignificant due to the human control of wildfires and the lack of acceptance of prescribed fire as a management tool.

As this site begins to deteriorate from a combination of frequent and severe grazing during the growing season, bunchgrasses such as needle and thread and green needlegrass will decrease in both frequency and production. Grasses such as blue grama and threadleaf sedge will increase. Under continued frequent and severe defoliation, with no rest periods, rhizomatous wheatgrasses will also begin to decrease. Forbs and shrubs such as curlycup gumweed, western ragweed, hairy false goldenaster, spreading buckwheat, pricklypear, and broom snakeweed will also increase. If continued, the plant community will become sod-bound, and all midgrasses can eventually be removed from the plant community. Over the long-term, this continuous use in combination with high stock densities, will result in a broken sod, with areas of bare ground developing, and species such as broom snakeweed and annual bromes (cheatgrass), invading."

The state and transition model for this ecological site is displayed in Figure 6.8-1. The transitions, or pathways, described above are presented in the figure.

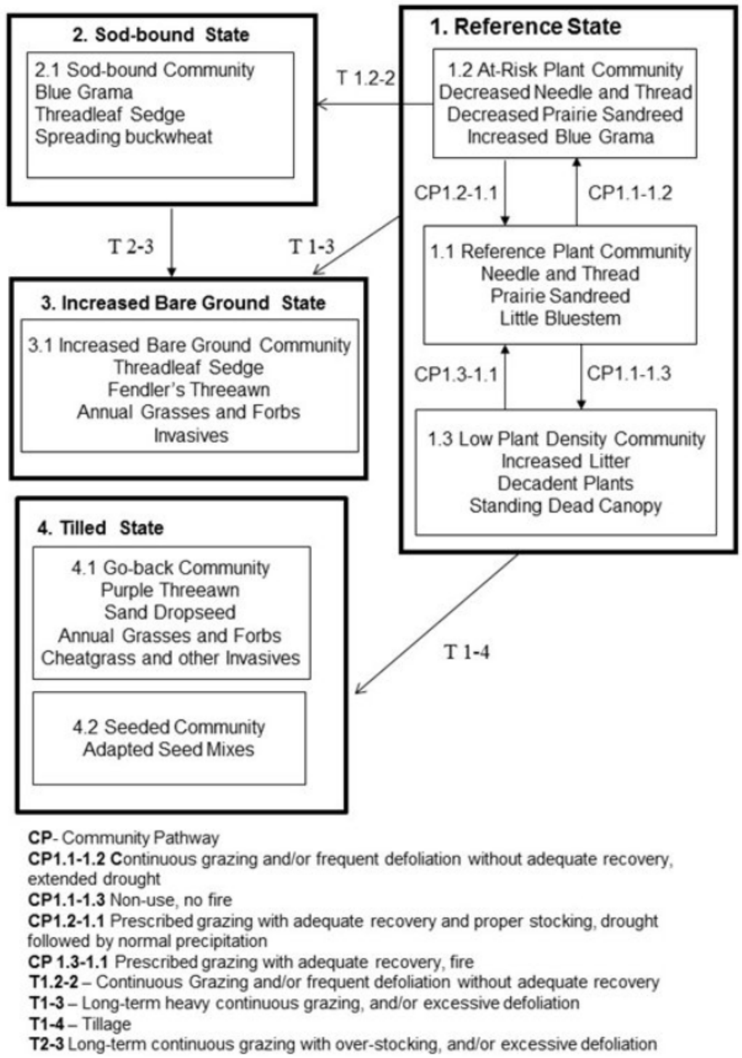


Figure 6.8-1 State and Transition Model: Sandy 12 - 17-inch Central High Plains, Northern Part.

6.9 Lower Laramie River Watershed Management Plan

The information presented in this chapter provides recommendations for improvements associated with:

- Irrigation system rehabilitation components
- Livestock / wildlife upland watering opportunities
- Grazing management opportunities
- Stream channel stability components
- Environmental enhancement opportunities

These improvements focus on potential mitigation of several key issues that presently exist within the watershed. For the Lower Laramie River watershed, the watershed management plan consists of a compilation of the recommendations for each category. The plan is tabulated in Table 6.9-1.

6.10 Project Summary Matrix

In an effort to help the LRCD and the WWDO prioritize projects for completion or funding, a summary matrix was prepared. The matrix consists of a tabulation of the individual components of the watershed management plan and various attributes for each. Table 6.10-1 provides a summary of the attributes and Table 6.10-2 presents the summary matrix.

Table 6.9-1 Lower Laramie River Watershed Management Plan.

Lower Laramie River Watershed Management Plan			
Watershed Management Plan Component	**Sponsor Reference**	**Project Name**	**Description**
Environmental Components			
ENV-001	deRyk-001	Lower Laramie River Bank Stabilization Project 1	Realign Streambank and Stabilize Erosive Banks
ENV-002	Lanier-001	Lower Laramie River Bank Stabilization Project 2	Stabilize Erosive Streambank
ENV-003	Nockels-001	Chugwater Creek Bank Stabilization Project 1	Stabilize Erosive Streambank
ENV-004	WGF-001	Wilson No. 2 Ditch Diversion Fish Passage Project	Enhance Fish Passage Capabilities
ENV-005	WGF-002	North Laramie Land Company Canal Fish Passage Project	Enhance Fish Passage Capabilities
ENV-006	WGF-003	Burger Ditch Diversion Structure Fish Barrier	Increase Fish Barrier Opportunity
ENV-007	Freeborn-001	Lower Laramie River Stabilization Project 3	Stabilize Erosive Streambank
ENV-008	Freeborn-002	Lower Laramie Wetland Rehabilitation Project	Restore Wetland Functionality
Irrigation Components			
IRR-001	Christinic-001	Christinic Pipeline Conversion Project	Convert Open Ditch to Buried Pipeline
IRR-002	Cochorn-001	Cochorn Pipeline Conversion Project	Convert Open Ditch
IRR-003	Faris-002	Faris Pipeline Project	Install Pipeline within Conveyance System
IRR-004	Farthing-001	Iron Mountain Ditch No. 2 Headgate Replacement Project	Replace Failing Headgate
IRR-005	Farthing-002	Davidson Ditch Headgate Replacement Project	Replace Failing Headgate
IRR-006	Kontour-001	Kontour Headgate Replacement Project	Replace Failing Headgate
IRR-007	Schockley-001	Schockley Headgate Project	Replace Headgate/Ditch Lost to Bank Erosion
Livestock/Wildlife Water Supply Components			
L/W-001	Brant-001	Brant Stock Reservoir Rehabilitation Project	Rehabilitate Existing Sediment-Filled Stock Reservoir
L/W-002	Brown-001	Brown Well and Stock Tank Project	Construct New Well, Pipeline, and Stock Tank
L/W-003	Faris-001	Faris Well Replacement Project	Rehabilitate Existing Well System
L/W-004	Gillaspie-001	Gillaspie Spring Development Project 1	Replace Existing Spring Development/Pipeline/Tank
L/W-005	Gillaspie-002	Gillaspie Spring Development Project 2	Replace Existing Spring Development/Pipeline/Tank
L/W-006	Gillaspie-003	Gillaspie Solar Project 1	Install Solar Platform/Pump in Existing Well
L/W-007	Gillaspie-004	Gillaspie Solar Project 2	Install Solar Platform/Pump in Existing Well
L/W-008	Irvine-001	Irvine Stock Reservoir Rehabilitation	Rehabilitate Existing Stock Reservoir
L/W-009	Langseth-001	Langseth Well Construction Project 1	Construct New Well, Pipeline, and Stock Tank
L/W-010	Langseth-002	Langseth Well Construction Project 2	Construct New Well, Pipeline, and Stock Tank
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L/W-012	Preston-002	Preston Stock Reservoir Construction Project	Construct New Stock / Wildlife Reservoir
L/W-013	Purdy-001	Purdy Spring Development Project 1	Construct New Spring Development/Tank
L/W-014	Purdy-002	Purdy Spring Development Project 2	Construct New Spring Development/Tank
L/W-015	Watson-001	Watson Pipeline Project 1	Construct New Pipeline/Tank System From Existing Well
L/W-016	Watson-002	Watson Pipeline Project 2	Construct New Pipeline/Tank System From Existing Well
L/W-017	West-001	West Well and Pipeline Construction Project	Construct New Well, Pipeline, and Stock Tank

Table 6.10-1 Attributes of Project Summary Matrix.

Attribute	Project Evaluation Categories		
	ss Preferable		More Preferab
WWDC Priority[1]	LOW: WWDC Priority of 4,5 or 6	MEDIUM: WWDC Priority 2 or 3	HIGH: WWDC Priority 1 or "Shovel Ready"
Water Rights	SIGNIFICANT: Significant permitting effort	ROUTINE: Routine permitting requirement: ex. WSEO Change in POD, water right	NONE: WSEO permit approved or not required
Land Ownership	Includes Federal	Mixed	Private Only
Implementation Practicality	Challenging effort	Moderate effort	Routine effort
Ease of Permitting	Federal permits/NEPA	Local or State permits	Permit(s) approved or No permit(s) required
Ancillary Benefits	Negligible associated benefits	Moderate associated benefits	Multiple associated benefits
Number of Beneficiaries	1	2 to 8	9 or more

Note[1]

According to the WWDC's recently revised operating guildelines for Account I (New Projects), project priorities are as follows:

1. Source water development
2. Storage
3. Pipelines, conveyance facilities, solar platforms and windmills
4. Irrigation
5. Environmental
6. Recreational

Table 6.10-2 Lower Laramie River Watershed Management Plan: Project Summary Matrix.

Lower Laramie River Watershed Management Plan												
Watershed Management Plan Component	Sponsor Reference	Project Name	Description	WWDC Program	Supply Type	WDCW Priority	Ownership	Implementation Practicality	Ease of Permitting	Estimated Cost	Benefits	Shovel Ready
Environmental Components												
ENV-001	deRyk-001	Lower Laramie River Bank Stabilization Project 1	Realign Streambank and Stabilize Erosive Banks	SWPP	N/A	Low	Private	Moderate	Moderate	$33,000	riparian, channel stability, water quality, sedimentation	No
ENV-002	Lanier-001	Lower Laramie River Bank Stabilization Project 2	Stabilize Erosive Streambank	SWPP	N/A	Low	Private	Moderate	Moderate	$24,750	riparian, channel stability, water quality, sedimentation	No
ENV-003	Nockels-001	Chugwater Creek Bank Stabilization Project 1	Stabilize Erosive Streambank	SWPP	N/A	Low	Private	Moderate	Moderate	$24,750	riparian, channel stability, water quality, sedimentation	No
ENV-004	WGF-001	Wilson No. 2 Ditch Diversion Fish Passage Project	Enhance Fish Passage Capabilities	SWPP	N/A	Low	Private	Moderate	Moderate	$103,125	fish passage	No
ENV-005	WGF-002	North Laramie Land Company Canal Fish Passage Project	Enhance Fish Passage Capabilities	SWPP	N/A	Low	Private	Moderate	Moderate	$103,125	fish passage	No
ENV-006	WGF-003	Burger Ditch Diversion Structure Fish Barrier	Increase Fish Barrier Opportunity	SWPP	N/A	Low	Private	Moderate	Moderate	$20,625	fish passage	No
ENV-007	Freeborn-001	Lower Laramie River Stabilization Project 3	Stabilize Erosive Streambank	SWPP	N/A	Low	Private	Moderate	Moderate	$37,125	riparian, channel stability, water quality, sedimentation	No
ENV-008	Freeborn-002	Lower Laramie Wetland Rehabilitation Project	Restore Wetland Functionality	SWPP	N/A	Low	Private	Moderate	Moderate	$94,188	wetlands	No
Irrigation Components												
IRR-001	Christinic-001	Christinic Pipeline Conversion Project	Convert Open Ditch to Buried Pipeline	SWPP	Rehabilitation	Low	Private	Routine	Routine	$59,125	conservation	No
IRR-002	Cochorn-001	Cochorn Pipeline Conversion Project	Convert Open Ditch	SWPP	Rehabilitation	Low	Private	Routine	Routine	$113,438	conservation	No
IRR-003	Faris-002	Faris Pipeline Project	Install Pipeline within Conveyance System	SWPP	Rehabilitation	Low	Private	Routine	Routine	$28,463	conservation	No
IRR-004	Farthing-001	Iron Mountain Ditch No. 2 Headgate Replacement Project	Replace Failing Headgate	SWPP	Rehabilitation	Low	Private	Routine	Routine	$58,750	conservation	No
IRR-005	Farthing-002	Davidson Ditch Headgate Replacement Project	Replace Failing Headgate	SWPP	Rehabilitation	Low	Private	Routine	Routine	$58,750	conservation	No
IRR-006	Kontour-001	Kontour Headgate Replacement Project	Replace Failing Headgate	SWPP	Rehabilitation	Low	Private	Routine	Routine	$7,319	conservation	No
IRR-007	Schockley-001	Schockley Headgate Project	Replace Headgate/Ditch Lost to Bank Erosion	SWPP	Rehabilitation	Low	Private	Moderate	Moderate	$91,138	conservation, riparian, channel stability, water quality	No

Table 6.10-2 Lower Laramie River Watershed Management Plan: Project Summary Matrix (Continued).

Lower Laramie River Watershed Management Plan												
Watershed Management Plan Component	Sponsor Reference	Project Name	Description	WWDC Program	Supply Type	WDCW Priority	Ownership	Implementation Practicality	Ease of Permitting	Estimated Cost	Benefits	Shovel Ready
Livestock/Wildlife Water Supply Components												
L/W-001	Brant-001	Brant Stock Reservoir Rehabilitation Project	Rehabilitate Existing Sediment-Filled Stock	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$22,674	wildlife	No
L/W-002	Brown-001	Brown Well and Stock Tank Project	Construct New Well, Pipeline, and Stock Tank	SWPP	New Supply	Medium	Private	Routine	Routine	$29,872	wildlife	No
L/W-003	Faris-001	Faris Well Replacement Project	Rehabilitate Existing Well System	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$50,600	wildlife	No
L/W-004	Gillaspie-001	Gillaspie Spring Development Project 1	Replace Existing Spring Development/Pipeline/Tan	SWPP	Rehabilitation	High	Private	Routine	Routine	$21,544	wildlife, riparian	No
L/W-005	Gillaspie-002	Gillaspie Spring Development Project 2	Replace Existing Spring Development/Pipeline/Tan	SWPP	Rehabilitation	High	Private	Routine	Routine	$15,263	wildlife, riparian	No
L/W-006	Gillaspie-003	Gillaspie Solar Project 1	Install Solar Platform/Pump in Existing Well	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$24,750	wildlife, riparian	No
L/W-007	Gillaspie-004	Gillaspie Solar Project 2	Install Solar Platform/Pump in Existing Well	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$24,750	wildlife, riparian	No
L/W-008	Irvine-001	Irvine Stock Reservoir Rehabilitation	Rehabilitate Existing Stock Reservoir	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$59,375	wildlife, riparian	No
L/W-009	Langseth-001	Langseth Well Construction Project 1	Construct New Well, Pipeline, and Stock Tank	SWPP	New Supply	High	Private	Routine	Routine	$47,438	wildlife	No
L/W-010	Langseth-002	Langseth Well Construction Project 2	Construct New Well, Pipeline, and Stock Tank	SWPP	New Supply	High	Private	Routine	Routine	$47,438	wildlife	No
L/W-011	Preston-001	Preston Stock Reservoir Rehabilitation Project	Rehabilitate Existing Stock Reservoir	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$89,750	wildlife	No
L/W-012	Preston-002	Preston Stock Reservoir Construction Project	Construct New Stock / Wildlife Reservoir	SWPP	New Supply	Medium	Private	Routine	Routine	$56,375	wildlife	No
L/W-013	Purdy-001	Purdy Spring Development Project 1	Construct New Spring Development/Tank	SWPP	New Supply	High	Private	Routine	Routine	$16,981	wildlife	No
L/W-014	Purdy-002	Purdy Spring Development Project 2	Construct New Spring Development/Tank	SWPP	New Supply	High	Federal	Routine	Routine	$16,981	wildlife	No
L/W-015	Watson-001	Watson Pipeline Project 1	Construct New Pipeline/Tank System From	SWPP	New Supply	Medium	Private	Routine	Routine	$81,950	wildlife	No
L/W-016	Watson-002	Watson Pipeline Project 2	Construct New Pipeline/Tank System From	SWPP	New Supply	Medium	Private	Routine	Routine	$20,763	wildlife	No
L/W-017	West-001	West Well and Pipeline Construction Project	Construct New Well, Pipeline, and Stock Tank	SWPP	New Supply	High	Private/State	Routine	Routine	$89,375	wildlife	No

VII. TASK 6: COST ESTIMATES

Conceptual-level costs have been developed for each of the alternative potential projects identified and described in Chapter 6. The basis for these costs are described in the following subsections for each of the overall project categories. Cost estimates presented represent 2019 dollars. NRCS Fiscal Year (2019) Practice Payment Rates for EQIP Program costs data were used where feasible for typical design items. Table 7.1-1 tabulates the total estimated costs. Appendix 6A presents the itemized cost items in addition to the conceptual designs and narrative descriptions of the projects.

7.1 Irrigation System Components

Costs associated with irrigation system components of the watershed management plan were estimated based upon current itemized unit costs for individual improvements. NRCS Fiscal Year (2019) Practice Payment Rates for EQIP Program costs cost data were used where feasible for typical design items. In Table 7.1-1 summarizes conceptual cost estimates for irrigation system components of the watershed management plan. Mobilization, contingencies, and engineering/technical support were added as percentages of the project subtotal.

7.2 Upland Wildlife/Livestock Water Components

The anticipated costs associated with these components of the watershed management plan were based upon previous experience completing similar projects in the study area, current NRCS EQIP cost tables, and current costs of various other system components obtained from reliable sources. Table 7.1-1 presents the estimated costs associated with each of the upland wildlife / livestock water source components of the watershed management plan. The following components are common to most of the systems and are itemized below for general reference.

Spring Developments: Typical costs range from $1,000 to $5,000 depending on size and yield of the spring. For the purposes of this Level I investigation a cost of $5,000 was used.

***Wells**:* Well construction costs were assumed to be approximately $50 per foot of depth. This value was determined based upon input from local drilling contractors.

***Solar Pump Facility**:* A cost of $11,000 to $13,000 per solar facility was used. This cost was assumed to include the solar arrays and requisite controls and regulators. Pumps were assumed to add an additional $2,500 to the solar pump system. Actual price would vary based upon depth to water.

***Pipelines**:* A cost of approximately $4 / lineal foot (installed) for 1.5-inch diameter pipe was used and is based upon information provided by the NRCS for “easily” installed pipeline. Areas where installation is more difficult (i.e, rough terrain, rocky, etc.) could result in higher costs. Length of pipe associated with each project was approximated within the GIS environment.

Table 7.1-1 Lower Laramie River Watershed Management Plan Conceptual Costs Summary.

Watershed Management Plan Component	Sponsor-Number	Project Subtotal	Contingencies (15% of subtotal)	Engineering and technical assistance (10% of subtotal)	Estimated project cost
ENV-001	deRyk-001	$26,400	$3,960	$2,640	$33,000
ENV-002	Lanier-001	$19,800	$2,970	$1,980	$24,750
ENV-003	Nockels-001	$19,800	$2,970	$1,980	$24,750
ENV-004	WGF-001	$82,500	$12,375	$8,250	$103,125
ENV-005	WGF-002	$82,500	$12,375	$8,250	$103,125
ENV-006	WGF-003	$16,500	$2,475	$1,650	$20,625
ENV-007	Freeborn-001	$29,700	$4,455	$2,970	$37,125
ENV-008	Freeborn-002	$75,350	$11,303	$7,535	$94,188
IRR-001	Christinic-001	$47,300	$7,095	$4,730	$59,125
IRR-002	Cochorn-001	$90,750	$13,613	$9,075	$113,438
IRR-003	Faris-002	$22,770	$3,416	$2,277	$28,463
IRR-004	Farthing-001	$47,000	$7,050	$4,700	$58,750
IRR-005	Farthing-002	$47,000	$7,050	$4,700	$58,750
IRR-006	Kontour-001	$5,855	$878	$586	$7,319
IRR-007	Schockley-001	$72,910	$10,937	$7,291	$91,138
L/W-001	Brant-001	$18,139	$2,721	$1,814	$22,674
L/W-002	Brown-001	$23,898	$3,585	$2,390	$29,872
L/W-003	Faris-001	$40,480	$6,072	$4,048	$50,600
L/W-004	Gillaspie-001	$17,235	$2,585	$1,724	$21,544
L/W-005	Gillaspie-002	$12,210	$1,832	$1,221	$15,263
L/W-006	Gillaspie-003	$19,800	$2,970	$1,980	$24,750
L/W-007	Gillaspie-004	$19,800	$2,970	$1,980	$24,750
L/W-008	Irvine-001	$47,500	$7,125	$4,750	$59,375
L/W-009	Langseth-001	$37,950	$5,693	$3,795	$47,438
L/W-010	Langseth-002	$37,950	$5,693	$3,795	$47,438
L/W-011	Preston-001	$71,800	$10,770	$7,180	$89,750
L/W-012	Preston-002	$45,100	$6,765	$4,510	$56,375
L/W-013	Purdy-001	$13,585	$2,038	$1,359	$16,981
L/W-014	Purdy-002	$13,585	$2,038	$1,359	$16,981
L/W-015	Watson-001	$65,560	$9,834	$6,556	$81,950
L/W-016	Watson-002	$16,610	$2,492	$1,661	$20,763
L/W-017	West-001	$71,500	$10,725	$7,150	$89,375
				Total	**$1,573,546**

Water Tanks (Stock and Storage): A cost of $3,200 per stock tank was used for a typical rubber-tire type tank. Cost of storage tanks were assumed to be approximately $1 per gallon of storage.

Stock Pond Construction. Stock pond construction or rehabilitation costs were estimated using volume estimates generated within the GIS environments: embankment volume, sediment removal, lining quantities, etc. Agridrain outlet facility: $5,000 installed

Fencing. A cost of $5 per linear foot was utilized for general fencing requirements (barbed or smooth wire).

7.3 Stream Channel Improvements and Environmental Enhancement Opportunities

Costs associated with these plan components are included in Table 7.1-1. Estimates were completed using NRCS Fiscal Year (2018) Practice Payment Rates for EQIP Program costs, input from local agencies, previous experience, and regional information.

VIII. TASK 7: ECONOMIC ANALYSIS

8.1 Overview

Sources of funding and financing for proposed projects within the watershed and the associated technical support and assistance are available from various local, private, state, and federal entities. The widespread opportunities described in this Level I watershed study, watershed management plan, and resulting proposed projects and alternatives make identifying and obtaining potential project funding dependent on local coordination and voluntary cooperation.

Local coordination is crucial in developing viable financing approaches that could be developed in implementing proposed projects and realizing beneficial watershed improvements. Voluntary cooperation between landowners, managers, irrigators, residents, organizations, and agencies is essential in addressing the identified land and water resource concerns and opportunities within the Lower Laramie River. Land and water users and managers interested in voluntarily implementing conservation projects and programs should be aware of the partnership opportunities and program incentives available in successfully achieving their watershed improvement goals and objectives.

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

- **Water Management and Conservation Assistance Programs Directory**, is an overview of local, state, and federal programs with associated contact information. (*http://wwdc.state.wy.us/wconsprog/2014WtrMgntConsDirectory.html*)

- **Habitat Extension Bulletin No. 50 – Fisheries and Wildlife Habitat Cost Share Programs and Grants** is published by the Wyoming Game and Fish Department and provides a very comprehensive listing of potential funding sources for fisheries and wildlife habitat projects. The document is available at the following website: (https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Extension%20Bulletins/B50-Fisheries-and-Wildlife-Habitat-Cost-Sharing-Programs-and-Grants.pdf)

Additional information about potential funding sources were reviewed and incorporated from previous watershed studies completed on behalf of the WWDC and specifically included excerpts from the *Upper Laramie River Watershed Study, Level I* [Anderson Consulting Engineers, 2016]. These potential sources described in this chapter are certainly not an all-inclusive listing of the available opportunities for water management and conservation projects. Also, the available funding levels for these programs vary annually because they are subject to budget appropriations; spending authorizations; and in some instances, donation amounts for private organizations. Additionally, the contact information for these sources can and does change occasionally. Important contact information for local conservation organizations include, but are certainly not limited to, the following contacts:

- Platte County Resource District (307-322-8145)
- NRCS Wheatland Field Office: (307 322-9060)
- Bureau of Land Management/Rawlins Field Office (307-328-4200)
- WGFD Cheyenne Department Headquarters (307-777-4600)

Table 8.1-1 summarizes the potential funding sources mentioned in this section.

8.2 Local Agencies

8.2.1 Conservation Districts

The study area is located primarily in Platte County and Albany County (small portions spill into Laramie and Goshen Counties). Conservation districts are locally led, locally elected county government entities. They function as representatives of local people with responsibility for natural resource issues. Local conservation district boards perform as a liaison between local landowners and resource users and state and federal government agencies. Conservation districts are providers of information and education at the local level. Districts also provide technical assistance as local resources, capacity, and expertise allow. They can assist in developing and implementing program and project design and funding through assistance in proposal preparation, presentation, and pursuit of grant assistance. Conservation districts can provide funding assistance, often through in-kind contributions such as staff time and technical aid. They can administer programs, projects, and grants on behalf of recipients of state and federal natural resource programs. Districts can assist with developing leveraged, partnered programs and projects. Additional information can be found on their website (http://www.conservewy.com) or through the contact below:

Platte County Resource District
504C Schroeder Drive
Wheatland, WY 82201
307-322-8145

Laramie Rivers Conservation District
5015 Stone Road #1
Laramie, WY 82070
307.721.0072

Laramie County Conservation District
11221 US Highway 30
Cheyenne, WY 82009
307-772-2600

Lingle – Fort Laramie Conservation District
1441 East M Street
Torrington, WY 82240
307-532-4880

Table 8.1-1 Summary of Potential Funding Sources.

Agency/Entity	Program Name	Project Type(s)	Internet Site	Telephone	Email
Local					
Goshen County Weed and Pest	n/a	Technical assistance, Cost-share programs, inspection service	http://www.goshenweedandpest.com/	307-532-3713	gocoweeds@gmail.com
Platte County Weed and Pest	n/a		n/a	307-322-3210	n/a
Albany County Weed and Pest	n/a		http://www.albanycountyweedandpest.com/	307-742-4469	n/a
Laramie County Weed and Pest	n/a		n/a	307-245-3213	n/a
Laramie Rivers Conservation District	n/a	Liaison, in-kind administrative and technical assistance, program coordination/partnering	http://www.lrcd.net/	307-721-0072	tony.hoch@lrcd.net
Larmier County Conservation District	n/a		https://www.lccdnet.org/	307-772-2600	jgeyer@lccdnet.org
Platte County Resource District	n/a		http://www.conservewy.com/pcrd.html	307-322-9060	n/a
Lingle - Ft. Laramie Conservation District	n/a		https://www.conservegoshen.com/districts/lingle-ft-laramie	307-532-4880	
NRCS Laramie Office	n/a	See Federal NRCS	https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wy/contact/local/?cid=nrcs142p2_027314	307-745-3698 ext. 2	n/a
NRCS Cheyenne Office	n/a		https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wy/contact/local/?cid=nrcs142p2_027303	307-772-2314 ext. 3	n/a
NRCS Wheatland Office	n/a		https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wy/contact/local/?cid=nrcs142p2_027332	307-322-9060 ext. 3	n/a
NRCS Torrington Office	n/a		https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wy/contact/local/?cid=nrcs142p2_027330	307-532-4880	n/a
State					
Wyoming Department of Environmental Quality - Water Quality Division	Nonpoint Source Implementation Grants (319 and 205j Programs)	Water quality BMPs	http://deq.wyoming.gov/wqd/non-point-source/resources/grant-resources/	Keith Guille 307-777-6105	Keith.Guille@wyo.gov
Wyoming Game and Fish Department	Habitat Trust Fund	improving wildlife habitat, promote human understanding and enjoyment of fish and wildlife	https://wgfd.wyo.gov/	Paul Dey 307-777-4559 Laramie Regional Office 307-745-4046	paul.dey@wyo.gov
	Fish Passage Grants	create and improve upstream and downstream passage of all life stages of fish			
Wyoming Office of State Lands and Investments	Farm Loan Program	Projects involving most agricultural purposes	http://lands.wyo.gov/	Jennifer Scoggin Director 307-777-6629	bridget.hill1@wyo.gov
	Joint Powers Act Loan Program	Aids cities, counties, and special districts in providing needed services			
Wyoming Water Development Commission	Wyoming Water Development Program	New development, dams and reservoirs, rehabilitation, water resources planning	http://wwdc.state.wy.us/	307-777-7626	Brandon Gebhart, P.E. (Director) brandon.gebhart@wyo.gov
	Small Water Project Program	Small reservoirs and stock ponds, wells, pipelines/conveyance, spring developments, windmills, wetland			Jodie Pavlica, P.E. (Project Manager) jodie.pavlica@wyo.gov
Wyoming Wildlife and Natural Resource Trust	n/a	Aquatic and wildlife habitat improvement, including water developments, prescribed burns, invasive plant control, etc.	http://wwnrt.state.wy.us	Bob Budd, Executive Director 307-777-8024	bob.budd@wyo.gov
Federal					
Bureau of Land Management	Riparian Habitat Management Program	Projects to maintain, restore, improve, protect and expand riparian/wetland areas	https://www.blm.gov/wyoming/	307-328-4200 (Rawlins FO) 307-261-7600 (Casper FO)	Rawlins_WYMail@blm.gov Casper_WYMail@blm.gov
	Range Improvement Planning and Development	Reservoirs, pits, spring developments, wells, and associated distribution pipelines			
	Watershed and Water Quality Improvement	Watershed health assessments, BMP implementation			
Bureau of Reclamation	WaterSMART Grants Program	Water conservation, efficiency and marketing	http://www.usbr.gov/WaterSMART/grants.html	Carlie Ronca (Area Manager) 307-261-5671	sha-wya-areamanager@usbr.gov
Environmental Protection Agency	Urban Waters Small Grants	Helps communities restore urban waters	https://www.epa.gov/urbanwaters/urban-waters-small-grants	EPA Region 8 303-312-6312	https://www.epa.gov/urbanwaterspartners/forms/contact-us-about-urban-waters-partnership
	Healthy Watersheds Program	Consortium to support individual watershed protection projects	https://www.epa.gov/hwp/what-epa-doing-healthy-watersheds	Peter Ismert (Region 8) 303-312-6215	ismert.peter@epa.gov
USDA - Farm Service Agency (USDA-FSA)	Conservation Reserve Program (CRP)	Removal of highly erobible lands from production	https://www.fsa.usda.gov/programs-and-services/conservation-programs/index	Cindy Hottel Agricultural Program Specialist 307-261-5081	cindy.hottel@wy.usda.gov
	Farmable Wetlands Program	Restores wetlands and wetland buffer zones that are farmed			
	Grassland Reserve Program	Prevents grazing and pasture land from becoming cropland/urban			
	Emergency Conservation Program (ECP)	Emergency livestock watering conservation during severe drought			
	Source Water Protection Program (SWPP)	Protects surface and groundwater used as drinking water by rural residents			
Fish and Wildlife Service	Partners for Wildlife Habitat Restoration	Various fish and wildlife habitat restoration projects	http://www.fws.gov/partners/?viewPage=home	Mark J. Hogan 307-332-8719	Mark_J_Hogan@fws.gov
	Wildlife and Sport Fish Restoration (WSFR) Program	provides oversight and/or administrative support for projects related to conservation, enhancing fish/wildlife habitat	https://wsfrprograms.fws.gov/Subpages/AboutUs/AboutUs1.htm	Steve Jose Chief, Wildlife and Sport Fish Restoration Program 303-236-8185	steve_jose@fws.gov
	Cooperative Endangered Species Conservation Fund	Grants for voluntary conservation projects related to candidate,listed and proposed endangered species	https://www.fws.gov/endangered/grants/	Brian Hires 703-358-2191	brian_hires@fws.gov
	North American Wetlands Conservation Act Program	Various wetlands conservation projects	https://www.fws.gov/birds/grants/north-american-wetland-conservation-act.php	Intermountain West Joint Venture 406-549-0732	info@iwjv.org
	Fish and Wildlife Service's (FWS) Challenge Cost Share Program	Projects and partnerships benefitting refuges	https://www.fws.gov/mountain-prairie/challengecostshare/	Betsy Matten Mountain-Prarie Region 303- 236-4307	Betsy_Matten@fws.gov
USDA - Natural Resources Conservation Service (USDA-NRCS)	Emergency Watershed Protection (EWP)	See websites and/or local contacts for detailed information on these programs	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/	State Office 307-233-6750 Laramie Office 307-745-3698 ext. 2 Cheyenne Office 307-772-2314 ext. 3 Wheatland Office 307-322-9060 ext. 3 Torrington Office 307-532-4880	astrid.martinez@wy.usda.gov
	Watershed Protection and Flood Prevention Operations Program (WFPO)		http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/		
	Watershed Surverys and Planning		http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wsp/		
	Environmental Quality Incentives Program (EQIP)		http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/		
	Conservation Stewardship Program (CSP)		http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/		
	Regional Conservation Partnership Program (RCPP)		http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/rcpp/		
	Agricultural Management Assistance (AMA)		http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/ama/?cid=stelprdb1242818		
	Conservation Innovation Grants (CIG) Program		https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/		
	Agricultural Conservation Easement Program (ACEP)		http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/		
	Watershed Rehabilitation Program		https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wr/		
	Sage Grouse Initiative (SGI)		http://www.sagegrouseinitiative.com/	Brian Jensen WY State Biologist 307-233-6740	brian.m.jensen@wy.usda.gov
US Army Corps of Engineers	See website for program names	Planning, Floodplain Mangement, Flood Damage, Aquatic Ecosystem Restoration	http://www.usace.army.mil/	Mike Happold 307-772-2300	Mike.T.Happold@usace.army.mil
USDA - Rural Development	See website for program names	Water & Environmental Programs	https://www.rd.usda.gov/programs-services/all-programs/water-environmental-programs	Lorraine Werner Program Director 307-233-6700	lorraine.werner@wy.usda.gov
Private					
Ducks Unlimited	See website for program names	Waterfowl aquatic and upland habitat protection, restoration and enhancement	http://www.ducks.org/conservation/du-regional-offices	Great Plains Regional Office: 701-355-3500	http://www.ducks.org/about-du/contact-du-online
National Fish and Wildlife Foundation	Acres For America	Conserves lands of national significance, protects fish and wildlife habitat	http://www.nfwf.org/whatwedo/programs/Pages/home.aspx	Rocky Mountain Regional Office 303-222-6482	seth.gallagher@nfwf.org
	Bring Back the Natives Grant Program	Riverine habitat and aquatic species restoration projects			
	Conservation Partners Program	Targets Farm Bill funds toward top priority conservation objectives			
	Five-Star Urban Waters Restoration Grant Program	Supports community-based wetland and riparian restoration			
	Pulling Together Initiative	Long-term weed management projects			
	Environmental Solutions for Communities Initiative	Supports projects that link economic development to stewardship of the environment			
Trout Unlimited	See website for program names	Erosion control, fish habitat structures, willow and other riparian plantings, etc.	http://www.tu.org/	1-800-834-2419 (National Office)	trout@tu.org

8.2.2 County Weed and Pest Districts

The Platte County Weed and Pest Control also provides technical and financial assistance to landowners within the study area. These special-purpose districts deliver a wide range of support, including weed information, treatment education, field mapping, infestation control and eradication, early detection and response, and cost-share or discounted product incentives. Local contact information for the Weed and Pest Control Districts within the study area includes the following:

Platte County Weed & Pest Control
506 Schroeder Road
Wheatland, WY (307) 322-3210

Statewide weed and pest information can be obtained from: *http://www.wyoweed.org/*

8.3 State Programs

8.3.1 Wyoming Department of Environmental Quality

The WDEQ Water Quality Division administers the Nonpoint Source Program, which solicits funding proposals under Sections 319 and 205(j) of the Clean Water Act that address nonpoint sources of pollution within the state of Wyoming. Program funding depends upon federal budget appropriations and the annual fund allocation from the EPA to the state of Wyoming. Funded proposals usually address multiple program objectives such as BMP installation, agriculture and urban, information and education, and BMP effectiveness or water quality monitoring.

- **Section 319** grant funds are available to local, state, and federal agencies; nongovernmental organizations; and private individuals who implement projects that reduce nonpoint source pollution and improve the quality of surface water and groundwater.

- **Section 205(j)** funds are available to cities, towns, counties, and conservation districts for water quality management planning projects. These funds are not intended for construction or implementation of water quality controls, but rather, are to be targeted for water quality planning and assessment.

Information regarding program eligibility, priorities, and applications is available at the WDEQ Non-point Source Grant Resources website: *http://deq.wyoming.gov/wqd/non-point-source/resources/grant-resources/*

8.3.2 Wyoming Game and Fish Department

The following summary of funding assistance available from the Wyoming Game and Fish Department (WGFD) is quoted from the Water Management & Conservation Assistance Program Directory (WWDC, 2014). The full document can be accessed here:

http://wwdc.state.wy.us/wconsprog/2014WtrMgntConsDirectory.html

"The Wyoming Game and Fish Department may offer technical and funding assistance to help landowners, conservation groups, institutions, land managers, government agencies, industry, and non-profit organizations develop or maintain water sources for fish and wildlife. Assistance may also be provided for protecting or improving riparian areas/wetlands, restoring streams, and upgrading irrigation infrastructure in a manner that provides improved fish passage or diversion screening."

- **Habitat Trust Fund:** Funds can be used for acquiring, maintaining, or improving wildlife habitat; or for promoting human understanding and enjoyment of the fish and wildlife resource (habitat or information and education projects). Funds can be used for internal projects or paid as grants to an outside entity. All proposals must have a WGFD sponsor and be entered into a department proposal database by early January or early August annually. Project proposals will be prioritized for funding by department staff during January through March and the Wyoming Game and Fish Commission grants preliminary approval in March and final approval in July for funds available in July. No cost share is required but is strongly recommended. Projects should occur in priority habitats or watersheds. Approximately $600,000 to $1,200,000 is allocated annually to projects across Wyoming.

- **Fish Passage Grants:** Funds can be used for creating or improving upstream or downstream passage of all life stages of fish in Wyoming waterways and for screening diversions. Examples include developing fishways or fish ladders, assisting with the replacement of traditional push-up diversion dams with more fish-friendly options, and installing various screening technologies to keep fish from becoming entrained into irrigation ditches. All proposals must have a WGFD sponsor and be entered into a WGFD proposal database by early January annually. Project proposals will be prioritized for funding by department staff during January through March and the Wyoming Game and Fish Commission grants preliminary approval in March and final approval in July for funds available in July. No cost share is required but is strongly recommended. Projects should occur in priority habitats or watersheds. Approximately $25,000 to $90,000 is allocated annually to projects across Wyoming.

  For more information related to these funds, contact Paul Dey at Wyoming Game and Fish (*paul.dey@wyo.gov*).

Additionally, during its 2014 session, the Wyoming Legislature approved the Governor's budget request to support the local sage grouse working groups and fund conservation projects benefiting sage grouse and their habitat. Implementation of projects consistent with local sage-grouse conservation plans will assist in keeping the sage grouse from being listed under the federal Endangered Species Act. A detailed listing of sage grouse funding opportunities is available from the Wyoming Game and Fish department: https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SGC_FUNDINGOPPS_REVISED0414.pdf. Requests for Wyoming Sage Grouse Conservation funding directly through WGFD must be made on a separate project proposal form that has been included in the Digital Library delivered with this report. The project proposal form and more information related to sage grouse conservation is also available from the WGFD website located at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

8.3.3 Wyoming Office of State Lands and Investments (OSLI)

The OSLI is the administrative arm of the Board of Land Commissioners and the State Loan and Investment Board. It is the statutory responsibility of the OSLI to carry out the policy directives and decisions of these two boards. The organizational structure of OSLI consists of the Office of the Director and four divisions: Administrative Services Division, Trust Land Management Division, Field Service Division, and Wyoming State Forestry. Collectively, these divisions serve the trust beneficiaries–Wyoming's school children and state institutions; numerous clients in agriculture, mineral, timber, transportation, communication, public utility, recreation, tourism and other Wyoming industries; local government entities; state and federal agencies; and the resident and nonresident general public.

- The Farm Loan Program, established in 1921, provides long-term real estate loans to Wyoming's agricultural operators. The use of this program has been expanded over the years to also include irrigation loans, beginning agricultural producer and livestock enhancement loans, and most recently, hydropower development loans. These loans are made for a wide range of agricultural purposes, including as most applicable to the potential projects identified in Chapter 6, purchasing, constructing or installing equipment and/or improvements necessary to maintain or improve the earning capacity of the farming operation. Eligible applicants include individuals whose primary residence is in Wyoming and legal entities with a majority of the ownership meeting the individual residency requirements.

- Joint Powers Act Loan Program was established in 1974 and the Legislature authorized the Joint Powers Act Loan Program to benefit local communities for infrastructure needs. Funding for this program is set at $60 million and is provided from the Wyoming Permanent Fund. These programs are an aid to cities, counties and special districts in providing needed government services and public facilities.

A summary of Wyoming State Loan Programs available through the Office of State Lands and Investments is included in the Digital Library delivered with this report. More information is also available at: *https://sites.google.com/a/wyo.gov/osli/grantsloans*

8.3.4 Wyoming Water Development Commission

The WWDC is responsible for coordinating, developing, and planning Wyoming's water and related land resources. The Commission, which consists of ten members who are appointed by the governor with approval of the Senate, represents the four state water divisions and the Wind River Reservation. Clients served by the Commission include conservation districts, irrigation districts, conservancy districts, municipalities, water and sewer districts, joint powers boards, improvement and service districts, counties, and state agencies. It should be noted that on-farm improvements (e.g., gated pipe, side rolls, center pivots, and related facilities and/or equipment such as pumps and power lines) are excluded from WWDC funding.

The WWDC administers and develops financing recommendations for the Wyoming Water Development Program, which was defined as the following by W.S. 41-2-112(a):

> *Established to foster, promote and encourage the optimal development of the state's human, industrial, mineral, agricultural, water and recreational resources. The program shall provide, through the commission, procedures and policies for the planning, selection, financing, construction, acquisition and operation of projects and facilities for the conservation, storage, distribution and use of water, necessary in the public interest to develop and preserve Wyoming's water and related land resources. The program shall encourage development of water facilities for irrigation, for reduction of flood damage, for abatement of pollution, for preservation and development of fish and wildlife resources and for protection and improvement of public lands and shall help make available the waters of this state for all beneficial uses, including but not limited to municipal, domestic, agricultural, industrial, instream flows, hydroelectric power and recreational purposes, conservation of land resources and protection of the health, safety and general welfare of the people of the state of Wyoming.*

The primary Wyoming Water Development Program encompasses new development, rehabilitation, dams and reservoirs, small water projects, water resources planning, and management of funds obtained from the Bureau of Reclamation. Information described below was extracted from the Operating Criteria of the Wyoming Water Development Program (*http://wwdc.state.wy.us/opcrit/WWDPopCriteria.html*). Additional project application information is available at: *http://wwdc.state.wy.us/project_application_info/project_app_info.html*

8.3.4.1 Programs

New Development Program: The New Development Program develops presently unused and/or un-appropriated waters of Wyoming. This program provides an opportunity for sponsors to develop water supplies for existing and anticipated future needs to ensure that lack of water supply will not inhibit economic growth. The program encourages water development through state/local partnerships. New development projects can proceed as sponsored projects, state projects, or the sponsor can complete a water supply project with state funding assistance. The application and review process for new development projects is addressed further in section 8.3.4.2.

Rehabilitation Program: The purpose of the Rehabilitation Program is to provide funding assistance for the improvement of water projects completed and in use for at least fifteen (15) years. The program serves to assist project sponsors in keeping existing water supplies effective and viable, thereby preserving their use for the future. Rehabilitation projects can improve an existing municipal or rural domestic water supply system or an agricultural storage facility or conveyance system. The projects serve to ensure dam safety; decrease operation, maintenance, and replacement costs; and/or provide a more efficient means of using existing water supplies. Rehabilitation projects are initiated by an application from a project sponsor and are usually assigned a Level II status. The project sponsor must be willing and capable of financially supporting a portion of the project development costs plus all operation and maintenance costs. The application and review process for rehabilitation projects is addressed further in section 8.3.4.2.

Dam and Reservoir Program: Proposed new dams with storage capacity of 2,000 acre-feet or more and proposed expansions of existing dams of 1,000 acre-feet or more qualify for the Dam and Reservoir Program. Dams and reservoirs typically provide opportunities for many potential uses. While water supply is emphasized in developing reservoir operating plans, recreation, environmental enhancement, flood control, erosion control and hydropower uses should be explored as secondary purposes. The application and review process for dam/reservoir projects is addressed further in section 8.3.4.2.

Small Water Project Program: This program provides grants up to $35,000 for a variety of projects such as small reservoirs, pipelines and conveyance facilities, springs, solar platforms, irrigation works, windmills and wetland developments. Small water projects are addressed further in section 8.3.4.3.

Drinking Water State Revolving Fund: Water development account funds can provide 50% of the state's matching fund requirements for the federal Drinking Water State Revolving Loan Fund (DWSRF). The DWSRF program may be used to fund improvements to water treatment systems and other Safe Drinking Water Act compliance issues.

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

- **River Basin Plans:** The program serves to develop basin-wide plans for each of the state's major drainage basins.

- **Watershed Studies:** These studies incorporate technical information that describe and evaluate the watershed's existing conditions including hydrology, geology, geomorphology, geography, soils, vegetation, water conveyance infrastructure, and stream system data.

Watershed Studies, developed through local public outreach, identify projects that are eligible for funding from WWDC and other sources. These projects help to improve or maintain watershed functions and systems.

- **Master Plans:** The program provides a service to municipalities, districts, and other entities to assist in preparing planning documents that serve as master plans for future water supply systems and improvements. The plans are 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. Master plans provide information to users as to whether the resource can adequately service the existing and anticipated demands for water within a certain area and provide reconnaissance level information regarding costs and scheduling.

- **Research:** Water development issues and problems may encompass watersheds, river basins or include the entire state. In order to address these issues, non-project specific research and data collection is necessary. The legislature has assigned the Water Development Program the following research tasks:

    - Instream flow: The WWDC files water right applications with the State Engineer for permits to appropriate water for instream flows in those segments of stream recommended by the WGFD. They also must generate feasibility reports for all instream flow permit applications, quantify existing water rights above and within the stream segment, and determine whether instream flows may conflict with future water development opportunities.

    - Groundwater Grant Program**:** The primary purpose of the program is to inventory the available groundwater resources in the state. The program also serves to assist communities in the development of efficient water supplies. Municipalities and special districts that purvey drinking water are eligible to receive up to $400,000 in grant funds if 25 percent of the total project costs will be paid by local matching funds.

    - University of Wyoming's Office of Water Programs: The WWDC provides funding each year to the UW Office of Water Programs to fund non-project water related research. The Selection Committee, made up of federal and state agency representatives, prioritizes topics and issues requests for proposals to address these areas of concern. From these requests, proposals are selected by the WWDC and SWC.

Upper Colorado River Basin Fund Memorandum of Agreement: The State of Wyoming has certain specified rights to apply for and recommend the expenditure of a percentage of collected revenues defined under the Colorado River Storage Project Act. Thus, the WWDC accepts applications and provides recommendations for projects to be funded by the Bureau of Reclamation in Wyoming.

8.3.4.2 Application and Review of New Development, Rehabilitation, and Dam/Reservoir Projects

a) Sponsor Requirements

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 loan. A project sponsor can be a municipality, irrigation district, joint powers board, or other approved assessment district, which will realize the major direct benefits of the project. The project sponsor must be willing and capable of financially supporting a portion of the project development costs and all operation and maintenance costs. Sponsors request project technical and financial assistance from the WWDC through the application process. The sponsor may request that a Level I or Level II study be conducted to identify solutions and alternatives for addressing water supply issues or they may request funds for a Level III construction project if it is determined the project is technically and economically feasible and serves to meet a water supply need or alleviate a water supply problem.

The WWDC may accept applications for Level I studies from applicants that are not public entities. Applicants may then know if there is a viable project before becoming a public entity. However, the applicant must be a public entity before applying for a Level II study. Under these circumstances, the Level I process will have a 2-year duration with the study being completed the first year and the sponsor forming the public entity the second year. If the WWDC is to consider waiving this requirement, a representative of the applicant shall be required to appear before the WWDC to make a formal presentation on the project and to answer questions regarding the application.

b) Application Process

Projects originate with sponsoring public entities and come to the WWDC through applications. Water development projects are defined with three levels. Project planning is performed in Levels I and II, and project construction is performed in Level III. Levels I and II are 100% State funded.

- Level I studies carry out necessary reconnaissance work
- Level II studies determine a project's feasibility
- Level III studies include project design, permitting, land acquisition, construction and construction engineering

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

- A fee of $1,000 must be submitted with the initial project applications, with the exception of projects advancing in the Water Development Program from studies which were completed within the last 5 years. If the application is denied, then seventy-five percent (75%) of the application fee shall be refunded to the applicant.

- A certified original of a resolution passed by the governing body of the sponsoring entity must accompany a new program application. Applicants that are not public entities shall provide evidence of support for the application by providing letters or petitions from interested water users as a substitute for a resolution. If the applicant is not a public entity at the time of the application, a written description of all steps completed by the sponsor to become a public entity and proposed time line for completion of requirements to become a public entity. This shall include a listing of all landowners notified by the sponsors of the intent to submit a funding application and form a special district.

- Financial information such as the annual budget, existing balance, revenue sources, and funding obtained as well as a map of the area must be submitted with the application.

- Level III studies must also include a comprehensive financing plan, and written verification from any impacted city, county, or special district that they have been notified of the project and its potential impacts.

- The deadline for Level I and II project applications is March 1 of each year; the deadline for Level III project applications is September 1 of each year.

c) Special Procedures for Dam and Reservoir Program

Since the federal permitting process for dams and reservoirs is very complex and could ultimately impact the feasibility of the project, work that would normally be completed under the Level III construction process can be completed under Level II-Phase III for dam projects. This work includes final engineering design, reviews required by the National Environmental Policy Act, consultations required by the Endangered Species Act, and acquisition of state and federal permits.

In addition, the WWDC may accept applications related to the construction of dams and reservoirs from applicants that are not public entities. This will allow the applicant to know if the proposed reservoir is feasible prior to becoming a public entity. However, the applicant must be a public entity before applying for Level II, Phase III funding.

d) Financial Plan

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 because of 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 the 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 believes is relevant to the Commission's final decision. The current standard terms of the Wyoming Water Development Program financial plan are summarized as follows:

- Typically, 67 percent grant to 33 percent loan mix (maximum grant is 75%)
- Minimum 4 percent loan interest rate (current rate is 4 percent, but legislature may increase the rate)
- Maximum 50-year term of loans; term shall not exceed the economic life of project.
- Payment of loan interest and principal may be deferred up to 5 years after substantial completion at WWDC's discretion under special circumstances.

e) Priorities

As previously discussed, the statutory guidelines are sufficiently broad to allow the program to address all types of projects involving water. However, in order to establish priorities and to utilize available program funds effectively and efficiently, it is necessary to develop priorities relative to the types of water projects the program should pursue. The WWDC has established eligible project priorities for each of the three Water Development Funds as shown in Tables 8.3-1 through 8.3-3.

f) Recommendation Process

The Water Development Commission uses the following process to generate funding recommendations for legislative consideration.

Table 8.3-1 Project Priority Ranking for New Development.

Project Priority	Project Description
1	Level III projects developing new storage
2	Level III projects developing unappropriated water – examples include wells & diversion structures requiring the issuance of new water rights
3	Level III transmission pipelines
4	Level III potable water storage tanks
5	Level III irrigation canals and structures serving new lands
6	Level II feasibility studies
7	Watershed Studies
8	Level I reconnaissance studies
9	Weather modification projects
10	River basin plans
11	Level II hydropower studies (level II studies only)
12	Level III raw water system controls and control valves
13	Level III water system controls and control valves
14	Previously approved subdivision improvements

Table 8.3-2 Project Priority Ranking for Rehabilitation.

Project Priority	Project Description
1	Level III rehabilitation of water diversion or control structures
2	Level III rehabilitation of existing irrigation canals
3	Level III replacement of existing transmission pipelines
4	Level III rehabilitation of existing water storage tanks
5	Level III rehabilitation of raw water storage facilities
6	Level III rehabilitation of existing reservoirs
7	Level II feasibility studies
8	Level I reconnaissance studies
9	Level III raw water systems to irrigate parks and lawns
10	Level III replacement of water system controls & control valves
11	Previously approved subdivision improvements
12	Level II hydropower studies (level II studies only)

Table 8.3-3 Project Priority Ranking for Dams and Reservoirs.

Project Priority	Project Description
1	Level III development of new storage in excess of 2000 AF
2	Level III development of storage enlargements in excess of 1000 AF
3	Purchase of existing storage as an alternative to building new storage
4	Level II feasibility studies
5	Level I reconnaissance studies

1) **Level I and II Applications**: Submitted on March 1st, documentation is reviewed and WWDC makes preliminary recommendations regarding applications at its November meeting.

2) **Level III Applications**: Submitted September 1st, consultant project reports are drafted by this date and are reviewed to determine whether the projects warrant advancement in the program.

3) **Preliminary Recommendations**: At the November WWDC meeting, the WWDO director presents funding recommendations for new applications and existing projects. Project sponsors are given the opportunity to present their requests. The WWDC takes preliminary action on the sponsor's request at this meeting.

4) **Public Meetings**: If a proposed Level I or Level II Study is of particular concern or controversy, the WWDC may solicit public input at a public meeting prior to finalizing its project recommendation.

5) **Public Hearings**: The Commission holds formal public hearings on all projects that are proposed for Level III Construction funding.

6) **Coordination with the Governor**: The WWDC provides the Governor with its preliminary recommendations and a financial report addressing impacts to the water development accounts. The Governor may provide input throughout the recommendation process.

7) **Final Recommendations**: The WWDC meets in December or early January to finalize its legislative recommendations on new applications and existing projects, considering public input and recommendations from the Governor. Sponsors and interested parties who disagree with the Commission's preliminary recommendation are provided the opportunity to address the Commission with their concerns.

8) **Select Water Committee**: Comprised of 6 senators and 6 representatives, the Committee provides legislative oversight for the program, and reviews the Commission's recommendations and budgets. Typically, the Select Water Committee serves as the sponsor for the Water Development Program legislation.

9) **Legislative Process**: The legislature must authorize the allocation of funds from the water development accounts to particular projects. This approval is solicited through the Omnibus Water Planning and Construction Bills.

8.3.4.3 Small Water Project Program (SWPP)

The SWPP is intended to be compatible with the conventional WWDC program described above and provide incentives for improving watershed condition and function. Fifty percent (50%) grants up to $35,000 are available for eligible projects that provide adequate public benefit, improve watershed health, and meet program definitions.

Eligibility:

According to the WWDC's operating criteria, the following types of projects are eligible for funding through the SWPP:

1) **Small Reservoir:** A small reservoirs may be eligible (Size limitations have been removed).

2) **Well:** A well may be eligible for funding depending on the depth of the well and scope of the project. Projects that propose to drill into unproven aquifers, as determined by the WWDO, may be eligible for the SWPP at the discretion of the WWDC. Such discretion will be exercised in cases including, but not limited to, cases where the well does not meet the minimum requirements of the project in terms of quality and quantity.

   The determination of unproven aquifer status will be clearly communicated by the WWDO prior to the issuance of notice to proceed so the project sponsor may decide to cancel the project before funding is committed. If the sponsor decides to proceed with a well into an unproven aquifer they should be prepared to pay the drilling cost with the understanding that reimbursement for eligible.

3) **Solar Platforms:** Construction of solar platforms may be eligible for funding through the SWPP.

4) **Pipelines and conveyance facilities:** Rehabilitation of existing pipelines or conveyance facilities or construction of new pipelines or conveyance facilities may be eligible for funding through the SWPP.

5) **Springs:** Improving flows of existing springs and installation of collection facilities associated with springs may be eligible for funding through the SWPP.

6) **Wetland Development:** Development of wetlands where multiple benefits accrue may be eligible for funding through the SWPP.

7) **Environmental:** Projects that provide for stream bank stability, water quality improvements, or erosion protection may be eligible for funding through the SWPP.

8) **Irrigation:** Irrigation projects may be eligible for funding through the SWPP.

9) **Windmill:** Rehabilitation of existing windmills or construction of new windmills may be eligible for funding through the SWPP.

10) **Rural Community Fire Suppression:** Supply and storage projects for rural community fire suppression may be considered for funding through the SWPP.

11) **Recreational:** Projects for recreational purposes may be considered for SWPP funding. Funding can only be provided to eligible public entities including but not necessarily limited to conservation districts, watershed improvement districts, water conservancy districts, and irrigation districts.

Application, Evaluation and Administration. Details of the application and evaluation process and program administrative procedures are provided in the Small Water Project Program Operating Criteria available online at: *http://wwdc.state.wy.us/small_water_projects/SWPPopCriteria.html* . Some key aspects of the process and procedures applicable to the potential projects identified in Chapter 6 include the following:

- Small water projects must adequately demonstrate a public benefit. Public benefit may be demonstrated for projects included in WWDC Watershed Studies. Eligible projects may be located on Federal, State, public, or private lands.

- Applications shall be received by January 1 of each calendar year. Applications meeting criteria requirements will be considered during the regularly scheduled WWDC meeting in March. Applications shall 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.

- Projects that improve watershed condition and function, provide multiple benefits, and meet the funding criteria specified in W.S. 99-3-703(j)(vii) or W.S. 99-3-704(g)(vii), are eligible for consideration.

- The sponsoring entity will be required to address the WWDC and provide testimony and other additional supporting evidence that justifies SWPP funding whenever the public benefit documentation, submitted with the application, is deemed to be insufficient by the WWDC.

- Projects that have completed the following requirements prior to application will be classified as "Shovel Ready" and may be considered as a funding priority at the Commission's discretion.

    - Permit procurement

    - State and Federal agency notifications

    - Land procurement, right of way, or easement acquisition

    - Have finalized all other financial agreements

8.3.5 Wyoming Wildlife and Natural Resource Trust

The Wildlife and Natural Resource Trust (WWNRT), created in 2005, is an independent state agency governed by a nine-member citizen board appointed by the Governor. Funded by interest earned on a permanent account, donations, and legislative appropriation, the purpose of the program is 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 may be considered for funding.

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.

- 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 preferred 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:

- Improvement and maintenance of existing aquatic habitat necessary to maintain optimum fish populations.

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

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

Non-profit and governmental organizations (including watershed improvement districts, conservation districts, etc.) are eligible for funding by WWNRT. The application form has been included in the digital library and more information on the application process is available here: *https://sites.google.com/a/wyo.gov/wwnrt/how-to-apply*

8.4 Federal Agencies

8.4.1 Bureau of Land Management (BLM)

- **Range Improvement Planning and Development** 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 the 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 matching 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.

- **BLM's 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 (EPA Clean Water Act) 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 Total Maximum Daily Loads (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 are the restoration and maintenance of healthy watershed function. These goals will typically be accomplished through approved BMP's, e.g. prescribed burns, vegetation treatments, instream structures, enhancement of vegetation cover, controlling accelerated soil erosion, increasing water infiltration, and enhancement of stream flows and water quality.

Additionally, 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.

- **BLM's Riparian Habitat Management 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.

8.4.2 United States Bureau of Reclamation (USBR)

The USBR mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the public. The USBR has a major responsibility, in partnership with states, water users, and other interested parties, to help improve water resources and the water use efficiency in the western United States.

The USBR Sustain and Manage America's Resources for Tomorrow (WaterSMART) Program establishes a framework to provide federal leadership and assistance on the efficient use of water, integrating water and energy policies to support the sustainable use of all natural resources, and coordinating the water conservation activities of various department bureaus and offices. Through the WaterSMART Program, the department is working to achieve a sustainable water management strategy to meet the nation's water needs through projects that conserve and use water more efficiently, increase the use of renewable energy and improve energy efficiency, protect endangered and threatened species, facilitate water markets, or carry out other activities to address climate-related impacts on water or prevent any water-related crisis or conflict.

A major component of WaterSMART is the Water and Energy Efficiency Grant Program, through which USBR provides funding in two groups. In Funding Group I, up to $300,000 in federal funding is available per project, for smaller on-the-ground projects. In Funding Group II, up to $1 million in funding is available for larger, phased, on-the-ground projects that may take up to 3 years to complete. Water and Energy Efficiency Grants are awarded through a west-wide competitive process that requires a minimum 50 percent cost share by the recipient.

The Water Conservation Field Services Program (WCFSP), by contrast, provides smaller amounts of funding ($100,000 per project maximum) through local competitions within a region or area. The projects funded are generally smaller in scope than Water and Energy Efficiency Grant projects and are focused on fundamental conservation improvements as identified in water conservation plans developed by water users. Financial assistance provided through the WCFSP also requires a minimum 50 percent cost share by the recipient.

At the time of the report, the USBR was in the process of updating the Water Conservation Field Services Program and had issued a Temporary Reclamation Manual Release (TRMR) to ensure consistency and efficiency when providing financial assistance as part of the Water Conservation Field Services Program. This TRMR provided that financial assistance will be available under the WCFSP for water conservation planning, development of system optimization reviews, designing water management improvements, and demonstration projects. The Reclamation was working on a permanent Water Conservation Field Services Program Directive and Standard, which would include an opportunity for public review. In the meantime, this TRMR was issued to ensure that some key program requirements were captured. Please visit http://www.usbr.gov/watersmart/ for more information or contact:

Josh German
303-445-2839
jgerman@usbr.gov

8.4.3 Environmental Protection Agency (EPA)

The EPA has several grant programs that could potentially provide funding opportunities for projects described in this report.

- **Urban Waters Program:** This program was established in 2012 to help local residents and their organizations, particularly those in underserved communities, restore their urban waters in ways that also benefit community and economic revitalization. The two types of grants available through this program are listed below:
  - **The Urban Waters Small Grants** are competed and awarded every two years. Since its inception in 2012, the program has awarded approximately $5.3 million in Urban Waters Small Grants to 92 organizations across the country, with individual award amounts of up to $60,000. Urban Waters Small Grants Program projects must address local water

quality issues related to urban runoff pollution, provide additional community benefits, actively engage underserved communities, and foster partnerships. Specific information pertaining to the types of projects funded was not available.

  - **The Five Star/Urban Waters Restoration Grant Program** projects include on-the-ground activities (for example: wetland or river habitat restoration), integrated education, outreach and training, measurable ecological and community benefits, and community partnership building emphasis. As this program is organized by the National Fish and Wildlife Foundation (NFWF), see Section 8.5.2 for more information.

- **Healthy Watersheds Program:** After decades of focusing almost exclusively on restoring impaired waters, EPA created the Healthy Watersheds Program to help address the "maintain" component of the "restore and maintain" goal intended by Congress in the 1972 Federal Water Pollution Control Act amendments. Through a multi-year cooperative agreement awarded in 2015, EPA is helping to support watershed protection via a healthy watershed grants consortium. This consortium brings together like-minded partners from all levels of government, private organizations and industry to support individual watershed protection projects through grants, using leveraged funding from government and non-government sources together. Details and contact information on healthy watersheds grants can be found at: *https://www.epa.gov/hwp/what-epa-doing-healthy-watersheds*

- **Section 319** was added to the Clean Water Act (CWA) in 1987 to establish a national program to address nonpoint sources of water pollution. Section 319(h) specifically authorizes EPA to award grants to states with approved Nonpoint Source Assessment Reports and Nonpoint Source Management Programs. The funds are to be used to implement programs and projects designed to reduce nonpoint source pollution. Grant funds are available to local, state, and federal agencies; nongovernmental organizations; and private individuals through the Wyoming Department of Environmental Quality (See Section 8.3.1).

8.4.4 Farm Service Agency

The FSA administers a variety of different programs that may be applicable to some of the alternative projects identified in Chapter 6. The FSA is a member agency of the USDA. Programs administered through the FSA are offered through local county committees. Technical assistance needed for implementing FSA programs is provided through the NRCS.

Several of the available programs are briefly discussed below and more information can be obtained from the FSA conservation program website (*https://www.fsa.usda.gov/programs-and-services/conservation-programs/index*):

- **Conservation Reserve Program (CRP)**: The CRP offers agricultural producers annual rental payments to remove highly erodible cropland from production. Through the CRP, farmers and ranchers establish long-term conservation practices on erodible and environmentally sensitive land. In exchange, they receive 10–15 years of annual rental payments and cost-share assistance. The CRP is a voluntary program specifically for highly erodible lands currently in active production planted two of the five most recent crop years. Land offered for CRP is ranked according to environmental benefit for wildlife habitat, erosion control, water quality, and air quality. Land must meet the requirements of CRP and be determined by the NRCS to be eligible and suitable for the following:

Riparian buffers	Shelter belts	Salt tolerant vegetation
Filter strips	Living snow fences	Shallow water areas for wildlife
Grass waterways	Contour grass strips	Buffers for Wildlife Habitat
Wetlands Buffer	Wetland Restoration	

- **Emergency Conservation Program (ECP):** The ECP 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 for livestock during periods of severe drought. 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. The FSA County Committee is able to approve applications up to $50,000 while $50,001 to $100,000 requires state committee approval. Some of the conservation practices included are removing debris, restoring fences and conservation structures, and providing water for livestock in drought situations.

- **Farmable Wetlands Program**: The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer zones to improve both vegetation and water flow. FWP provides annual rental payments in return for restoring wetlands and establishing plant cover. Eligible land must have been used for agricultural purposes for 3 of the past 10 crop years.

- **Grassland Reserve Program**: The Grassland Reserve Program (FWP) is designed to prevent grazing and pasture land from being converted to cropland, urban development, or other non-grazing uses. Participants in the program voluntarily limit future development of their grazing and pasture land, while still being able to use the land for livestock grazing and activities related to forage and seed production.

- **Source Water Protection Program (SWPP)**: The SWPP is designed to help prevent pollution of surface and ground water used as the primary source of drinking water by rural residents.

8.4.5 U.S. Fish and Wildlife Service

Technical and financial assistance are available to private landowners, for profit or nonprofit entities, public agencies and public-private partnerships under several programs addressing the management, conservation, restoration or enhancement of wildlife and aquatic habitat (including riparian areas, streams, wetlands and grasslands). These programs include, but are not necessarily limited to:

- **Partners for Fish and Wildlife Program:** The Partners for Fish and Wildlife Program serves as the primary tool for conservation delivery on privately owned land for the USFWS. The program provides technical and financial assistance to private landowners and tribes on a voluntary basis to help meet the habitat needs of federal trust species and conservation partner-designated species of interest. The program targets habitats that are in need of restoration or enhancement such as riparian areas, streams, wetlands, and grassland. Field biologists work one-on-one with landowners and partners to plan and implement a variety of projects, including grazing lands management, sage steppe enhancement, stream habitat improvement and fish passage, invasive species removal, and wetland establishment.

- **Wildlife and Sport Fish Restoration (WSFR) Program** works with states, and the District of Columbia to conserve, protect, and enhance fish, wildlife, their habitats, and the hunting, sport fishing, and recreational boating opportunities they provide. The WSFR Program provides oversight and/or administrative support for the following grant programs: Wildlife Restoration Grant Program, Sport Fish Restoration Grant Program, Boating Infrastructure Grant Program, State Wildlife Grant Program, Tribal Wildlife Grant Program, and Tribal Landowner Incentive Grant Program.

- **Cooperative Endangered Species Conservation Fund:** Cooperative Endangered Species Conservation Fund (Section 6 of the ESA) provides grants to states and territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species. The program provides funding to states and territories for species and habitat conservation actions on nonfederal lands. States and territories must contribute a minimum nonfederal match of 25 percent of the estimated program costs of approved projects, or 10 percent when two or more states or territories implement a joint project.

- **North American Wetlands Conservation Act (NAWCA) Grant Program:** This program promotes long-term conservation of wetlands ecosystems and the waterfowl, migratory birds, fish and wildlife that depend upon such habitat. Conservation actions supported are acquisitioning, enhancing, and restoring wetlands and wetlands-associated habitat. This program encourages voluntary, public-private partnerships. Public or private, profit or nonprofit entities, or individuals establishing public/private sector partnerships are eligible. Cost-share partners must at least match grant funds with non-federal monies.

- **Fish and Wildlife Service's (FWS) Challenge Cost Share Program:** This program started in 1988 as a way to enhance partnerships with state and local governments, individuals, and public and private groups. The program enables the FWS to manage cooperatively its natural and cultural resources and fulfill stewardship responsibilities to fish and wildlife management. Under this program, projects must occur on a refuge or directly benefit a refuge. The program encourages refuge managers to form partnerships and leverage allocated funds to complete the projects. Appropriated funds may be used to pay for no more than 50 percent of the cost of a project. Nonfederal sources, including state/local governments, private individuals/ organizations, business enterprises, and philanthropic and charitable groups provide the matching 50 percent cost share. The cooperator share may be a nonmonetary contribution. Cooperative agreements are signed with the cost-share partners

More information regarding these programs and others is available at: *http://www.fws.gov/grants/programs.html*

8.4.6 Natural Resources Conservation Service (NRCS)

The NRCS administers a number of funding and technical assistance programs applicable to many of the alternative projects, described below. The NRCS provides leadership in a partnership effort to help people voluntarily conserve, improve, and sustain natural resources on private lands. The purpose and mission of the agency is to help landowners treat their private property according to its needs and within its capability. The treatment includes a balance between the land use for economic return and protecting its ability to be productive from generation to generation.

Technical and cost-share assistance is available through the NRCS. This assistance includes designs, specifications, construction, and management and financial help for practice and system installation. Local people, individually and collectively, decide how to use NRCS capabilities in the natural resource conservation planning and application process. The role of NRCS is to support and facilitate these individual and local decisions based on good resource information, whether that is a grazing management plan or layout for an irrigation system. For example, the Conservation of Private Grazing Land (CPGL) **e**nsures that technical, educational, and related assistance is provided to those who own private grazing lands. This technical assistance will offer opportunities for: better grazing land management; protecting soil from erosive wind and water; using more energy-efficient ways to produce food and fiber; conserving water; providing habitat for wildlife; sustaining forage and grazing plants; using plants to sequester greenhouse gases and increase soil organic matter; and using grazing lands as a source of biomass energy and raw materials for industrial products.

NRCS administers the following Landscape Planning Programs:

- **Emergency Watershed Protection (EWP) Program:** This program assists in implementing emergency measures, including the purchase of floodplain 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.

- **Watershed Protection and Flood Prevention Operations (WFPO) Program:** This program provides technical and financial assistance to entities of state and local governments and tribes for planning and installing watershed projects.

- **Watershed Surveys and Planning (WSP):** The WSP authorizes the NRCS to cooperate with federal, state, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, sediment, and to conserve and develop water and land resources.

- **Watershed Rehabilitation Program**: This program helps project sponsors rehabilitate aging dams that are reaching the end of their 50-year design lives. This rehabilitation addresses critical public health and safety concerns. Since 1948, NRCS has assisted local sponsors in constructing more than 11,800 dams.

NRCS administers the following 2014 Farm Bill programs:

- **Agricultural Management Assistance (AMA):** The AMA provides financial assistance to agricultural producers to address resource issues such as water management, water quality, invasive species control, and erosion control by incorporating conservation into their farming or ranching operations. The purpose of the AMA is to assist producers in reducing risk to their operation.

- **Conservation Stewardship Program (CSP):** The CSP encourages land stewards to improve their conservation performance by installing and adopting additional activities, and improving, maintaining, and managing existing activities on agricultural land and non-industrial private forest land.

- **Environmental Quality Incentives (EQIP):** Through EQIP, technical assistance, cost share, and incentive payments are available to agricultural producers to implement conservation practices that improve water quality, enhance grazing lands, and/or increase water conservation.

- **Regional Conservation Partnership Program (RCPP):** The RCPP promotes coordination between the NRCS and its partners to deliver conservation assistance to producers and landowners. The NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. Assistance is delivered in accordance with the rules of EQIP, CSP, Agricultural Conservation Easement Program (ACEP), and HFRP and in certain areas the Watershed Operations and Flood Prevention Program.

- **Agricultural Conservation Easement Program (ACEP):** The ACEP provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements (ALE) component, NRCS helps tribes, state and local governments, and nongovernmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements (WRE) component, the NRCS helps to restore, protect and enhance enrolled wetlands.

Other NRCS Programs:

- **Conservation Innovation Grants (CIG) Program:** The CIG is intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, EQIP funds are used to award competitive grants to nonfederal governmental or nongovernmental organizations, tribes, or individuals.

- **Sage Grouse Initiative (SGI):** The Sage Grouse Initiative is an organization of public and private entities conserving at-risk wildlife through voluntary cooperation, incentives, and community support. The Natural Resources Conservation Service launched SGI in 2010, applying the power of the Farm Bill to target lands where habitats are intact and sage grouse numbers are highest – covering 78 million acres across 11 western states. While private lands are the primary focus, the Initiative serves as a catalyst for public land enhancements. The Sage Grouse Initiative applies Farm Bill dollars and certifies conservation projects in the core areas for sage grouse with a dual goal of sustaining rangelands and sage grouse. In addition to directing dollars to private lands where 40 percent of sage grouse live, SGI dollars can be applied on public lands where ranchers have grazing leases. For more details related to funding opportunities, please contact your local NRCS office. Detailed information related to the Sage Grouse Initiative can be found at the following website: *http://www.sagegrouseinitiative.com/*

Information on all NRCS programs is available from the local contacts listed in Table 8.1-1.

8.4.7 US Army Corps of Engineers (USACE)

The 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 floodplain management. The Corps is responsible for a worldwide military construction program, an extensive environmental program and a broad national civil works program.

The Corps of Engineers 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.

- **Floodplain Management Services:** This program provides technical services and planning guidance for support and promotion of effective floodplain 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 floodplain 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 Corps 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. An initial study is 100% federally funded up to $100,000. All planning costs after the first $100,000 are cost shared 50/50. All design and construction costs are cost shared 75% Federal and 25% non-Federal. The Federal cost limit is $5,000,000. The non-Federal sponsor cost share can be a contribution of cash, Lands, Easements, Rights-of-way, Relocations, and Disposal areas (LERRDs), or work-in-kind. Work-in-kind may be provided subsequent to the execution of a Project Partnership Agreement (PPA), and the value may not exceed 80% of the non-Federal share.

- **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 as 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 Corps 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 Corps of Engineers 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 of the U.S. This would include dams and dikes, levees, riprap, bank stabilization and development fill. There are three kinds of permits issued by the Corps: They are Individual, Nationwide and Regional General permits.

The local contact for the USACE is:

Wyoming Regulatory Office
2232 Dell Range Blvd,
Suite 210
Cheyenne, Wyoming 82009
Ph: 307-772-2300

8.4.8 United States Department of Agriculture (USDA) Rural Development

The USDA Rural Development's Water & Environmental Program (WEP) 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.

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. 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 associated 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. More information can be found at: https://www.rd.usda.gov/programs-services/all-programs/water-environmental-programs.

8.4.9 Wyoming Landscape Conservation Initiative (WLCI)

The WLCI is a long-term science based effort to assess and enhance aquatic and terrestrial habitats at a landscape scale in southwest Wyoming, while facilitating responsible development through local collaboration and partnerships. The WLCI is composed of numerous committees and teams made up of representatives from the participating agencies. These agencies include: BLM, USGS, US Fish and Wildlife Service, US Forest Service, Wyoming Game and Fish Department, Wyoming Department of Agriculture, Southwest Wyoming County Commissions, Southwest Wyoming Conservation Districts, US National Park Service, NRCS, University of Wyoming, and the US Bureau of Reclamation.

Information gathered through scientific inventory and assessment of species and habitat is combined with local input and knowledge to develop and implement conservation projects. The WLCI conducts regular Local Project Development Team meetings, where public participation is needed and expected. Ideas for projects can be presented at these meetings or sent to the WLCI Coordination Team through the BLM High Desert District Office at (307) 352-0227 or *blm_wy_wlci_wymail@blm.gov.*

The project application form, project tracking and project ranking score sheet are available from the following website, and have been included in the digital library delivered with this report (*http://www.wlci.gov/lpdt-resources*).

8.5 Non-Profit and Other Organizations

8.5.1 Ducks Unlimited

Ducks Unlimited, Inc. (DU) is a potential funding source for wetlands and waterfowl restoration projects. Although direct grant funding is limited (to the extent that there is generally about $20,000 to $30,000 available annually statewide), in-kind assistance may be available from the local chapter of DU. Additional information on DU's funding programs and opportunities is available in the Water Management & Conservation Assistance Program Directory referenced previously.

DU offers a waterfowl habitat development and protection program called Matching Aid to Restore States Habitat (MARSH). This is a reimbursement program that provides matching funds for restoring, protecting, or enhancing 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. Specifics for proposal submission, budget preparation, project development, and receipt of funding can be further explained by the DU local coordinator.

Great Plains Regional Office
(701) 355-3500

8.5.2 National Fish and Wildlife Foundation (NFWF)

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 to projects that sustain, restore, and enhance our nation's fish, wildlife, and plants and their habitats. The available programs and initiatives are listed and detailed here: *http://www.nfwf.org/whatwedo/programs/Pages/home.aspx*. The programs listed, support diverse projects for wildlife and habitat conservation across the county. The initiatives provided in this listing, each have a Board of Directors approved business plan developed by scientists and other experts. Grants are available to support the actions identified in the business plan.

Some of the grants/programs that may be applicable to potential projects in the Lower Laramie River Study Area include, but are not limited to the following:

- **Acres for America:** Acres for America is one of the most effective public-private partnerships in the history of U.S. conservation efforts. The Acres for America program conserves lands of national significance, protects critical fish and wildlife habitat and benefits people and local economies.

- **Bring Back the Natives Grant Program:** This program invests in conservation activities that restore, protect, and enhance native populations of sensitive or listed fish species across the United States, especially in areas on or adjacent to federal lands. The program emphasizes coordination between private landowners and federal agencies, tribes, corporations, and states to improve the ecosystem functions and health of watersheds. The end result is conservation of aquatic ecosystems, increase of in-stream flows, and partnerships that benefit native fish species throughout the U.S. This funding opportunity also provides grants to implement the goals of the National Fish Habitat Action Plan.

- **Conservation Partners Program:** The primary goals of this program are targeting funds made available by the federal Farm Bill toward priority conservation objectives and maximizing the funds benefits. Through these regional grants, this conservation program has begun to place expert staff ("boots-on-the-ground") where they can maximize outreach to the private landowner.

- **Five-Star Urban Waters Restoration Grant Program:** This program provides 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. Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Funding levels are modest, from $10,000 to $40,000, with $20,000 as the average amount awarded per project. However, when combined with the contributions of partners, projects that make a meaningful contribution to communities become possible.

- **Pulling Together Initiative:** This program provides support on a competitive basis for the formation of local Weed Management Area (WMA) partnerships that engage 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 strategy; minimum 1:1 nonfederal match is required.

- **Environmental Solutions for Communities Initiative:** This program was designed to support projects that link economic development and community well-being to the stewardship and health of the environment. Funding is available for projects that conserve critical land and water resources or improve local water quality. Another priority of this initiative is restoring and managing natural habitat, species and ecosystems that are important to community livelihoods.

Information about all of these and other NFWF grants/programs is available at their website: http://www.nfwf.org/whatwedo/grants/pages/home.aspx.

8.5.3 Trout Unlimited

The mission of the Wyoming Council of Trout Unlimited is to conserve, protect, and restore Wyoming's cold-water (trout) fisheries and their watersheds. The (TU) Council is made up of 11 chapters located throughout the state. While a majority of Trout Unlimited members are indeed enthusiastic anglers, their focus is not only on maintaining fisheries for the purpose of angling. Healthy trout fisheries are indicative of well-functioning, sound ecosystems and the work done towards restoring good trout habitat will ultimately benefit the overall environment.

Of special concern are Wyoming's four subspecies of native cutthroat trout that currently inhabit a tiny fraction of their historic range. Working with federal and state agencies, local officials and landowners, Wyoming Trout Unlimited is actively engaged in a battle to keep these fish from being listed under the Endangered Species Act. Trout Unlimited provides funding and volunteer labor for a 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 and can include local conservation districts and state and federal agencies. Those interested should contact the Council office.

8.6 District Formation

8.6.1 Overview

Many of the funding programs presented above require a legal entity such as a watershed improvement district, an irrigation district, or a municipality as the project sponsor. Within the State of Wyoming, there are at least seventeen different types of districts which can be formed, those most closely associated with watershed studies are:

1. Watershed Improvement District
2. Irrigation District
3. Water Conservancy Districts
4. Flood Control Districts
5. Drainage Districts

Reasons for establishing a district include:

- Establishment of a management structure
- Ability to pool financial and human resources
- Ability to evaluate, construct, manage, operate, and maintain water projects

- Ability to lobby representatives
- Protection of resources
- Eligibility for loans and grants from the WWDC or other state and federal agencies.

Appendix 8A contains additional information regarding districts and their formation.

8.6.2 Watershed Improvement Districts

A Watershed Improvement District (WID) is formed to:

- Provide for the prevention and control of erosion, floodwater and sediment damages, for agricultural uses, and the storage, conservation development, utilization and disposal of water, and thereby to preserve and protect land and water resources, and protect and promote the health, safety, and general welfare of the people of this state. (WS 41-8-102).

The purpose of the Watershed Improvement District (WID) legislation is to create a venue through which landowners can improve and maintain the quality of their watersheds with local or federally matched money. The elected board of directors, constituted of district landowners, shall authorize and oversee projects within their district. This mechanism allows local control of projects and funding. WIDs are eligible to receive grants and loans from the WWDC and to service the debt associated with the loans.

Watershed Improvement Districts are formed as subdistricts of Conservation Districts. The conservation district in which such subdistricts are formed shall cooperate, advise, and consult with the Wyoming Department of Agriculture in matters pertaining to the organization, operation and maintenance of the watershed improvement district.

8.6.3 Irrigation Districts

"The provisions of [Chapter 7 of the Wyoming Water Code for the establishment of irrigation districts] shall be liberally construed to promote the public welfare by reclaiming and irrigating lands, constructing and completing reservoirs, canals, ditches, or other works specified in the petition and the preservation of or operation of any irrigation system heretofore or hereafter constructed according to law." (W.S. 41-7-102).

An Irrigation District may be formed whenever a majority of those landowners who represent one third (1/3) of the lands within the proposed district desire to provide for the irrigation of the same; or to improve the existing water supply for said lands; or to purchase, extend, operate, or maintain constructed irrigation works; or to cooperate with the United States under the reclamation laws. [W.S. 41-7-201(a)].

8.6.4 Water Conservancy Districts

Water conservancy districts are designed “to provide for the conservation of the water resources of the State of Wyoming.” There are seven (7) statutorily-identified purposes for water conservancy districts [(W.S. 41-3-701(a)]:

(i) Be essentially for the public benefit and advantage of the people of the state of Wyoming;
(ii) Indirectly benefit all industries of the state;
(iii) Indirectly benefit the state of Wyoming in the increase of its taxable property valuation;
(iv) Directly benefit municipalities by providing adequate supplies of water for domestic use;
(v) Directly benefit lands to be irrigated or drained from works to be constructed;
(vi) Directly benefit lands now under irrigation by stabilizing the flow of water in streams and by increasing flow and return flow of water to such streams; and
(vii) Promote the comfort, safety and welfare of the people of the state of Wyoming.

The conservancy district has the power to:

- To enter into contracts, to create and maintain offices; to elect, appoint and employ officers, attorneys, agents, and employees;
- To identify the lands that that are susceptible of irrigation from district sources, to allocate water to all such lands; and to levy assessment;
- To fix rates for selling or leasing water;
- To adopt plans and specifications for the works for which the District was organized;
- To appropriate and otherwise acquire water and water rights and related activities;
- To subscribe for, purchase and acquire stock in canal and similar companies;
- To provide, sell, lease, and deliver water for municipal, domestic, transportation, industrial, manufacturing, irrigation, power, recreation, and any and all other beneficial uses and to derive revenue and benefits therefrom;
- To invest surplus money;
- To refund bonded indebtedness incurred by the District;
- To borrow money and incur indebtedness and to issue bonds; and
- To adopt bylaws.
- To levy and collect taxes and special assessments

8.6.5 Flood Control Districts

The provisions of [Chapter 7 of the Wyoming Water Code for the establishment of irrigation districts] shall be liberally construed to promote the public welfare by reclaiming and irrigating lands, constructing and completing reservoirs, canals, ditches, or other works specified in the petition and the preservation of or operation of any irrigation system heretofore or hereafter constructed according to law.” (W.S. 41-7-102).

8.6.6 Drainage Districts

Drainage districts are formed for the construction or maintenance of drains, ditches, levees or other works, over the lands of others, to promote the public health or welfare, and the drainage of lands. [W.S. 41-9-101(a)].

IX. TASK 8: PERMITS

9.1 Overview

Implementation of any of the projects recommended in the watershed management plan (Chapter 4) will require some form of permit, agency review, easement, or procurement of access consent. Depending on the type of project and the land owner (federal, state, or private), the process can range from a negligible effort to potential road blocks requiring significant efforts to successfully complete. In this chapter, permitting information is provided for a variety of projects as follows:

Section 9.2: Basic requirements and activities needed to be on the property, collect data and obtain easements are discussed

Section 9.3: Project-specific permitting requirements are presented for typical projects eligible for funding through the WWDC's Small Water Projects Program (SWPP).

Section 9.4: Environmental Permitting and Mitigation

Section 9.5: Information pertaining to online tools and databases to help with the data collection and permitting is presented.

Appendix 9A contains additional information pertaining to each of the federal, state and local agencies.

9.2 Property Access, Easements, and Land Procurement

Permission must be obtained from the landowner, lessee, or management agency prior to any fieldwork on any proposed project area within the watershed. Verbal permission from landowners is sufficient for initial site visits; however, if project specific field data needs collected and potential project alternatives developed then written permission should be acquired. Other negotiations could be necessary for securing easements, rights-of-way (ROW), and property access for planning or construction activities associated with a proposed project.

The Enterprise Technology Services' (ETS) Wyoming Statewide Parcel Viewer can be accessed via the website (*http://gis.wyo.gov/parcels/*) to help determine ownership information for any parcels that may be involved with a proposed project. Permits or right-of-way access are required for the WYDOT and numerous utility and energy entities when project construction involves their properties. Information regarding state land parcels and surface leases can be accessed from the OSLI's State Land Access website:

(http://gis.statelands.wyo.gov/GIS/OSLIGIS/StateLandAccess/)

and OSLI's Search Surface Plat Book website:

(*http://statelands.wyo.gov/surfaceplatbook/*).

9.2.1 Trespassing to Collect Data

In 2015 and 2016, Senate File 12 and Senate File 75 (Trespassing to Collect Data), respectively, were passed by the Wyoming Legislature and signed into law by Governor Mead. These State laws protect landowners' property rights by allowing law enforcement officials to file criminal charges if an individual or entity trespasses onto private property for the purpose of collecting data. The state law also prohibits any information from being used by a government entity if it is collected by someone who trespassed on or across private land. However, if information was illegally collected and provided to a government agency, it will be expunged by the agency, but will be retained to use as evidence against the trespasser.

Because participation in the watershed study is voluntary, the project team worked with the WWDC, local sponsors, and landowners to gain verbal permission before entering private land. Obtaining landowner permission for collecting resource data for the watershed study is required in accordance with Wyoming Statute (W.S.) 6-3-414, Trespassing to Unlawfully Collect Resource Data. Consequently, the project team collected all field data on private lands in the company of the landowner or leasee. Also, global positioning system (GPS) units with 2015 parcel data and a GPS-enabled camera were used to collect field data, which ensures that field data collection occurred only on the participating landowners' properties.

9.2.2 Land Procurement, Right-of-Way, or Easement Acquisition

The proposed projects described in this study predominantly involve private lands and are situated within the parcel boundaries of the participating landowners. There are a small number of the proposed projects' components that would involve access to rights-of-way along a county road or access to irrigation district infrastructure and would require temporary or conditional use permits obtained from those entities. If a proposed project were to be located entirely or partially on federal lands, crossing federal lands, or funded by federal agencies or programs, additional requirements for compliance with NEPA would apply, which is described more in Section 9.5.

9.2.3 Utilities

Permits or right-of-way access are required for numerous utility and energy entities when project construction involves their easements and properties. In the state of Wyoming, the State's "Wyoming Underground Facilities Notification Act" requires everyone who owns underground facilities in the state to be a member of One-Call of Wyoming. Before any excavation begins, the excavator is required to provide advance notice (at least 2 business days before intending to dig) to the One-Call of Wyoming Notification Center at 811 (or if calling from out-of-state, 1.800.849.2476) [Wyoming State Legislature, 2013]. For more information about One Call of Wyoming, please visit their website:

http://www.onecallofwyoming.com/

9.3 Permitting for Proposed Projects

In the following sections, the permit requirements of specific types of projects within the watershed management plan are presented, including:

- Livestock/wildlife projects
    - Water wells (and spring developments)
    - Stock reservoirs/Ponds
- Irrigation System projects
- Water Storage Projects

Table 9.3-1 presents a tabulation of permits that each of the various agencies may require. Appendix 9A contains additional information regarding the federal, state and local agencies which may require coordination.

9.3.1 Livestock/Wildlife Water Projects

Permits, clearances, and approvals that possibly need to be obtained for typical livestock/wildlife water projects for a typical project component such as a water well, stock reservoir/pond, solar panel and pump, pipeline, and stock tanks are identified within this chapter. Additional requirements from various entities may also exist and involve further investigation for some of the proposed projects. The extent of involvement and the nature of coordination would be determined on a project-by-project basis. More detailed discussions of those requirements are included in Appendix 9A.

Table 9.3-1 Tabulation of Agencies and Pertinent Permit Requirements.

Agency	Potential Permit and/or Clearance
Federal	
U.S. Army Corps of Engineers (USACE)	Authorization of Permit for Discharge of Dredged or Fill Material (Section 404 permit) Requires further delineation of jurisdictional wetlands and a wetland mitigation plan.
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act, Section 7 and 10 consultations
Bureau of Land Management (BLM)	BLM clearance necessary if located or crossing BLM lands, NEPA review required
Forest Service (USFS)	USFS clearance necessary if located or crossing USFS lands, NEPA review required
Natural Resource Conservation Service (NRCS)	NRCS approval necessary if funded by Farm Bill or USDA, NEPA review may be required

Table 9.3-1 Tabulation of Agencies and Pertinent Permit Requirements (Continued).

State	
Wyoming State Engineer's Office (SEO)	Ground Water Division approval of Water Well Permits Ground or Surface Water Division approval of Spring Development Permits Surface Water Division Approval of Ditches, Pipelines, and Changes in Points of Diversion Surface Water Division Approval of Diversions or Headgates Surface Water Division approval of Reservoir Permits Safety of Dams Approval of Safety of Dam Size Facilities and Dam Modifications
Wyoming State Historical Preservation Office (SHPO)	SHPO compliance letter for projects on federal land or that include a federal action
Wyoming Game and Fish Department (WGFD)	Coordination for terrestrial and aquatic wildlife under the NEPA, the ESA, Section 404 of the federal CWA, and the Federal Fish and Wildlife Coordination Act Greater Sage-Grouse Core Area Protection
Wyoming Department of Environmental Quality (WDEQ)	401 Certification for 404 Permits under the federal Clean Water Act WYPDES Construction General Permit (CGP) for Large Construction Activity (> 5 acres) or Small Construction Activity (between 1 acre and 5 acres) Applicable Water Quality Standards for Wells, Reservoirs, and Streams
Wyoming Office of State Lands and Investments (OSLI)	Construction of Improvements on State Land application approval
Wyoming Department of Fire Protection and Electrical Safety	Electrical Wiring Permit to install electrical equipment on new construction or remodeling Electrical installations must be performed by licensed electricians unless exempted
Local	
Platte County	Permits for building structures, wind and solar energy systems, and floodplain development
Special Districts	Permits or clearances from special districts including water and sewer, sanitary and improvement, flood control, irrigation, road, and improvement/service districts

9.3.1.1 Water Well

Drilling a water well or rehabilitating an existing water well to provide a source of livestock/wildlife water are typical projects in the watershed management plan. In the state of Wyoming, any person drilling a water well must obtain a water right permit prior to constructing any well by making application to the SEO using their Application for Permit to Appropriate Groundwater (U.W. 5 Form). Work cannot begin until the permit is approved by the State Engineer in accordance with Title 41 Water, Chapter 3 Water Rights; Administration and Control (W.S. 41-3-930). Necessary groundwater applications, regulatory information, and form instructions can be accessed via the SEO's website:

https://sites.google.com/a/wyo.gov/seo/regulations-instructions

Also, the drilling and/or pump contactor and the well owner must comply with the requirements pursuant to the Rules and Instructions, Part III of the Water Well Minimum Construction Standards (W.S. 41-3-909), which can be obtained via the website:

https://sites.google.com/a/wyo.gov/seo/ground-water/water-well-construction

Additionally, the water quality of the completed well must be suitable for livestock and cannot exceed suitability constituents for any of the Class III Groundwater standards (Table I) of Chapter 8, Quality Standards for Wyoming Groundwaters (W.S. 35-11-302), which can be accessed at the website:

http://deq.wyoming.gov/wqd/groundwater/resources/rules-regs/

Spring developments (which can be technically considered wells) also need to be permitted by the SEO in accordance with either their groundwater or surface water rules and regulations. If a spring is for stock and/or domestic use, yields 25 gallons per minute or less, includes a man-made development (i.e., no machinery used), and is identifiable as groundwater, then the spring is permitted by making application to the SEO using their Application for Permit to Appropriate Groundwater (U.W. 5 Form). Work cannot begin until the permit is approved by the State Engineer in accordance with Title 41 Water, Chapter 3 Water Rights; Administration and Control (W.S. 41-3-930). If a spring development doesn't meet of the described conditions, then the spring is permitted by completing a surface water application via the SEO's website:

https://sites.google.com/a/wyo.gov/seo/regulations-instructions

9.3.1.2 Stock Reservoir/Pond

Some of the proposed projects within the watershed include constructing or rehabilitating a stock reservoir or pond to provide a source of livestock/wildlife water. In Wyoming, a permit from the SEO is required before commencing construction of a dam or reservoir involving the storage or impoundment of water. Stock reservoirs must not exceed 20 acre-feet in capacity, cannot have a dam height greater than 20 feet, and the use of the stored water should be for stock purposes only pursuant with Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 3 Reservoirs (W.S. 41-3-301). Any individual or entity intending to construct a stock reservoir or pond must make application to the SEO using their Application for Permit to Appropriate Surface Water (S.W.4 Form) and cannot commence construction until the permit is approved by the State Engineer in accordance with Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 3 Reservoirs (W.S. 41-3-301). Necessary surface water applications including the SW-4 Stock Reservoirs and SW-4A Stock Reservoir Multiple Points of Storage forms, regulatory information, and form instructions can be accessed via the SEO's website:

https://sites.google.com/a/wyo.gov/seo/regulations-instructions

Wyoming's Safety of Dams legislation (W.S. 41-3-307 through 41-3-318), which is administered by the SEO, typically does not apply to stock reservoirs when the dam height is less than 20 feet high and reservoir capacity is less than 50 acre-feet. Additionally, the water quality of a completed stock reservoir or pond must be suitable for agriculture water supply including livestock watering and cannot exceed any of the Class 2D, Class 3D, and Class 4 surface water quality standards (Appendix B) of Chapter 1, Wyoming Surface Water Quality Standards (W.S. 35-11-101) found at the website:

http://deq.wyoming.gov/wqd/surface-water-quality-standards/

In addition, the construction or rehabilitation of a reservoir would typically involve the discharge of dredged or fill material into waters of the United States and could require a Section 404 permit under the federal Clean Water Act (CWA). Because numerous waterbodies and wetlands are considered waters of the United States, they are subject to the United States Army Corps of Engineers' (USACE) regulatory authority. Permit applications can be obtained by contacting the USACE Omaha District Wyoming Regulatory Office in Cheyenne by telephone (307) 772-2300 or website (http://www.nwo.usace.army.mil/Missions/Regulatory-Program/Wyoming/). As part of the 404 permitting process, when an applicant submits a pre-construction notification (PCN) to the USACE, the PCN is forwarded to the WDEQ for review under Section 401 of the CWA. WDEQ then determines compliance with Chapter 1, Wyoming Surface Water Quality Standards (W.S. 35-11-101). If the project is compliant, then the WDEQ issues a 401 Water Quality Certification. Information about the WDEQ's 401 Certification process can be obtained by visiting their website:
http://deq.wyoming.gov/wqd/401-certification/

9.3.2 Irrigation Projects

Rehabilitation of existing diversions, ditches, or pipelines for diverting irrigation water from a river, creek, or reservoir to irrigated lands are also typical projects in the watershed management plan. This type of a project requires verifying the applicable water rights to ensure the appropriation has been approved by the SEO pursuant with Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 1 Generally (W.S. 41-3-101). ***If the proposed project does not involve a change in the point of use, point of diversion, or an enlargement, additional approval from the SEO is not likely to be required. Before initiating any irrigation structure project, however, the SEO should be consulted for a final determination of their requirements.***

However, any enlargement or change in point of use of the structure or facility would require the submittal of an application and/or petition to the SEO and the Board of Control (BOC) for approval. Necessary application forms and instructions including the SW-2 Enlargement of Ditches, Pipelines and Change in Point of Diversion and Means of Conveyance petition examples can be obtained via the SEO's website (*https://sites.google.com/a/wyo.gov/seo/regulations-instructions*). Likewise, any individual or entity intending to construct a new diversion structure, ditch, or pipeline from a stream that does not use an existing, permitted structure or facility must make application to the SEO using their Application for Permit to Appropriate Surface Water (S.W.1 Form) and cannot commence construction until the permit is approved by the State Engineer in accordance with Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 1 Generally (W.S. 41-3-101). It is recommended that coordination with the SEO occur with any proposed project before rehabilitating an existing structure or constructing a new one. Moreover, there may be additional permission or approval necessary if the structure or facility supplies water to any other irrigators or water users.

In addition to the SEO requirements, the construction or rehabilitation of a diversion structure including a headgate, weir, or diversion dam along with any associated in-stream or streambank work would involve the discharge of dredged or fill material into waters of the United States and could require permitting under Section 404 of the CWA. It is recommended that coordination with the USACE occur to determine any agricultural exemptions from Section 404 regarding the construction or maintenance of irrigation ditches, including any construction or rehabilitation of siphons, pumps, headgates, wingwalls, weirs, screens, or other facilities as are appurtenant and functionally related to irrigation ditches. More information can be obtained by contacting the USACE's Wyoming Regulatory Office by telephone (307) 772-2300 or via the website:

http://www.nwo.usace.army.mil/Missions/Regulatory-Program/Wyoming/

Again, when an applicant submits a 404 permit PCN to the USACE, the PCN is forwarded to the WDEQ for review under Section 401 of the CWA to determine compliance surface water quality standards or total maximum daily loads (TMDLs). Information about the WDEQ's 401 Certification is available via the website:

http://deq.wyoming.gov/wqd/401-certification/

9.3.3 Water Storage Projects

9.3.3.1 Dam and Reservoir Permitting

Any individual or entity intending to construct a new reservoir or enlarge an existing reservoir exceeding 20 acre-feet in capacity or having a dam height greater than 20 feet must make application to the SEO using their Application for Permit to Appropriate Surface Water (S.W.3 Form) and cannot commence construction until the permit is approved by the State Engineer in accordance with Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 3 Reservoirs (W.S. 41-3-301). Applications and instructions for SW-3 Reservoirs and SW-3A Special Application Reservoirs can be obtained by accessing the website:

https://sites.google.com/a/wyo.gov/seo/applications-forms#Surface

Wyoming's Safety of Dams legislation (W.S. 41-3-307 through 41-3-318) requires that the State Engineer ensures the safety and structural integrity of water storage facilities within Wyoming. Consequently, any individual or entity proposing to construct, enlarge, repair, alter, or remove a dam with a height greater than 20 feet or a capacity of more than 50 acre-feet of water, or diversion system with headgates or diversion structures carrying 50 cubic feet per second (cfs) must have plans and specifications prepared by a Wyoming licensed Professional Engineer and shall be submitted to the State Engineer for approval pursuant to

Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 3 Reservoirs (W.S. 41-3-308). On-site inspections of any new or rehabilitated facilities are conducted by the SEO personnel.

In addition to the SEO requirements, the construction or rehabilitation of a reservoir or pond typically involves the discharge of dredged or fill material into waters of the United States and could require permitting under Section 404 of the federal Clean Water Act (CWA). Because numerous waterbodies and wetlands within the study area are considered waters of the United States, they are subject to the USACE' Section 404 regulatory authority. Section 404 applications and instructions can be obtained by contacting the USACE's Wyoming Regulatory Office by telephone (307) 772-2300 or can be obtained by visiting the website:

http://www.nwo.usace.army.mil/Missions/Regulatory-Program/Wyoming/

Again, when an applicant submits a 404 permit PCN to the USACE, the PCN is forwarded to the WDEQ for review under Section 401 of the CWA to determine compliance with surface water quality standards or TMDLs. Information about the WDEQ's 401 Certification is available via the website:
http://deq.wyoming.gov/wqd/401-certification/

9.3.3.2 National Environmental Policy Act Process for Water Storage Projects

Within this study area, federal regulations in accordance with the NEPA and the ESA dictate the permitting requirements and review process of water-related projects including water storage projects. These review processes are required because of the need for securing permits under the federal CWA and Section 7 consultation under the federal ESA. The timeframe for securing the necessary permits from federal agencies for water storage projects could take several years depending on the complexity of the proposed facility because of the requirements of the NEPA and the ESA. Federal regulations direct that the USACE evaluate practicable and reasonable alternatives under the NEPA. The issuance of a 404 permit for discharge must only be for the least environmentally damaging practicable alternative to the aquatic ecosystem and does not have other significant adverse environmental consequences.

Generally, the effort to comply with the NEPA on any proposed reservoir project would probably require the preparation of an environmental impact statement (EIS). The BLM or the USFS would likely be the lead agency for any water-storage project that is situated on federal land while the NRCS would likely be the lead agency for any reservoir project funded by USDA on private lands. For proposed reservoirs on private lands funded privately or by state programs, the permitting process still requires that NEPA be addressed and would be led by the appropriate local or state agency or landowner. Coordination with the USACE would be required prior to initiation of any water storage project. The most important aspect regarding the permitting process for a new dam and reservoir storage project is developing a valid purpose and demonstrable need for the project.

9.3.4 Other Project Types

Permit and clearance approvals for any the proposed projects ultimately depend on the site-specific project and its location. Generally, the permits, clearances, and approvals discussed in Sections 9.3 through 9.5 could also be applicable for any proposed municipal, rural domestic water, groundwater exploration, weather modification, pipelines and conveyance facilities, wetland development, environmental (streambank, water quality, erosion protection), and solar or windmill projects depending on the specific nature and/or location of the project.

9.3.5 Mitigation

Mitigation requirements may be necessary for a proposed project to address impacts to wetlands, riparian vegetation, stream-channel habitat, cultural resources, fish and wildlife resources, and possibly threatened or endangered species. In developing the proposed projects within this study report, a decided effort was made to avoid potential impacts by evaluating and considering these resources as part of the conceptual plans. When necessary, the plan designs were and should be adjusted accordingly; avoiding the need for mitigating significant impacts. Avoiding potential impacts to species of concern and their associated habitats could typically be accomplished by scheduling construction activities outside of the relevant nesting, parturition, breeding, or migration seasons. Sage grouse core area needs are discussed in Section 9.4.3.

9.4 Environmental Evaluation

9.4.1 National Environmental Policy Act Compliance

Compliance with the NEPA typically applies whenever a proposed project included in the Watershed Management Plan is located on federal lands, needs passage across federal lands, is funded entirely or partially by federal agencies or programs, or needs to secure a federal permit. The NEPA process is intended to help sponsors and agencies review the potential project effects and involve the public in making informed decisions about the environmental consequences of a project. If any proposed project occurs on BLM or USFS lands or would be a recipient of U.S. Department of Agriculture (USDA) Farm bill funding, the BLM, USFS, or NRCS would likely be considered the "lead or action agency" in the NEPA process.

The USACE usually has a role in reviewing proposed projects that involve impacting or enhancing a wetland, which would require a Section 404 permit. Typically, federal agencies have a Memorandum of Understanding (MOU) to outline responsibilities and roles of the agencies when a proposed project involves multiple agencies. Specifically, in regards to the NRCS providing technical assistance to conservation districts and landowners on any proposed project funded by the WWDC's Small Water Project Program (SWPP), the NRCS' National Environmental Compliance Handbook, Subpart D - The National Environmental Policy Act, 610.40 Overview of NEPA Requirements, 610.43 Federal Actions and Major Federal Actions states the following about federal actions:

A. Federal Actions

(1*) NEPA compliance is triggered when NRCS proposes a Federal action. A Federal action occurs when NRCS has control or responsibility over the implementation of a proposed activity including technical or financial assistance. Most NRCS Federal actions involve financial assistance through Farm Bill and watershed programs, or approvals, but Federal actions also include activities such as granting compatible uses agreements for easements where NRCS exercises control.*
(2) Federal actions do not usually include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance. However, there may be instances where a project can become "federalized" due to a substantial input of Federal resources in the form of technical assistance or when NRCS has some control or responsibility in the result. When NRCS provides technical designs, standards, or specifications, the RFO should evaluate and determine whether NRCS has control or responsibility over the action, thus making it a Federal action subject to NEPA.
(3) Important note: NEPA only applies to Federal actions. It is NRCS policy and required by NRCS regulations to conduct an EE as a part of every planning activity, even if it is not considered a Federal action (highly erodible land and wetland determinations are technical determinations and not considered planning activities). The results of this process are documented on the NRCS-CPA-52 worksheet, to- (i) Inform the landowner of the plan's impacts.
(ii) Provide a record that the EE was conducted.

9.4.2 Proposed, Threatened, and Endangered Species

The following species have the potential to occur within the proposed project areas within the watershed study area [Wyoming Natural Diversity Database, 2016]:

Petition Under Review:	Plains Spotted Skunk (Spilogale putorius interrupta) Little Brown Myotis (Myotis lucifugus)
Threatened:	Preble's Meadow Jumping Mouse (Zapus hudsonius preblei)
Endangered:	Least Tern (Sternula antillarum) Black-footed ferret* (Mustela nigripes)

**The black-footed ferret is listed as an Endangered - Nonessential Experimental Population*

9.4.3 Other Species of Concern

The Wyoming Natural Diversity Database (WYNDD) records and maintains a list of plant species in Wyoming that are thought to be rare or sensitive, as discussed in Section 4.3.1.8. Appendix 4D lists the tracked or watched status of 26 plant species of concern that potentially occur within the study area. Tracked species are those that are vulnerable to extirpation because of rarity, inherent vulnerability, or habitat threats.

Watched species are those that appear to be presently secure but have limited distribution. Although some of these plant species could occur on a proposed project area, none of the species are currently protected by state or federal regulation but still deserve appropriate planning and implementation considerations.

Also, the WYNDD records and maintains a list of species for amphibians, birds, crustaceans, fish, insects, mammals, mollusks, and reptiles in Wyoming that are thought to be rare or sensitive, as discussed in Section 4.3.2.6. Appendix 4E lists the tracked or watched status of 3 amphibians, 81 birds, 9 fish, 26 mammals, 7 mollusks, and 17 reptiles [WYNDD, 2016]. Appendix 4E also shows that the Greater sage-grouse is classified as "Not Warranted for Listing," which reflects the U.S. Department of Interior's decision in September 2015 to withdraw the sage-grouse from the USFWS's candidate species list, which is discussed in Section 4.3.2.5.

The Greater sage-grouse is still recognized as a sensitive species/species of concern by the BLM and a species of concern by the WGFD. In June 2008, Executive Order 2008-2 was signed by then Governor Mead which stresses additional management consideration to sage-grouse and sage-grouse habitat statewide. In August 2019, Executive Order 2019-3, Greater Sage-Grouse Core Area Protection, was signed by Governor Gordon, which requires state agencies to encourage development outside of the core areas and to focus management to the greatest extent possible on the maintenance and enhancements of habitat within them. Additional information about Wyoming's sage grouse management including mitigation, de minimus activities, core area maps and data, and the Density Disturbance Calculation Tool (DDCT) can be found at the website:

https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

Sponsors for a proposed project within the watershed should contact the WGFD at least 60 days prior to submitting an application for a permit or project so any sage-grouse related issues could be identified and any stipulations could be incorporated before commencing project activities.

9.4.4 Fish Distribution, Wildlife Habitat Distribution, Sensitive/Endangered Species

Available information and geospatial data regarding fish distribution, wildlife habitat distribution, and sensitive and threatened/endangered plant and animal species (e.g., Greater sage-grouse) have been obtained, described, mapped, and incorporated into the study's ArcGIS geodatabase and digital library. Fish habitats within the study area include perennial and intermittent streams, springs, lakes, ponds, and reservoirs that support fish through at least a portion of the year.

The WGFD geodata that shows hunt areas, herd units, seasonal range, crucial ranges, parturition areas, and migration routes and barriers for antelope, elk, mule deer, moose, and white-tailed deer within the watershed have already been collected. The WYNDD records and maintains a list of species in Wyoming that are thought to be rare or sensitive. Tracked species are those that are vulnerable to extirpation because of rarity, inherent vulnerability, or habitat threats. Watched species are those that appear to be presently secure but have limited distribution. The WGFD also maintains geodata for the Greater sage-grouse, including core areas, distribution, and habitat connectivity and corridors.

9.4.5 Fish Species

Project alternatives may have impacts to streams and reservoirs and associated fishery resources; therefore, coordination with the WGFD is recommended before proceeding with any of the proposed projects. Most of the other proposed projects such as livestock/wildlife water developments are expected to have no direct effect on fishery resources because they are off channel/upland projects.

9.4.6 Big-Game Species

The watershed contains portions of crucial big-game habitat for antelope, elk and mule deer managed by the WGFD and seasonal ranges for several big-game species as described in Section 4.3.2.2. Additionally, WGFD Crucial Habitat Priority Areas exist within the watershed that contains big-game crucial winter ranges and year-long ranges. Crucial habitats have biologically important features that need to be protected or managed to maintain viable, healthy wildlife populations and are where the WGFD concentrates their habitat protection and management activities. Typically, the proposed projects included in the Watershed Management Plan are implemented in a manner that improves or maintains these habitat features.

9.4.7 Wetlands Delineation

Site-specific wetland delineation and inventories were not part of the scope of the watershed study. Geospatial data for the mapped National Wetlands Inventory (NWI) areas were used in preparing conceptual proposed project plans listed in Chapter 6 for irrigation systems and for livestock/wildlife water to avoid impacts to wetland resources. The alternatives for rehabilitating reservoirs, dam embankments, and inlet/outlet ditches may also affect wetland resources depending on the specific provisions of the plans, designs, and construction specifications. Entities should consult with the USACE about any jurisdictional determinations when proposing any water-development projects with wetlands before implementing any proposed project. Specific mitigation measures would need to be formulated to compensate for wetland losses determined by certified wetland delineations.

9.5 Planning Resources and Tools

Sources of technical support and assistance for project planning and implementation within the watershed are primarily provided through partnerships between local landowners, conservation districts, the NRCS, BLM, USFS, WGFD, and/or the Nature Conservancy. In addition, online planning tools and publicly available maps are also available for planning efforts. These web-based mapping applications can help local sponsors with assisting landowners who are interested in moving forward with a conceptual project proposed in the Watershed Management Plan.

9.5.1 Wyoming Department of Enterprise Technology Services (ETS)

The Wyoming Department of ETS was established to increase the ability of state agencies to deliver quality cost-effective services to the Wyoming citizens. The ETS' "State Agency Map Portal", which can be accessed via the website (gis.wyo.gov), provides links for GIS web applications with publicly accessible maps, as shown in Table 9.5-1.

Table 9.5-1 Wyoming Department of Enterprise Technology Services State Agency Map Portal GIS Web Applications.

Agency	Address	Description
Enterprise Technology Services (ETS)	*http://gis.wyo.gov/parcels/*	Wyoming Statewide Parcels
	http://gis.wyo.gov/Wyofires/	Wyoming Current Fire Map
State Parks and Historic Trails	*http://gis.wyo.gov/WYOutsideResourceGuide/*	State Parks Events Info
Office of State Lands and Investment (OSLI)	*http://www.onanypc.com/statelandaccess/*	Public Access to State Lands
	http://www.onanypc.com/osligis/oilandgas/	State Oil and Gas Information
Wyoming Pipeline Authority (WPA)	*http://www.wyopipeline.com*	Pipeline Data
Public Service Commission (PSC)	*http://psc.state.wy.us/htdocs/Dwnload/CertMaps/electric.pdf*	Electric Utilities Areas Map
	http://psc.state.wy.us/htdocs/Dwnload/CertMaps/Gas.pdf	Gas Utilities Certificate Area Map
State Engineer's Office (SEO)	*http://seo.maps.arcgis.com/home/index.html*	State Engineer's Office Information
Wyoming Department of Environmental Quality (WDEQ)	*http://deq.state.wy.us/lqd_permit_public/*	Viewer of Active Mining Permits
Wyoming Game and Fish Department (WGFD)	*http://wisdom.wygisc.org/*	G&F decision support system
Wyoming State Geological Survey (WSGS)	*http://www.wsgs.uwyo.edu/data/maps/published.html*	Geologic Maps
	http://www.wsgs.uwyo.edu/Data/GIS/IMS-Projects.aspx	Various geologic mapping projects
	http://www.wsgs.uwyo.edu/Data/GIS/	Digital data by theme
Wyoming Geographic Information Science Center (WyGISC)	*http://www.uwyo.edu/wygisc/*	Home page for WyGISC
Wyoming Climate Office	*http://www.wrds.uwyo.edu/sco/data/PRISM/PRISM.html*	PRISM Climate Data Server
	http://ims2.wrds.uwyo.edu/Website/Statewide/	Water/Climate Map Server

9.5.2 Wyoming Association of Conservation Districts - SuiteWater

The Wyoming Association of Conservation Districts (WACD), in partnership with the Wyoming Geographic Information Science Center (WyGISC), have created SuiteWater: a web-based mapping application and planning tool developed by and for Wyoming conservation districts. SuiteWater provides users with integrated geospatial data, digital imagery, background information and documents, and user-generated data for developing natural resource plans. However, access to SuiteWater is limited to the conservation district boards and employees and WACD Directors, staff, and advisors. Requests for access to SuiteWater must be submitted to the WACD for approval.

http://suitewater.wygisc.org/

9.5.3 Natural Resources Conservation Service - Web Soil Survey

Local sponsors, landowners, managers, and water users can access soils information via the NRCS' Web Soil Survey (WSS).

http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

The WSS provides soils information produced by the National Cooperative Soil Survey in updated soil maps and data. Soil mapping data and interpretations can be used for general or local planning. No online account is necessary unless datasets are downloaded from the website. Site-specific soil maps of an area can be created and customized using the online tools to customize a soil map report, measure distances, explore interpretations and ratings, and download associated geospatial data. Although the WSS is useful in analyzing soils data during project planning, on-site soil investigations are recommended for most implementation activities including but not limited to reservoir, irrigation, and wetland construction or rehabilitation projects.

9.5.4 Wyoming Cultural Resource Information System

The Wyoming State Historic Preservation Office (SHPO) has created online applications and web services for researching cultural resources within any proposed project area. The SHPO's online resources include the Natural Resource and Energy Explorer (NREX) via:

https://nrex.wyo.gov/

and the Cultural Resource Management Tracker (CRMTracker) via:

http://www.gnomon.com/CRMTracker/CRMTracker_AllOrg/CRMTrackerHome.aspx

NREX has replaced the Cultural Research Information Summary Program (CRISP) and is discussed further in the following section. Additional cultural resource web service information can be obtained by contacting the State Historic Preservation Office by telephone (307) 777-7697 or via the website:

http://wyoshpo.state.wy.us/OLResources/Index.aspx

9.5.5 Natural Resource and Energy Explorer

The Natural Resource and Energy Explorer (NREX) is a web GIS-based software tool that supports pre-planning development considerations by enabling discovery; energy analysis and assessment, environmental, cultural, socioeconomic, and infrastructural assets for user-defined, project-scale areas of interest in the state. The tool is designed to support the Energy Atlas concept within Governor Mead's Energy Strategy Initiative by providing public access to credible geographic data and information maintained by state agencies. NREX canbe used by developers, conservationists, consultants, planners, policy makers, and managers for resource assessment. NREX can be accessed via the website:

https://nrex.wyo.gov

9.5.6 Wyoming State Engineer's Office e-Permit System

The Wyoming State Engineer's Office (SEO) e-Permit system facilitates the supervision and protection of surface water and groundwater for the purpose of appropriation, distribution, and application to beneficial use of water in Wyoming. The SEO's e-Permit system is a web-based, online application that allows registered users to submit applications, petitions, and other requests; search the SEO's database of water rights; track the application process; access water right related documents; and download streamflow and reservoir data. The SEO's e-Permit system can be accessed via the website:

http://seoweb.wyo.gov/e-Permit/

9.5.7 Wyoming Interagency Spatial Database and Online Management System

The Wyoming Interagency Spatial Database and Online Management (WISDOM) System is another online planning tool that allows individuals to access data about Wyoming's wildlife resources for use in developing project plans. WISDOM was developed as a partnership between the Western Governors' Association, WGFD, WyGISC, WYNDD, WDEQ, OSLI, WYDOT, NRCS, the Nature Conservancy, and USFWS. WISDOM provides users with landscape-level information for initial project planning phases; however, site-specific analysis with applicable agencies is still warranted regarding crucial wildlife habitat requirements and conservation potential. WISDOM preserves the confidentiality of sensitive data by displaying land ownership as federal, state, or private, and the records for certain species are generalized to prevent users from viewing specific location data. WISDOM is available online at:

http://wisdom.wygisc.org/

9.5.8 Wyoming Density and Disturbance Calculation Tool for Greater Sage-Grouse

The Wyoming Geographic Information Science Center (WyGISC), in partnership with the Wyoming Game and Fish Department (WGFD), the BLM, and the USFS created the Greater Sage-Grouse Online Density and Disturbance Calculation Tool (DDCT), which is a web-based application tool that calculates both the number of disruptive activities averaged per square mile and total surface disturbance within the DDCT assessment area for proposed projects in protected sage-grouse core areas. The DDCT web application is used by individuals in preparation of required permits for development activities. Users must register before the web application can be used. The DDCT is available online at:

http://ddct.wygisc.org/

9.5.9 U.S. Fish and Wildlife Service Information for Planning and Conservation (IPaC)

The U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Conservation (IPaC) is a web-based application that is available to anyone needing assistance in determining how their activities may impact sensitive natural resources such as migratory birds, species listed under the ESA, or wetlands. Information that users obtain from IPaC is produced by USFWS field offices and could help improve the efficiency of project planning, discussions, and recommendations.

IPaC is available online at:

https://ecos.fws.gov/ipac/

Additional assistance regarding IPaC or USFWS requirements can be obtained by contacting the Wyoming Ecological Services Field Office by telephone (307) 772-2374 or website:

https://www.fws.gov/wyominges/index.php

X. CONCLUSIONS AND RECOMMENDATIONS

A multidisciplinary inventory of the Lower Laramie River watershed was conducted in an effort to identify and evaluate key resource issues and concerns related to watershed function and condition. The objective of the watershed management plan is to provide watershed stakeholders with a list of practical and technically feasible projects with which they can then proceed with implementation.

10.1 Conclusions

Upon completion of the watershed inventory phase of the project, the project team developed the watershed management plan. The plan was ***developed*** based upon findings of the inventory phase, a series of public meetings, and interaction with the PCRD staff. In previous chapters, key issues, problems and opportunities were identified and ultimately, project goals and objectives were formulated to address ***them***. Specifically, plans were developed associated with the following broad categories:

- *Irrigation System Conservation and Rehabilitation,*
- *Livestock/Wildlife Upland Watering Opportunities,*
- *Surface Water Storage Opportunities,*
- *Environmental Enhancement Opportunities, and*
- *Grazing Management Opportunities.*

In summary, the following conclusions are provided.

10.1.1 Irrigation System Components

1. Irrigated agriculture is a dominant activity within the study area. The extent of irrigated lands, and corresponding irrigation infrastructure is significant. Wheatland Irrigation District (WID) represents the major stakeholder in the area and comprises over 54,100 irrigated acres and is supplied by over 120 miles of canals, ditches, and laterals. An irrigation district master plan was completed in 2011 by Anderson Consulting Engineers and included a lengthy list of recommendations for district managers to use for their planning purposes. The master plan should continue to be referenced by WID to drive their future planning efforts.

2. Several of the projects included in the Watershed Management Plan were recommended by stakeholders within the WID and involve smaller conservation/pipeline projects on lands located “downstream” of WID responsibility. It is recommended that the PCRD work together with these and other stakeholders and the WID to strive to develop projects that may benefit greater numbers of users and be consistent with WID infrastructure.

3. Funding assistance is available from a number of sources, as previously mentioned, especially from the WWDC Small Water Project Program but also from various programs administered by

the NRCS. The WID, as a legal entity, is also eligible for other funding opportunities through the WWDC and other agencies and programs.

4. Partnering opportunities may exist for construction of in-stream structures such as irrigation diversions. For example, Trout Unlimited (TU) has recently provided partial funding for projects within the region in an effort to enhance fisheries populations. Fish passage opportunities identified in the plan could potentially be funded by multiple entities.

10.1.2 Livestock/Wildlife Upland Watering Opportunities

1. There are numerous opportunities to improve range and riparian conditions by means of increasing the availability of upland water sources for wildlife and livestock use.

2. Opportunities to improve range and riparian conditions require installing and operating well-distributed, reliable upland water sources and watering facilities for wildlife and livestock. Installing pipelines and stock tanks is the foundation of effective grazing management and can be an economical way to improve rangeland conditions. Strategic fencing is frequently required to optimize these benefits.

3. Pipeline/tank systems appear to offer the most efficient and cost-effective means to provide adequate watering to large areas of rangeland. Water sources for these systems will depend on the location of the rangeland to be served and the available alternative sources. The most likely sources are wells or spring developments.

4. Through discussion with local landowners and stakeholders, a total of 17 potential livestock / wildlife water supply projects were identified. Conceptual plans and conceptual level cost estimates were prepared for each project. Projects ranged from installation of stock tanks to well spring development and pipeline construction.

5. Most of the livestock / wildlife projects could be completed entirely on private lands. Consequently, permitting issues are greatly simplified. However, a few will involve coordination with the Bureau of Land Management (BLM). BLM consultation will be necessary in order to obtain the requisite permits and cultural clearances.

10.1.3 Surface Water Storage Opportunities

1. No new storage facility projects were identified in this study and no previous studies were found which identified any potential projects. Limitations and complexities of water administration in the basin make development of storage opportunities possible, but problematic.

10.1.4 Stream Channel Condition and Stability

1. Based on the geomorphic assessment and input from the project Sponsor, the project team identified several locations where stream channel migration is resulting in bank erosion threatening infrastructure. It is recognized that meandering streams will continually migrate laterally resulting in erosive banks in some locations and sediment deposition in others. However, when erosion threatens highways, irrigation structures, homes, or other infrastructure, mitigation is recommended. Likewise, mitigation is also prudent when migration threatens activities such as pastures, crops, etc.

2. Channel degradation does not appear to be systemic. Significant or system-wide indicators of channel instability were not observed nor were they presented by area stakeholders. Impairments appear to be locally identifiable and include primarily:

   - Riparian Vegetation Degradation: Impaired riparian condition and habitat, and
   - Riparian Degradation: Generally, bank erosion and physical disturbance of stream banks.
   - Imbalance of Sediment Supply: Imbalance between stream capacity and sediment supply can lead to channel degradation or aggradation

10.1.5 Grazing Management Opportunities

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

2. Development of reliable water sources and associated watering facilities can aid in distribution of grazing animals and the timing and frequency of grazing. However, additional measures such as cross-fencing, low-stress herding, mineral/salting, and stock density should be evaluated as part of the site-specific, grazing management inventory and plan.

3. Available tools such as the ESD and the STM can be used by landowners and managers to become aware of the growth potential of desirable vegetation and predicted responses on a particular range site.

4. These tools could be used in developing appropriate rangeland treatments and grazing practices to begin the transition from a current state or condition to a more desirable plant community condition.

10.1.6 Environmental Enhancement Opportunities

1. Several environmental enhancement opportunities were identified. Two of the projects involve construction of barriers to fish passage to facilitate fisheries management objectives. Funding

for these projects could potentially be completed through partnering with agencies such as Wyoming Game and Fish and private entities such as Trout Unlimited.

2. Other environmental enhancement opportunities include the potential to convert abandoned stream channel oxbows to wetland features. Similar projects have been recently completed within the similar watersheds which could potentially be implemented providing valuable wetland habitat.

10.2 Recommendations

Based upon the information presented throughout this report, and the conclusions presented above, the recommendations listed below are presented for consideration:

1. Many of the irrigation rehabilitation alternatives and the livestock / wildlife upland watering alternatives fall within the constraints for funding eligibility of the WWDC's Small Water Project Program (SWPP). These projects should be reviewed and selected alternatives should be implemented as soon as is practical. Completion of one or more of these projects in the near future would serve to benefit those directly involved in the project and increase interest and awareness of the benefits associated with the watershed planning process.

   Funding through the SWPP does not require formation of a public entity as defined by WWDC criteria. Consequently, individuals can seek funding through this program by applying through a conservation district as their sponsor. As discussed in Chapter 7, grants are available for up to 50 percent of the total project cost or $35,000, whichever is less.

   Several alternative sources exist for funding of improvements within the watershed including on-farm improvements, irrigation rehabilitation projects, stream enhancements/restoration projects, and conservation and flood control projects. Creative strategies for funding/financing of projects should be more fully investigated following identification of projects worthy of additional evaluation and potential implementation. As an example, replacement of a failing ditch headgate and diversion which are also identified by WGFD as barriers to fish passage, could potentially be eligible for funding through SWPP. Additional funding may also be attained through WGFD, Trout Unlimited, and other sources because of the fisheries and stream habitat benefits achievable with completion of the project. *By combining funding sources, the owner could conceivably obtain grants for most, if not all, of the project costs.*

2. Continued communication between the PCRD and stakeholders regarding irrigation system improvements is highly recommended. Irrigation system infrastructure is generally eligible for funding through the WWDC's Small Water Project Program (SWPP). We have found through the completion of previous watershed studies, that interest in the program grows as projects are completed. Therefore, we highly recommend that the PCRD include reference to the SWPP in future newsletters and communications in an effort to broadcast its benefits. Upon completion

and with consent of the existing participant, PCRD could include reference of project completion to demonstrate SWPP opportunities.

3. Community-sponsored stream channel and habitat improvement projects could provide numerous benefits to the watershed. Potential projects would include efforts such as bank stabilization efforts using techniques such as willow plantings. In addition to providing direct benefits to the specific stream, ancillary benefits include education and community involvement. Specifically, Rock Creek/Wheatland Creek and other clean-up projects could be completed within city limits.

4. Landowners or managers seeking to participate in the SWPP should consult and coordinate with the PCRD, which is the eligible sponsor of SWPP applications and project agreements. Guidance and design from NRCS can help offset potential costs to the applicant.

5. The Lower Laramie River study's GIS and digital library should be used as a tool in planning and developing potential projects and should be updated as necessary from available information sources. This information used in conjunction with the Wyoming Association of Conservation District's (WACD) SuiteWater tools provide powerful watershed analytical capabilities. In addition, the Digital Library provided in this project contains a wealth of information and resources pertinent to PCRD activities.

6. Potential funding opportunities exist for proposed and future improvement projects within the watershed including ranch and farm improvements, irrigation system rehabilitation, riparian/wetland enhancements, river corridor and stream channel restoration, and urban drainage and flood control projects. For example, the Saratoga Encampment Rawlins Conservation District (SERCD) was recently granted funding through the USDA ***Regional Conservation Partnership Program (RCPP)***. The funding is intended for achieving resource management goals from improving water quality and wildlife habitat to streambank restoration. Where appropriate, partnering SWPP funding with RCPP funded projects could provide multiple financial benefits.

7. Innovative strategies for coordinated project funding and financing should be investigated and focus on local, collaborative endeavors that integrate more than one watershed issue or concern that could potentially result in achievement of multiple benefits.

8. Every effort was made to provide information within this document to support the application for SWPP funding from the WWDC with PCRD sponsorship. Project narratives, conceptual designs, cost estimates, and discussion of project benefits can all be incorporated directly into the SWPP application by the PCRD.

9. The public outreach portion of this project attempted to accommodate all interested parties. To the best of the project team's knowledge, all who expressed interest in participating were

contacted. However, our experience has shown that additional "new" individuals will come forward wishing to participate after this Level I study is completed. These individuals must be made aware that they <u>are</u> eligible for SWPP funding; the WWDC has removed the requirement of a completed watershed study for eligibility. They simply have not had the benefit of having met with the project team and having a portion of their application needs provided to them. They would be subject to the same application requirements and deadlines as those who did participate.

10. The Lower Laramie River Watershed Management plan was completed based primarily upon input obtained from the PCRD and participating agencies, landowners, and stakeholders.

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APPENDIX 2A

FINAL RESULTS PRESENTATION MATERIALS

Lower Laramie River Watershed Study
Results Presentation

October 22nd, 2019 • 6 p.m.
Platte Valley Bank
200 16th Street • Wheatland, WY 82201

Please join us as we discuss the results of the Lower Laramie River Watershed Study funded by the Wyoming Water Development Commission and sponsored by the Platte County Resource District.

The purpose of the study is to identify water supply needs and to develop a watershed management plan that identifies practical economic solutions. Irrigation, upland livestock water, water storage and stream channel improvement projects may be eligible for funding through various State mechanisms.

For more information call:
Jay Schug / Anderson Consulting Engineers / 970.226.0120
Jodee Pring/ Wyoming Water Development Office / 307.777.7626

Anderson Consulting Engineers, Inc
Civil • Water Resources • Environmental

Lower Laramie Final Results Presentation: 10/22/19
Location: Platte Valley Bank, Wheatland Wyoming
Time: 6pm
Attendees:

Jay Schug (Anderson Consulting Engineers)
Brian Thompson (Anderson Consulting Engineers)
Brady Irvine (PCRD)
Jodee Pring (WWDO)
Mabel Jones (WWDO)
Bill deRyk (landowner)
Daryl Brown (landowner)
Levi Clark (land owner / board member)
Brook Brockman (NRCS)
Additional landowner / name unknown

6pm Jay started Final Results Presentation presentation
6:30 Talk ended

Q/A Session:

1. Question regarding engineering designs versus conceptual designs and cost of engineering design was asked. Jodee and Jay fielded the question and walked attendees through the application/engineering design process and recommended working with NRCS for the design aspect. NRCS representative present responded with more details related to the engineering process through them.
2. Jay presented conceptual designs to stakeholders who had projects included in the study and explained the project packet given to them, fielded questions regarding their projects and the next steps necessary to apply for funding.
3. "Shovel-ready" projects were discussed and how they can elevate the priority of the project in the WWDC project ranking matrix.
4. Funding partnership opportunities were discussed including information related to the NRCS EQIP program.
5. WWDC Funding process was discussed with limitations and deadlines

7:15 Meeting ended

Lower Laramie River Watershed Study Level I

Presented to:

Wyoming Water Development Commission

Platte County Resource District

October 22, 2019

Anderson Consulting Engineers   Hinckley Consulting

Project Funding:

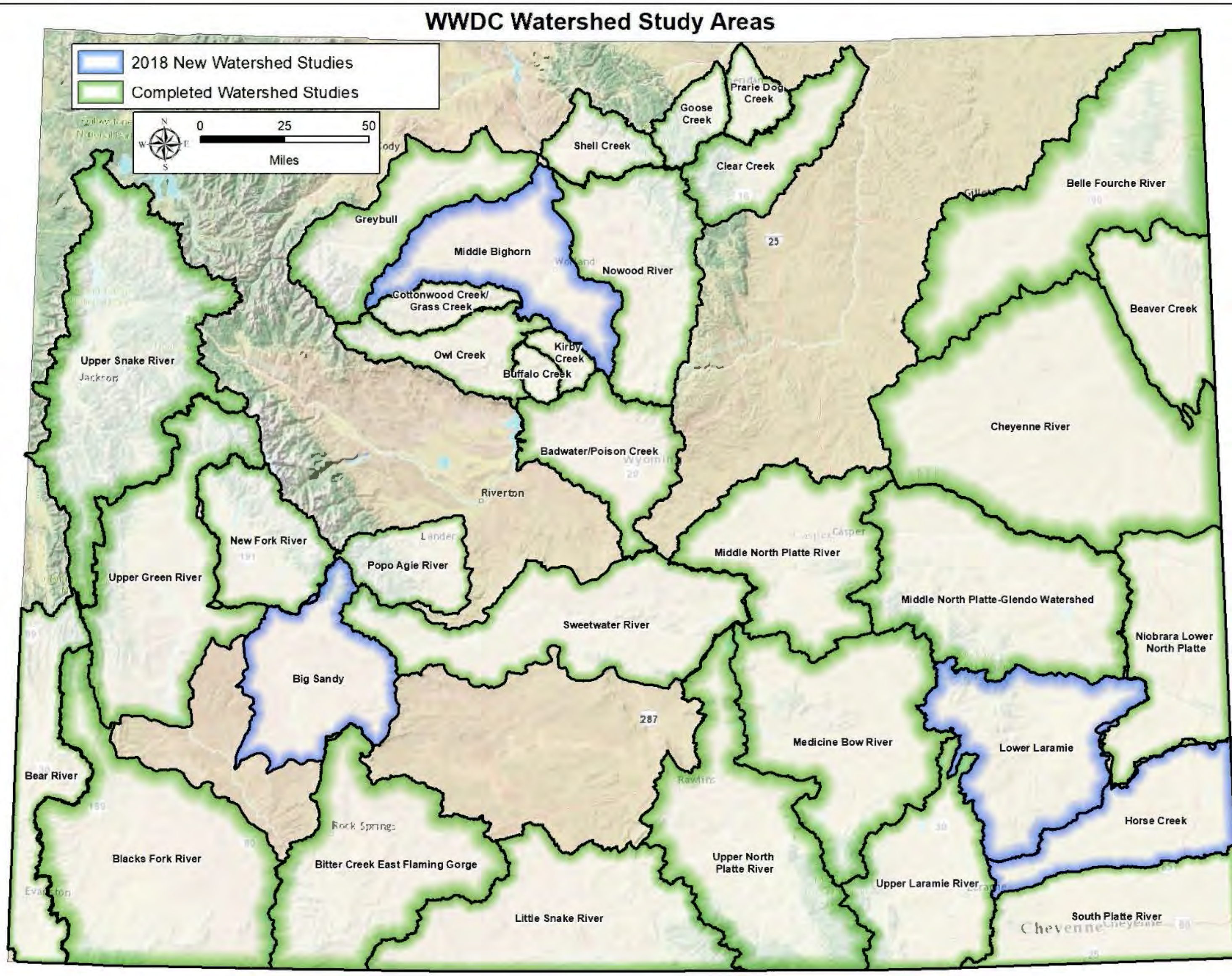
- Wyoming Water Development Commission

Project Sponsors:

- Platte County Resource District

Project Contractor:

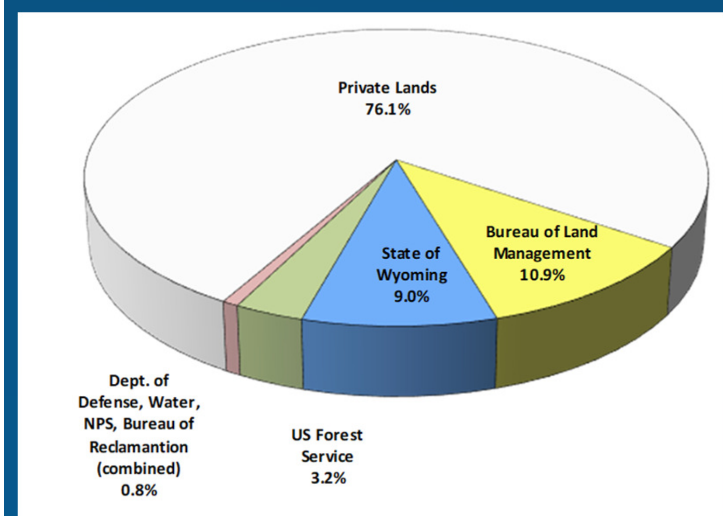
- Anderson Consulting Engineers

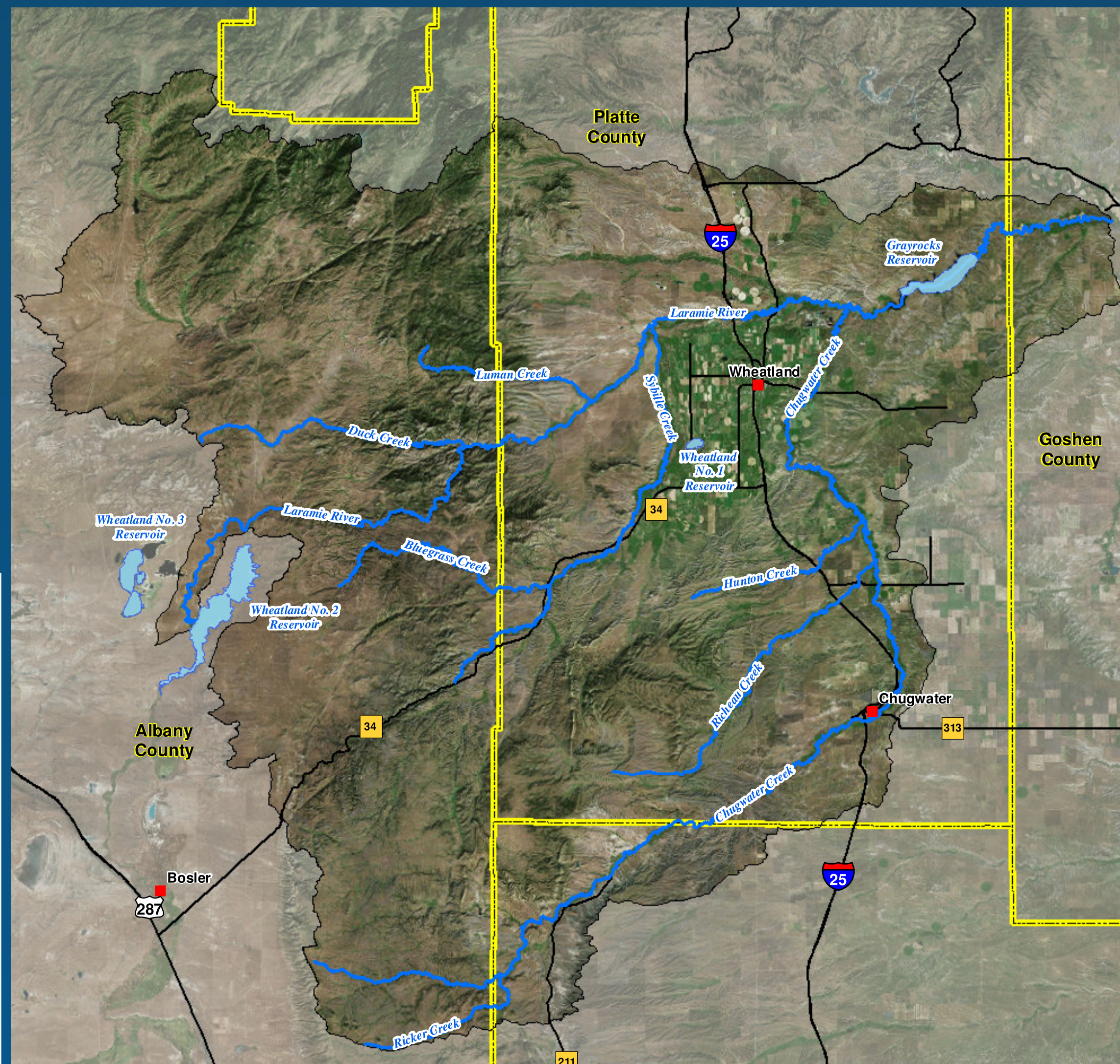

WWDC Watershed Study Areas
2018 New Watershed Studies
Completed Watershed Studies
0
25
50
Miles
Upper Snake River
Greybull
Middle Bighorn
Cottonwood Creek/
Grass Creek
Owl Creek
Kirby
Creek
Buffalo Creek
Shell Creek
Goose
Creek
Prarie Dog
Creek
Clear Creek
Nowood River
Belle Fourche River
Beaver Creek
Cheyenne River
Badwater/Poison Creek
Riverton
New Fork River
Popo Agie River
Upper Green River
Middle North Platte River
Middle North Platte-Glendo Watershed
Niobrara Lower
North Platte
Sweetwater River
Big Sandy
Medicine Bow River
Lower Laramie
Horse Creek
Bear River
Blacks Fork River
Bitter Creek East Flaming Gorge
Little Snake River
Upper North
Platte River
Upper Laramie River
South Platte River
Cheyenne

Project Study Area

STUDY AREA CHARACTERISTICS

- Size: ~2,300 square miles total
- Area includes:
  - Platte County Resource District (Sponsor)
  - Laramie Rivers Conservation District
  - Laramie County Conservation District
  - Lingle-Ft. Laramie Conservation District





Purpose:

- To complete a comprehensive evaluation of the watershed,
- Develop a watershed management plan addressing issues identified

Watershed Inventory:

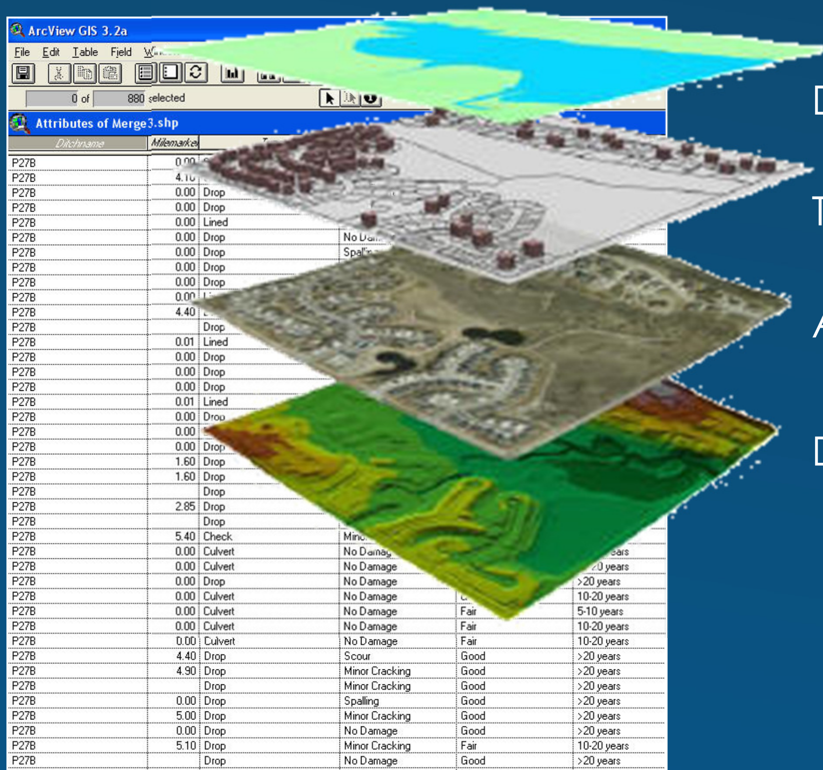
- Literature Review
- Field Data Collection
- Public Input
- Resource Issue Identification

Geographic Information System

Watershed Management Plan

- Resource Issue Recommendations
- Irrigation Rehabilitation
- Stream Restoration
- Upland Water Opportunities
- Conceptual Designs
- Cost Estimates
- Permitting Requirements
- Funding Opportunities

Project Geographic Information System (GIS)



Dataset Themes: Ownership, Hydrography, Soils, etc.

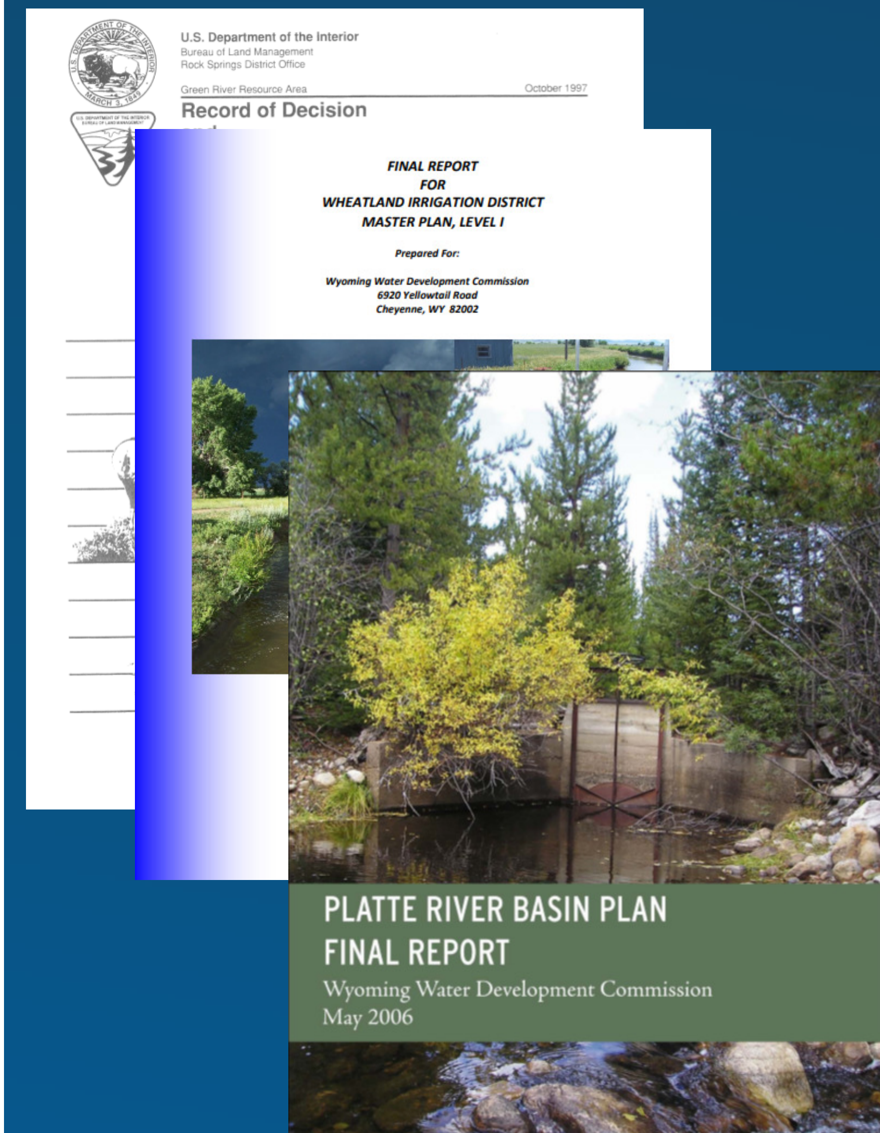
Topographic Mapping

Aerial Photography: true color, infra-red, historic

Digital Elevation Models: Base maps, Data Analysis

Databases and Attribute Tables

Data Collection: Digital Library



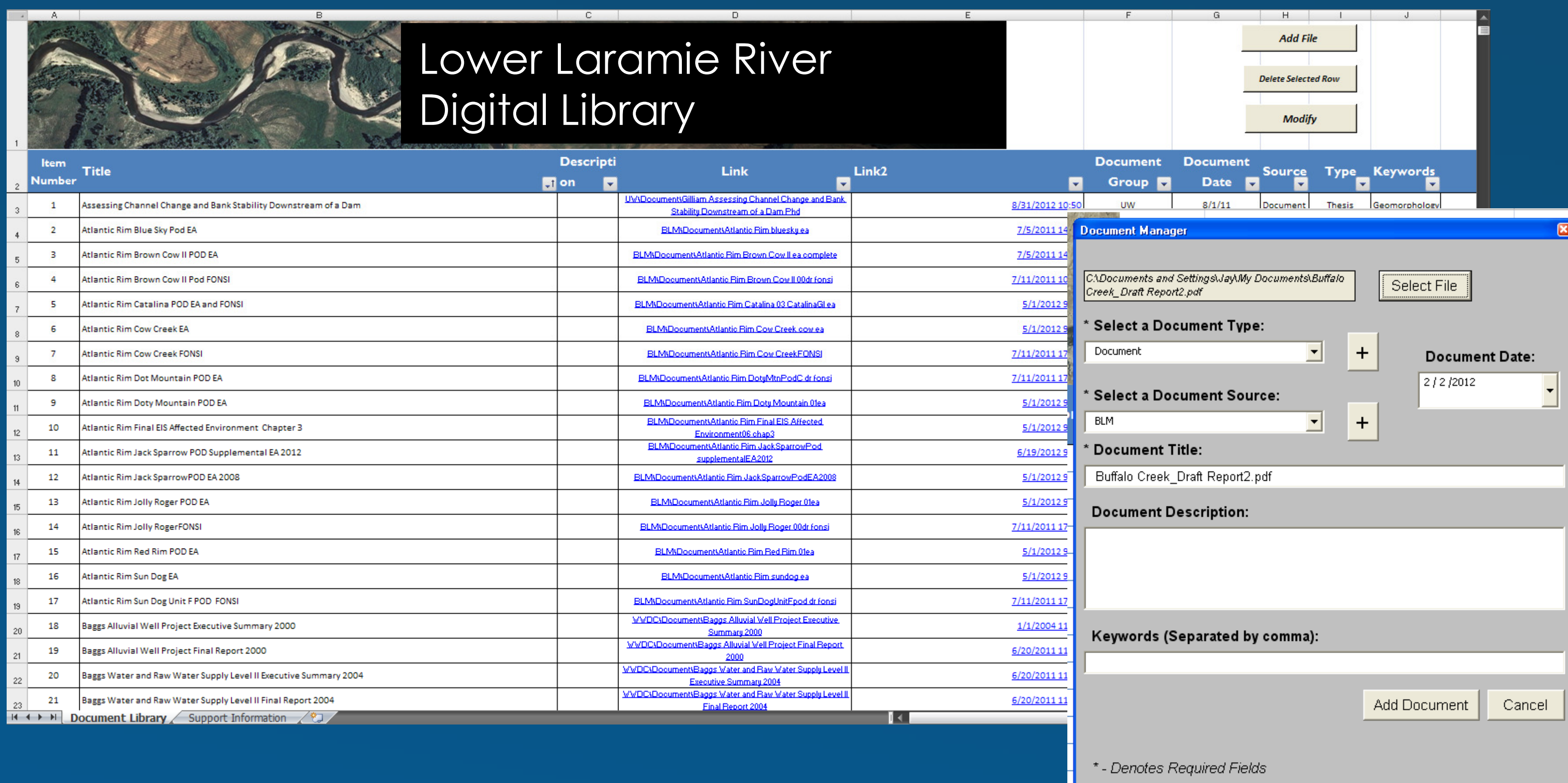
- Scanned documents referenced in the report.
- Reports prepared by:

- USGS,
- WWDO,
- NRCS/SCS,
- WYSEO ,
- BLM,
- USFS,
- Engineering/Environmental Consultants,
- Etc

• Review of Existing Information

The Lower Laramie River Digital Library

Spreadsheet – driven annotated bibliography
Documents accessed via hypertext
Macro-driven revisions to the database (sort / add / remove docs)



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<u>Watershed Management Plan</u>

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- Conceptual Designs
- Cost Estimates
- Permitting Requirements
- Funding Opportunities

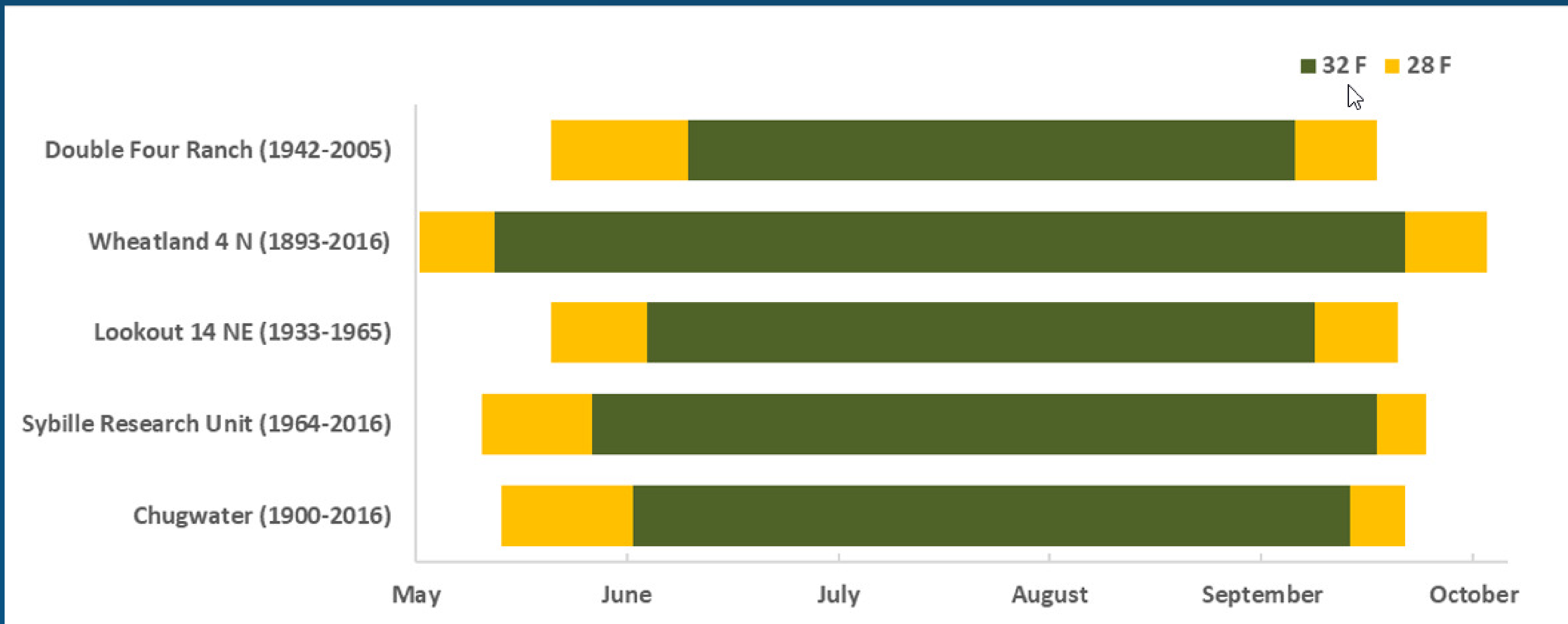
Watershed Inventory and Assessment

- Land Ownership
- Transportation, Energy and Communication Infrastructure
- Irrigation
- Range Conditions/Grazing Practices
- Grazing Allotments Administration
- Existing Water Supply
- Ecological Site Descriptions
- Range Conditions and Needs
- Oil and Gas Production and Resources
- Mining and Mineral Resources
- Fisheries and Wildlife
- Cultural Resources
- Natural Environment
- Climate
- Vegetation and Land Cover
- Overview
- Targeted Vegetation
- Wetlands

Watershed Inventory and Assessment provides an extensive amount of information for future permitting efforts, investigations, etc.

- Geology
- Surficial Units
- Bedrock Units
- Structure
- Geologic Hazards
- Soils
- Watershed Hydrology
- Groundwater
- Springs
- Alluvial Aquifers
- Bedrock Aquifers
- USGS Gaging Stations
- Stream Geomorphology
- Rosgen Classification System
- Ditch Characterization
- Water Quality
- Stream Classifications
- NPDES Permitted Discharges
- Waters Requiring TMDLs
- Water Storage and Retention
- Surface Water Availability and Shortages
- Available Flows Analysis
- Identification of Potential Sites
- Initial Screening of Storage Sites

Watershed Inventory and Assessment



Station	Period of Record	Threshold Temperature	Average Spring Last Freeze Date	Average Fall First Freeze Date	Average "Freeze Free" Period (days)
Chugwater	1900-2016	28°F	14-May	22-Sep	133
		32°F	2-Jun	14-Sep	104
Sybille Research Unit	1964-2016	28°F	11-May	25-Sep	141
		32°F	27-May	18-Sep	114
Lookout 14 NE	1933-1965	28°F	21-May	21-Sep	123
		32°F	4-Jun	9-Sep	98
Wheatland 4 N	1893-2016	28°F	2-May	4-Oct	154
		32°F	13-May	22-Sep	132
Double Four Ranch	1942-2005	28°F	21-May	18-Sep	119
		32°F	10-Jun	6-Sep	92

Incorporation of existing data

Watershed Inventory and Assessment

Designated Use	1	2AB	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C
	Surface Water Classification												
Drinking Water	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Cold Water game fish	Yes	Yes	No	Yes	No	If Present	No	No	No	No	No	No	No
Warm Water game fish	Yes	Yes	No	Yes	No	If Present	No	No	No	No	No	No	No
Nongame Fish	Yes	Yes	No	Yes	Yes	If Present	No	No	No	No	No	No	No
Fish Consumption	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No
Aquatic life other than fish	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Recreation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wildlife	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scenic Value	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Class 2AB
- Laramie River
- Gray Rocks Reservoir
- Chugwater Creek
- Richeau Creek
- North Chugwater Creek
- Spring Creek
- South Chugwater Creek
- Middle Chugwater Creek
- Strong Creek
- North Laramie River
- Fish Creek
- South Fork Fish Creek
- Owen Creek
- Sturgeon Creek
- Bear Creek
- Friend Creek
- Cow Creek
- Pinto Creek
- Cottonwood Creek
- Antelope Creek
- Bar M Creek
- Soldier Creek
- Dry Laramie Creek
- Sybille Creek
- Reservoir #1
- Deadhead Creek
- Bluegrass Creek
- Halleck Creek
- Mule Creek
- South Sybille Creek
- Canyon Creek
- Middle Sybille Creek
- North Sybille Creek
- Luman Creek
- Duck Creek
- Cherry Creek
- Dodge Creek

Class 2C
- Deer Creek
- Antelope Creek
- Hunton Creek
- Maxwell Creek
- Rock Creek (Wheatland)
- Ayers Draw
- Camp Creek

Class 3B
- Cottonwood Falls Spring
- Eagles Nest Canyon Creek
- South Hunton Creek
- Collins Cutoff Creek
- Brush Creek
- Marble Quarry Creek
- Rabbit Creek
- Slate Creek

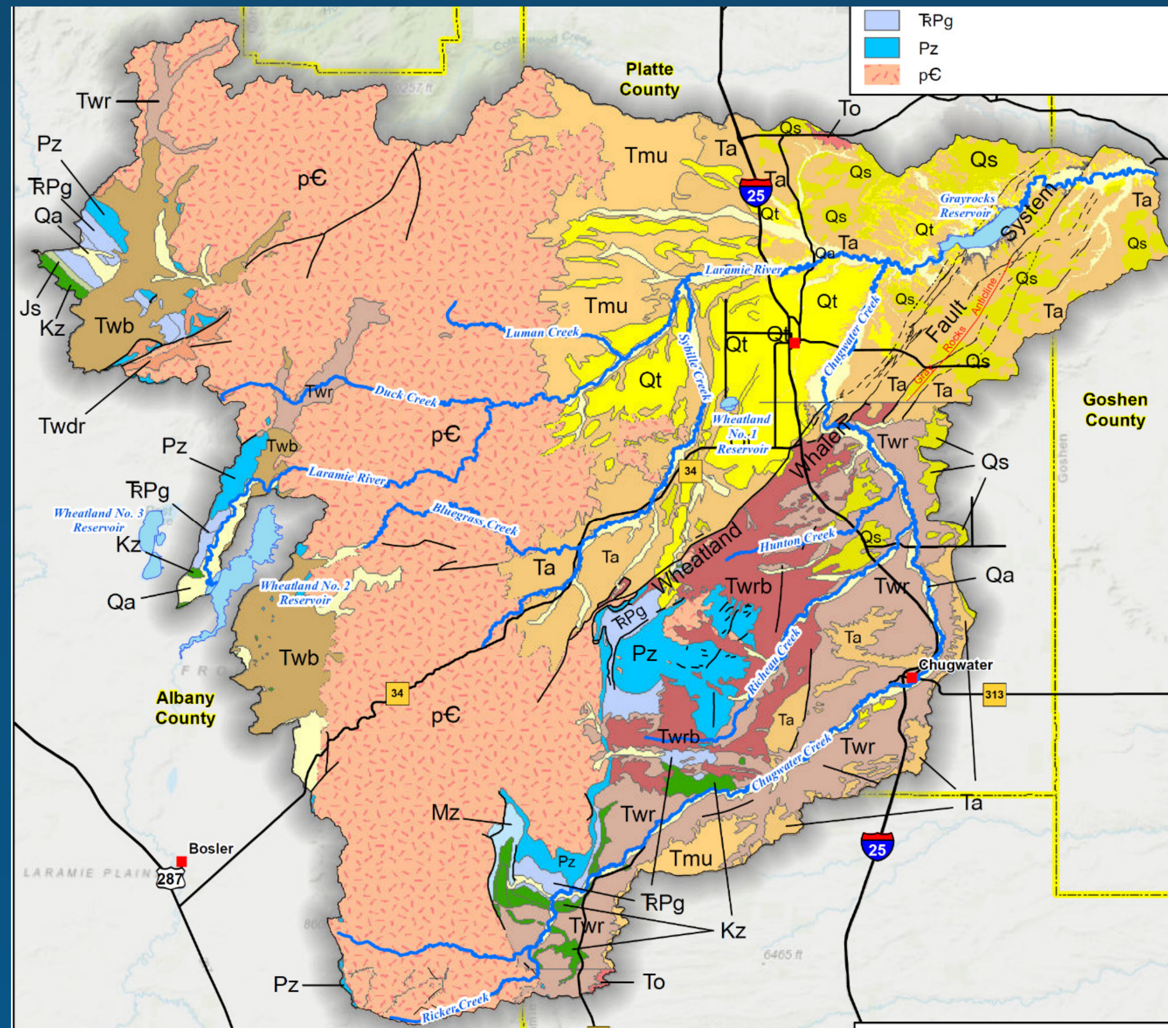
Class 4A
- Number 2 Canal

Incorporation of existing data

Watershed Inventory and Assessment

Geology:
- Surficial
- Bedrock
- Stratigraphy
- Geologic Structure
- Geologic Hazards

Groundwater:
- Recharge
- Levels and Flow
- Discharge
- Aquifers
- Quality/Sensitivity
- Use



Watershed Inventory and Assessment

Geology:

- Surficial
- Bedrock
- Stratigraphy
- Geologic Structure
- Geologic Hazards

Groundwater:

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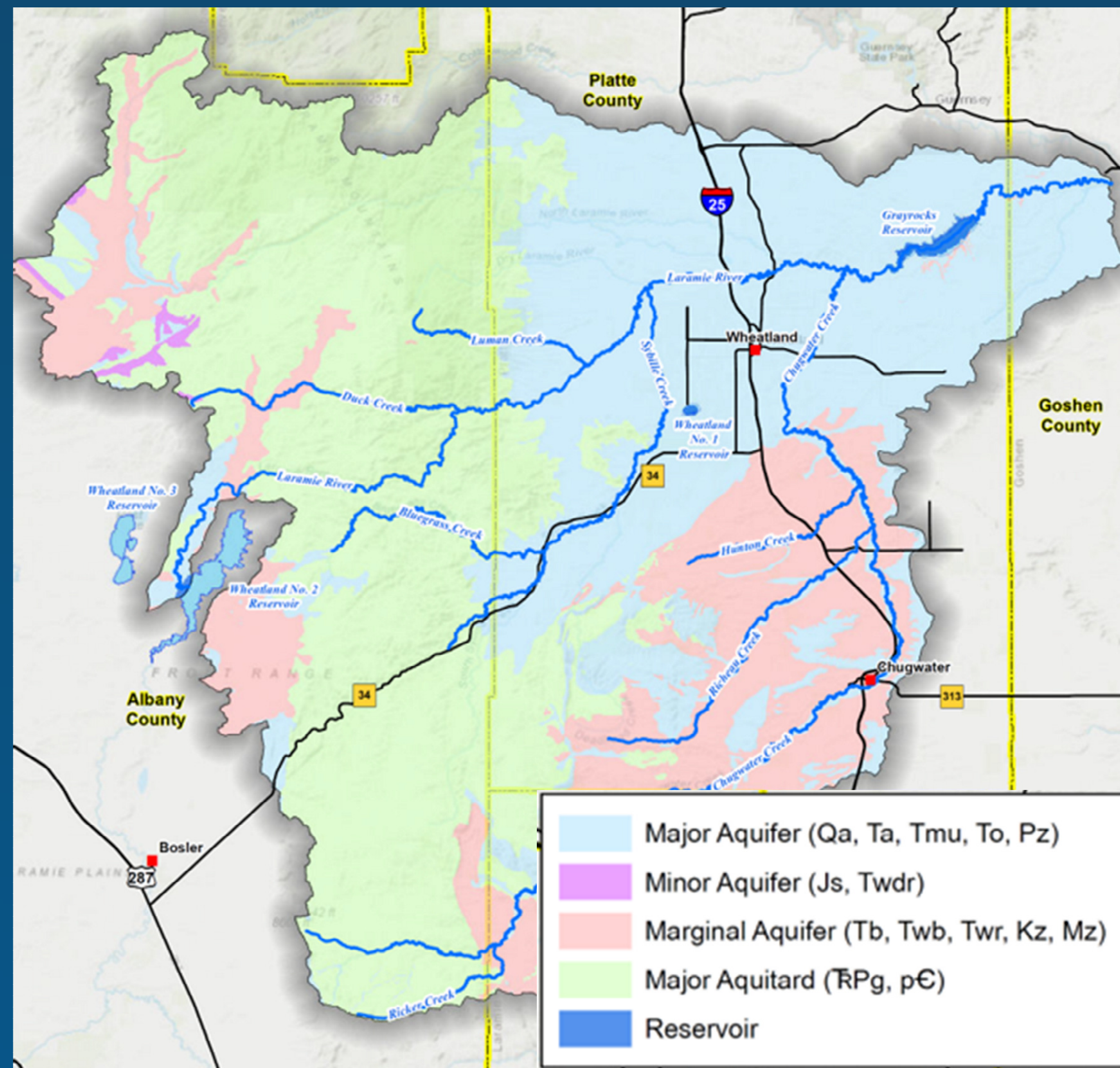
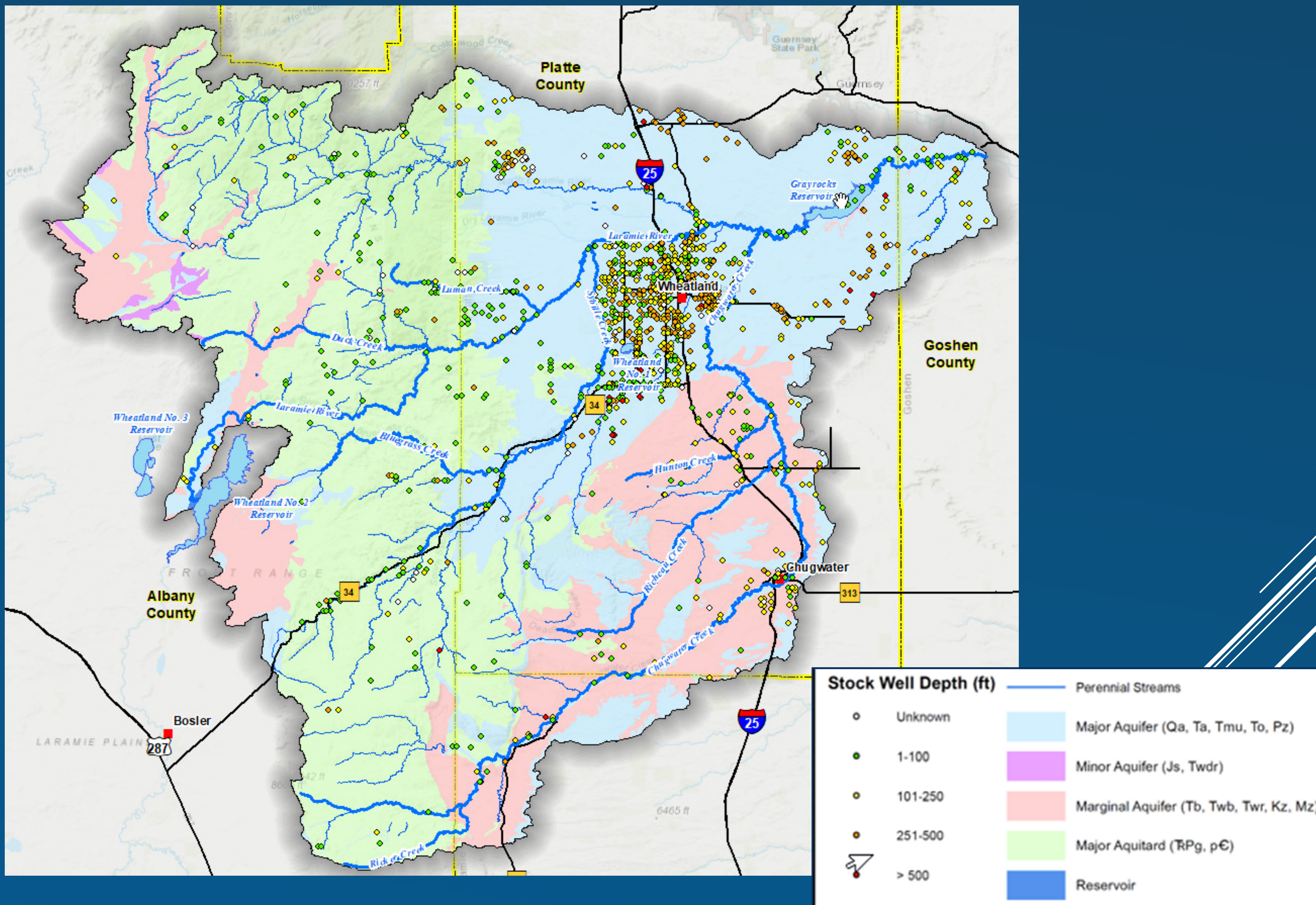
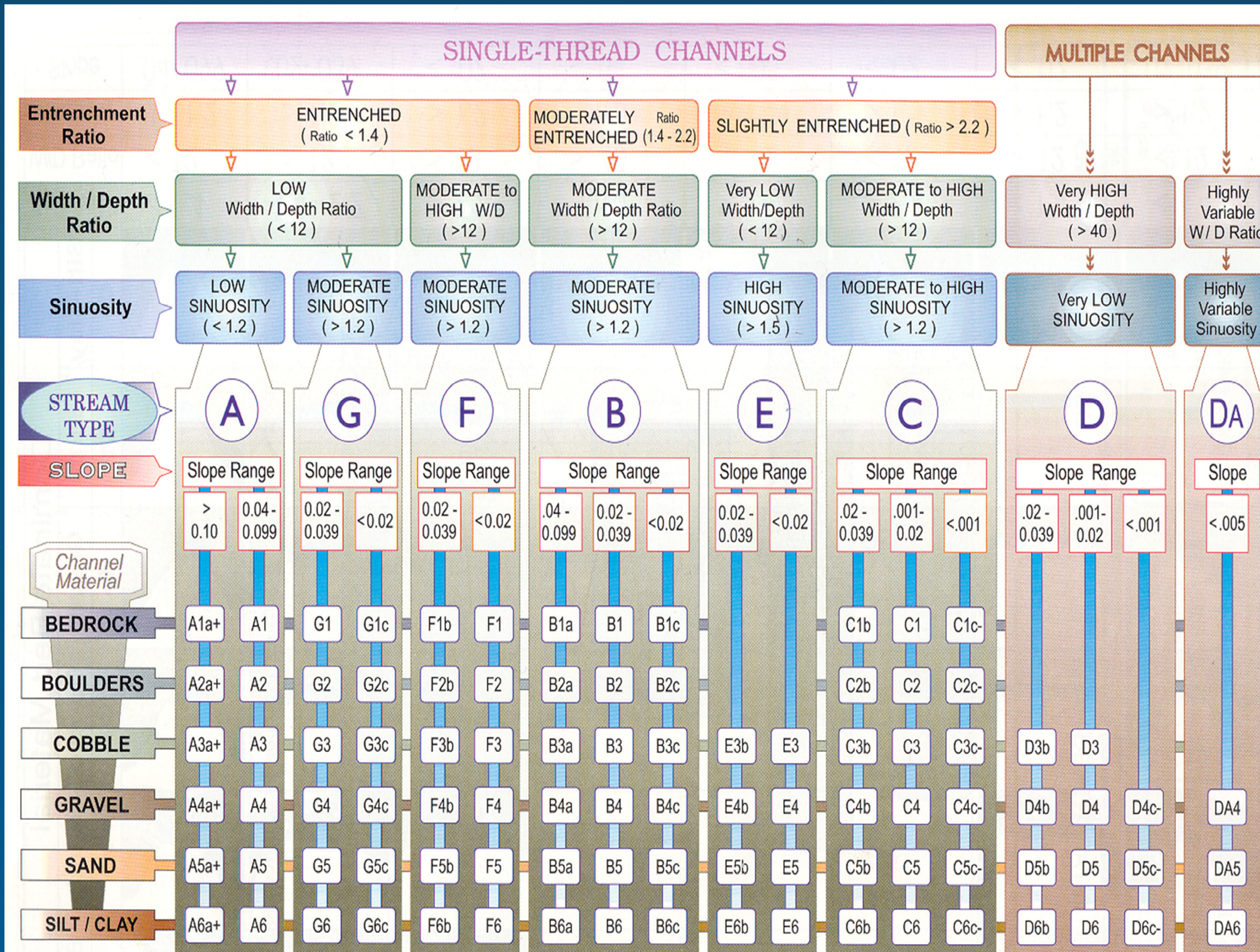
- Levels and Flow
- Discharge
- Aquifers
- Quality/Sensitivity
- Use



Watershed Inventory and Assessment



Watershed Inventory and Assessment: Geomorphology



Watershed Inventory and Assessment: Geomorphology

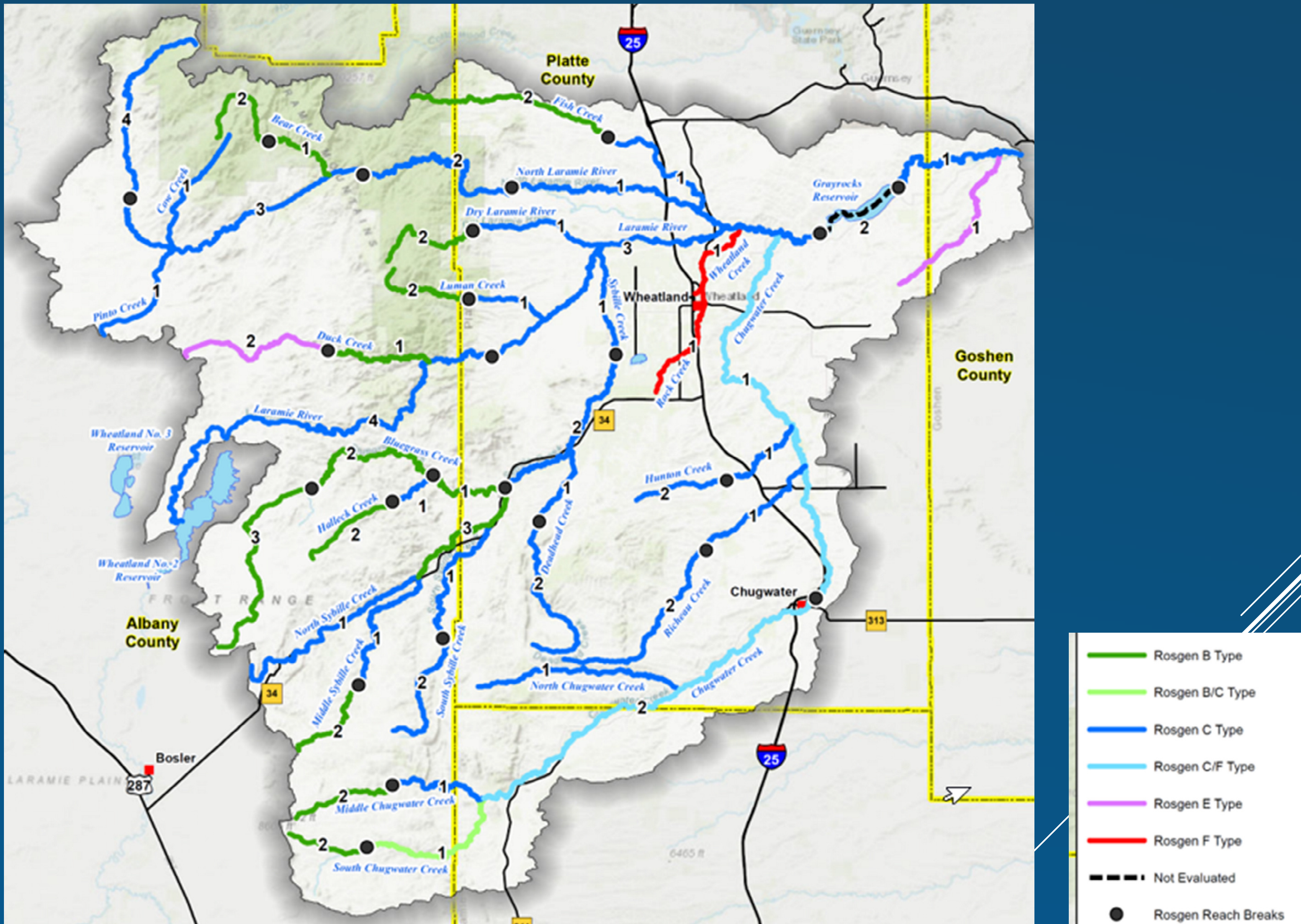
Type B: Sybille Creek

Type C: North Laramie R.

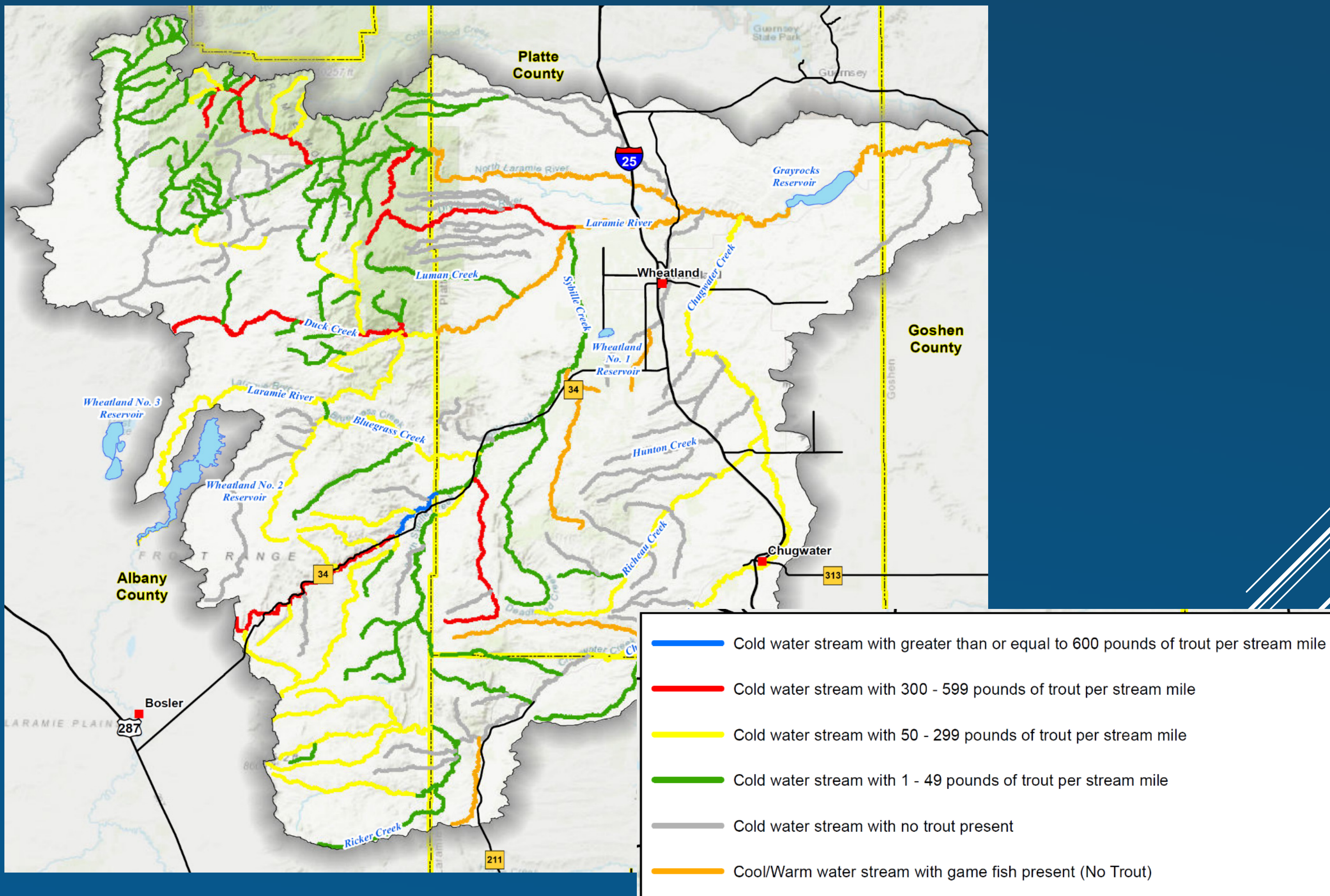
Type F: Chugwater Creek

Type C: Richeau Creek

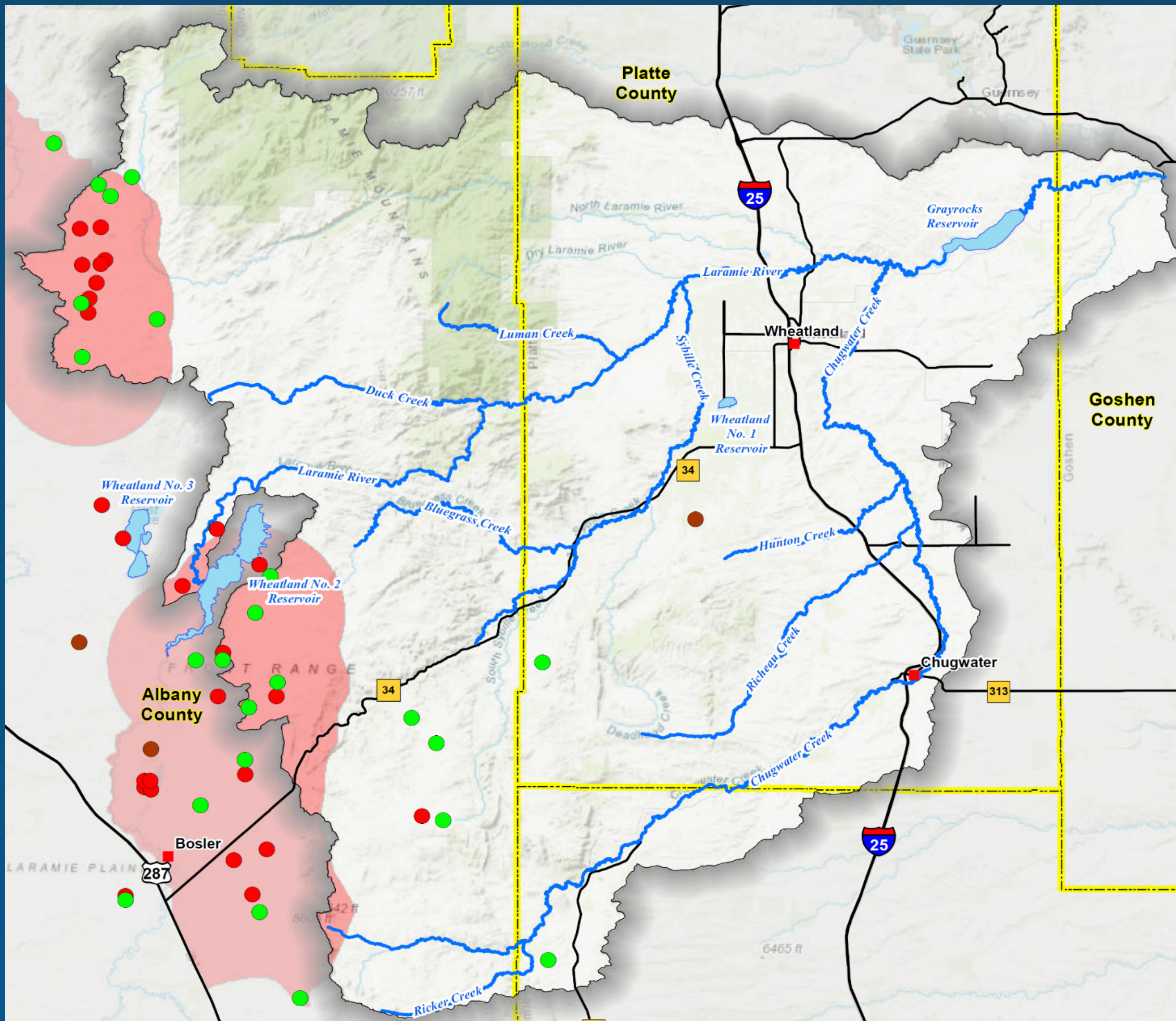
Watershed Inventory and Assessment: Geomorphology



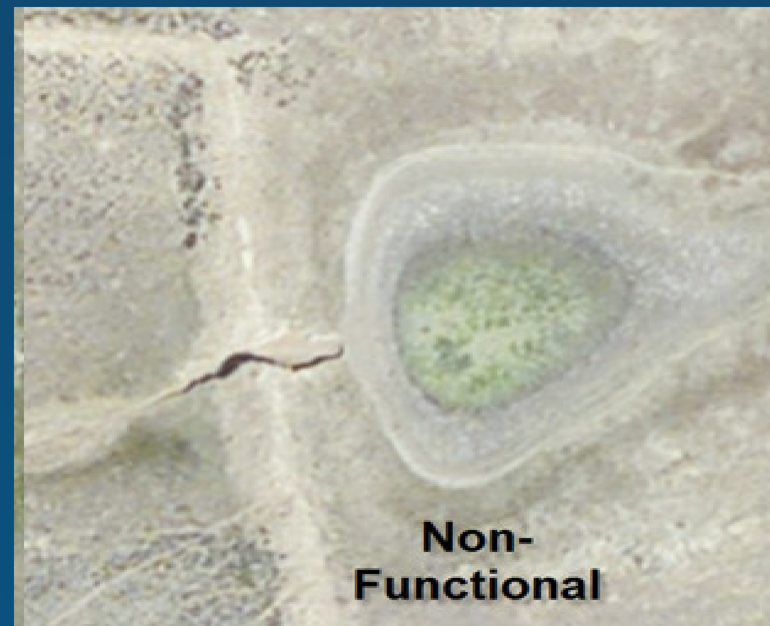
Watershed Inventory and Assessment: WGF Stream Class



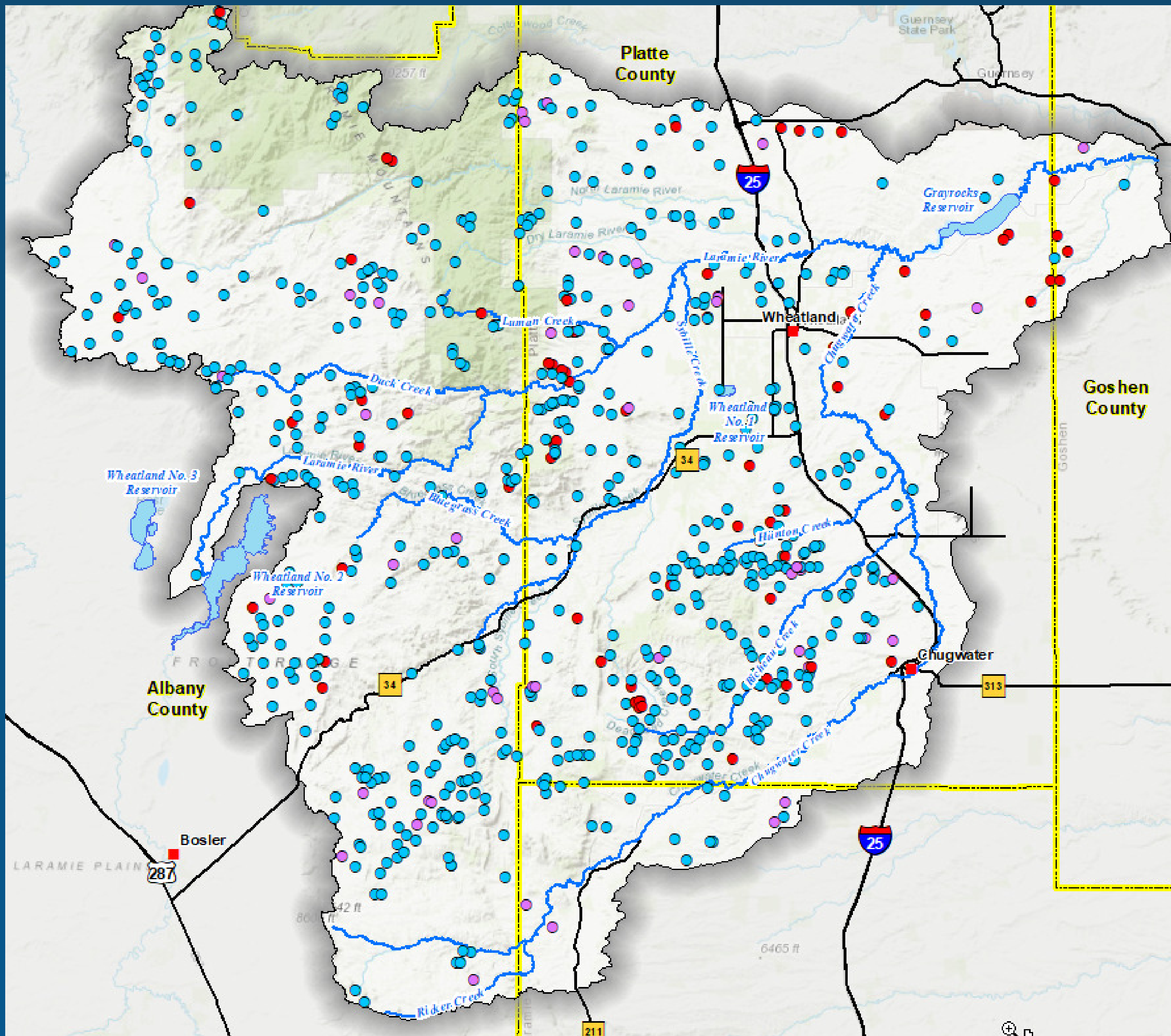
Watershed Inventory and Assessment: Sage Grouse



Watershed Inventory and Assessment: Stock Reservoirs



Watershed Inventory and Assessment: Stock Reservoirs



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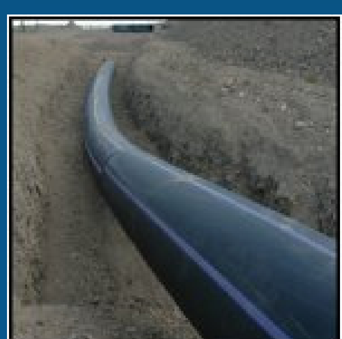
- Conceptual Designs
- Cost Estimates
- Permitting Requirements
- Funding Opportunities

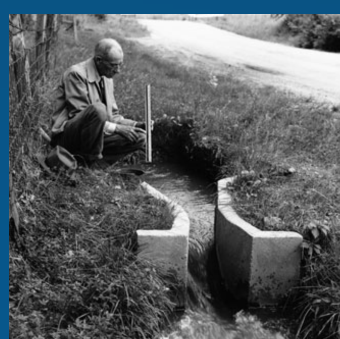
GOAL: Develop and evaluate practical and economical alternatives

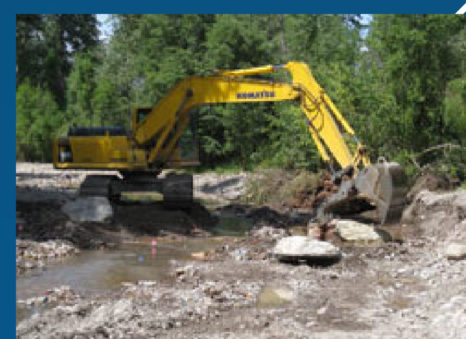
<u>Components of the Plan:</u>

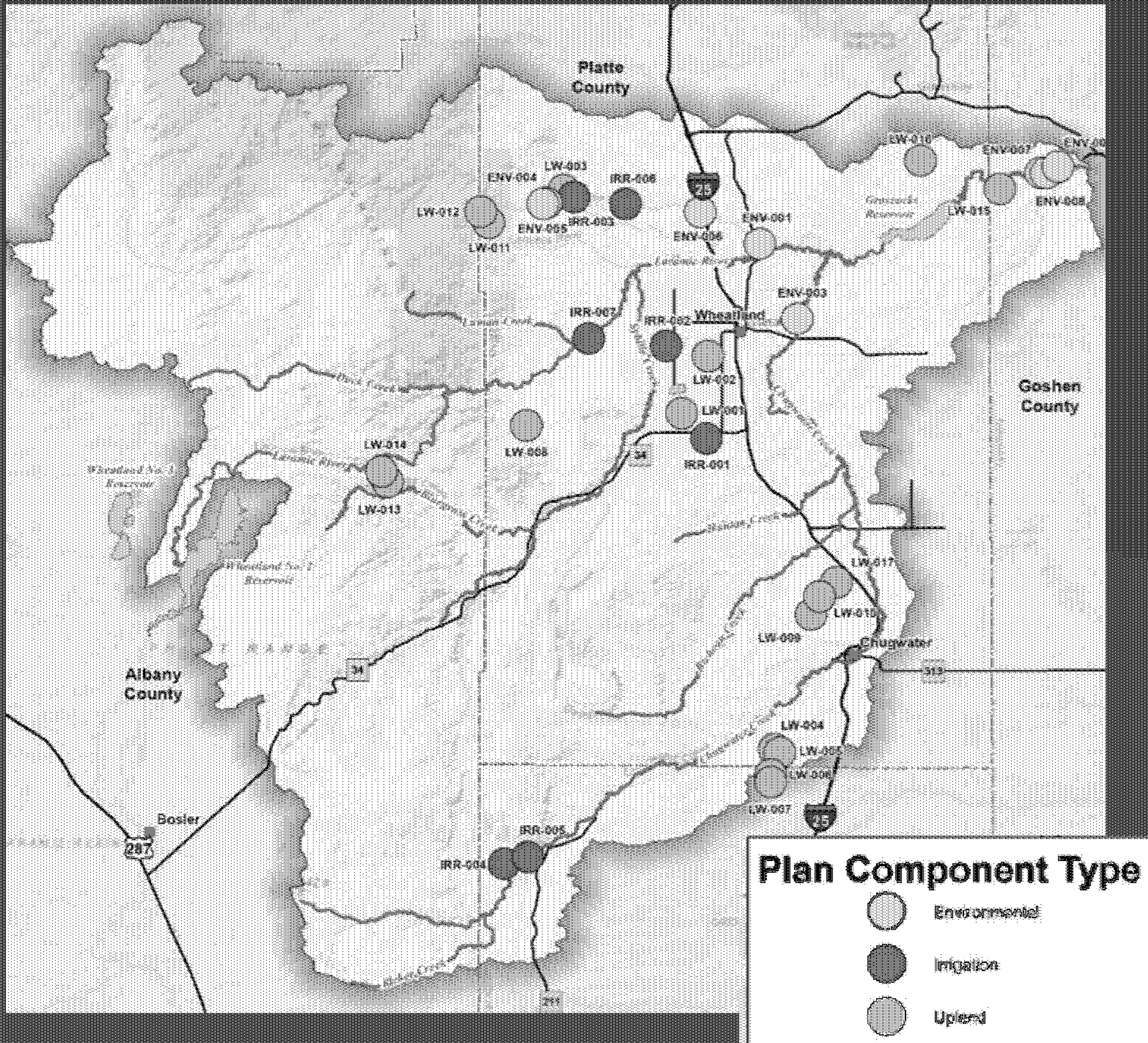
A. Water Storage
B. Upland Livestock/Wildlife
C. Channel Stability
D. Irrigation
E. Water Quality

- **Evaluate, Describe and Prioritize**
- **Project Plans, Maps, Designs, and Costs**
- **Facilitate Preparation of SWPP applications**







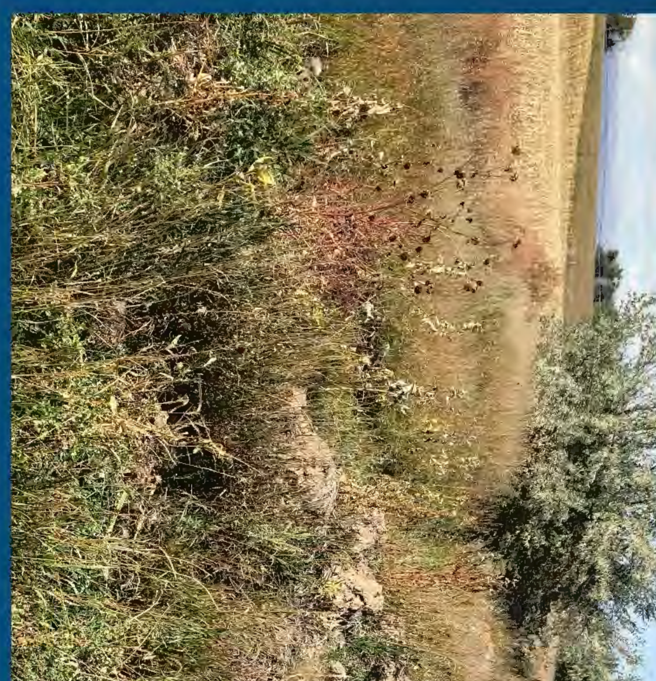

Plan Component Type
Environmental
Irrigation
Upland
Platte County
Goshen County
Albany County
Wheatland
Chugwater
Bosler
LW-001
LW-002
LW-003
LW-004
LW-006
LW-007
LW-008
LW-009
LW-010
LW-011
LW-012
LW-013
LW-014
LW-015
LW-016
LW-017
IRR-001
IRR-002
IRR-003
IRR-004
IRR-005
IRR-006
IRR-007
ENV-001
ENV-003
ENV-004
ENV-005
ENV-006
ENV-007
ENV-008
25
34
211
287
313

Irrigation Components

Lower Laramie River Watershed Management Plan		
Watershed Management Plan Component	**Project Name**	**Description**
Irrigation Components		
LL IRR-001	Christinic Pipeline Conversion Project	Convert Open Ditch to Buried Pipeline
LL IRR-002	Cochorn Pipeline Conversion Project	Convert Open Ditch
LL IRR-003	Faris Pipeline Project	Install Pipeline within Conveyance System
LL IRR-004	Iron Mountain Ditch No. 2 Headgate Replacement Project	Replace Failing Headgate
LL IRR-005	Davidson Ditch Headgate Replacement Project	Replace Failing Headgate
LL IRR-006	Kontour Headgate Replacement Project	Replace Failing Headgate
LL IRR-007	Shockley Headgate Project	Replace Headgate/Ditch Lost to Bank Erosion

Irrigation Components

- Headgate and diversion improvements
- Typical Improvements to ditches
  - Pipeline replacement
  - Elastomeric bitumen lining (Teranap)
  - Geotextile lining
  - Concrete lining
- Rehabilitation of poor or failing structures



Upland Water Components

Lower Laramie River Watershed Management Plan			
Watershed Management Plan Component	Sponsor Reference	Project Name	Description
Livestock/Wildlife Water Supply Components			
LL LW-001	Brant-001	Brant Stock Reservoir Rehabilitation Project	Rehabilitate Existing Sediment-Filled Stock
LL LW-002	Brown-001	Brown Well and Stock Tank Project	Construct New Well, Pipeline, and Stock Tank
LL LW-003	Faris-001	Faris Well Replacement Project	Rehabilitate Existing Well System
LL LW-004	Gillaspie-001	Gillaspie Spring Development Project 1	Replace Existing Spring Development/Pipeline/Tan
LL LW-005	Gillaspie-002	Gillaspie Spring Development Project 2	Replace Existing Spring Development/Pipeline/Tan
LL LW-006	Gillaspie-003	Gillaspie Solar Project 1	Install Solar Platform/Pump in Existing Well
LL LW-007	Gillaspie-004	Gillaspie Solar Project 2	Install Solar Platform/Pump in Existing Well
LL LW-008	Irvine-001	Irvine Stock Reservoir Rehabilitation	Rehabilitate Existing Stock Reservoir
LL LW-009	Langseth-001	Langseth Well Construction Project 1	Construct New Well, Pipeline, and Stock Tank
LL LW-010	Langseth-002	Langseth Well Construction Project 2	Construct New Well, Pipeline, and Stock Tank
LL LW-011	Preston-001	Preston Stock Reservoir Rehabilitation Project	Rehabilitate Existing Stock Reservoir
LL LW-012	Preston-002	Preston Stock Reservoir Construction Project	Construct New Stock / Wildlife Reservoir
LL LW-013	Purdy-001	Purdy Spring Development Project 1	Construct New Spring Development/Tank
LL LW-014	Purdy-002	Purdy Spring Development Project 2	Construct New Spring Development/Tank
LL LW-015	Watson-001	Watson Pipeline Project 1	Construct New Pipeline/Tank System From
LL LW-016	Watson-002	Watson Pipeline Project 2	Construct New Pipeline/Tank System From
LL LW-017	West-001	West Well and Pipeline Construction Project	Construct New Well, Pipeline, and Stock Tank

Upland Water Components

Development of Alternative Water Sources

- Ground water wells
- Solar Platforms
- Conventional Windmills
- Guzzler Construction
- Spring Development
- Stock water tank construction
- Stock pond construction
- Water pipeline construction

Upland Water Components




Environmental Components

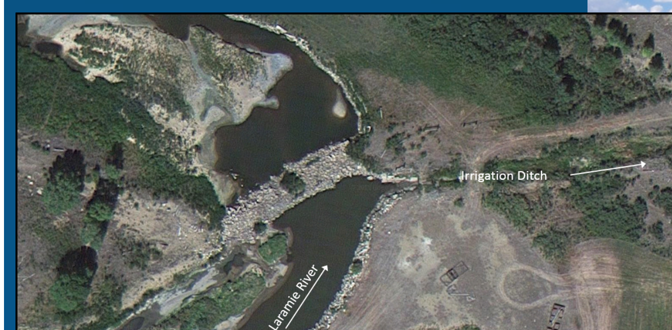
Lower Laramie River Watershed Management Plan			
Watershed Management Plan Component	**Sponsor Reference**	**Project Name**	**Description**
Environmental Components			
LLENV-001	deRyk-001	Lower Laramie River Bank Stabilization Project 1	Realign Streambank and Stabilize Erosive Banks
LLENV-002	Lanier-001	Lower Laramie River Bank Stabilization Project 2	Stabilize Erosive Streambank
LLENV-003	Nockels-001	Chugwater Creek Bank Stabilization Project 1	Stabilize Erosive Streambank
LLENV-004	WGF-001	Wilson No. 2 Ditch Diversion Fish Passage Project	Enhance Fish Passage Capabilities
LLENV-005	WGF-002	North Laramie Land Company Canal Fish Passage Project	Enhance Fish Passage Capabilities
LLENV-006	WGF-003	Burger Ditch Diversion Structure Fish Barrier	Increase Fish Barrier Opportunity
LLENV-007	Freeborn-001	Lower Laramie River Stabilization Project 3	Stabilize Erosive Streambank

Environmental Components

- Channel Bed / Bank Protection Alternatives
  - Structural Bank Protection
  - Bioengineered Protection
  - Integration of both structural / bioengineered
  - Land Management

- Identify / develop alternatives that enhance/maintain aquatic habitat / Barriers to fisheries

Diversion Structure Alternatives



Barriers to Fish Passage

Channel Gradient Restoration Alternatives

Environmental Components

Conceptual Designs

Conceptual Designs

Project Name: **Well and Pipeline Construction Project**
Project Sponsor/Number: ******-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 6,500
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50	250	$ 12,500
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500	1	$ 2,500
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	3	$ 10,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	7500	$ 22,500
7	Misc valves and piping at tank(s)	Ea	$ 500	3	$ 1,500
	Project Subtotal				$ 71,500
	Contingencies (15% of subtotal)				$ 10,725
	Engineering and technical assistance (10% of subtotal)				$ 7,150
	Estimated project cost				$ 89,375

Funding Sources

Funding Alternatives

State Sources

- Wyoming Water Development Commission
  - Wyoming Water Development Program
  - ***Small Water Project Program***
- Office of State Lands and Investments
  - Farm Irrigation Loans
  - Small Water Development Project Loans
- Wyoming Game and Fish Department
  - Riparian Habitat Improvement Grant
  - Water Development/Maintenance Habitat Grant
  - Upland Development Grant
  - Wyoming Sage Grouse Conservation Fund
- Wyoming Wildlife and Natural Resources Trust

➢ Find Partnering Opportunities
➢ Offset Project Costs

Federal Sources

- Bureau of Land Management
  - ✓Riprarian Habitat Management Program
  - ✓Cooperative Agreement for Range Improvements
- Natural Resources Conservation Service (NRCS)
  - ✓Environmental Quality Incentives Program (EQIP)
  - ✓Watershed Protection and Flood Prevention Program (PL566)
  - ✓ Wetlands Reserve Program
  - ✓Wildlife Habitat Improvement Program (WHIP)
  - ✓Emergency Watershed Protection
  - ✓Small Watershed Rehabilitation Program
  - ✓Grazing Lands Conservation Initiative Grants
- United States Environmental Protection Agency
  - ✓ Nonpoint Source Implementation Grants (319 Program)
  - ✓ Watershed Assistance Grants
  - ✓ Wildlife Habitat Incentives Program (WHIP)
- US Army Corps of Engineers
  - ✓Flooding problems funding
- Farm Service Agency (USDA)
  - ✓Conservation Reserve Program
  - ✓Continuous sign up High Priority Conservation Practices
- US Department of Commerce National Oceanic and Atmospheric Administration (NOAA)
  - ✓Community-Based Restoration Program (CRP)

Funding Sources

WWDC Small Water Project Program

To provide grant funding for Small Water Development Projects that improve watershed condition and function

Funding:
50% grants up to $35,000 are available for Eligible projects that provide adequate public benefit, improve watershed health, and meet the program definitions as outlined in the criteria

Small Water Project Program

Eligible Projects Include:

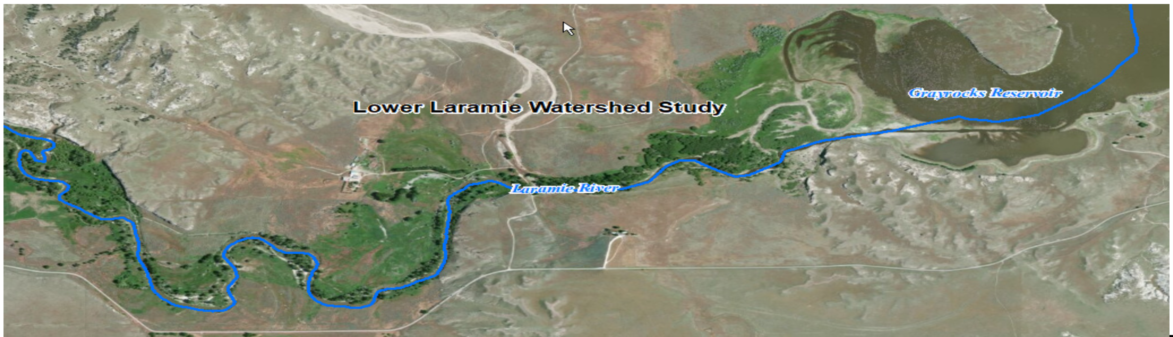
- *Small Reservoirs*
- *Wells*
- *Solar Platforms*
- *Pipelines and Conveyance Facilities*
- *Spring Development*
- *Wetland Development*
- *Environmental*
- *Irrigation*
- *Windmills*
- *Rural Community Fire Suppression*
- *Recreational*

Lower Laramie River Watershed Study

Jay Schug
Project Manager
Anderson Consulting Engineers
970.226.0120

APPENDIX 3A

DIGITAL LIBRARY CONTENTS



Item Number	Title	Description
1	2015 Western Invasive Weed Summit Summary and Next Steps	Describes the importance of a durable campaign to arrest the spread of invasive annual plants in the sagebrush ecosystem and secure the ecological, economic and social values of this landscape for generations to come.
2	2015-16 Annual Report	Highlights the projects and the partnerships within the Laramie Rivers Conservation District in 2015-16.
3	2017 Species of Greatest Conservation Need	List of Wyoming 2017 SGCN species and their classifications.
4	A Citizen's Guide to the NEPA	Guidelines for the layman to the NEPA (National Environmental Policy Act) and how to effectively participate in Federal agencies' environmental review process.
5	A Geomorphological Approach to Restoration of Incised Rivers	Rosgen's discussion of use of a 'reference reach' in design of restorative measures for incised channels
6	A Stream Channel Stablility Assessment Methodology	The stability assessment is conducted on reference reach (stable) reaches and a departure analysis is performed when compared to an unstable reach of the same stream type.
7	A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas	Provides guidance for assessing the condition of any riparian-wetland area other than a lotic (riverine) area.
8	ACEC Proposal Evaluation Form - Casper Field Office - RMP Process	Evaluations of 23 areas nominated as Areas of Critical Environmental Concern (ACECs) during the scoping process of the BLM Casper Resource Management Plan revision.
9	Agricultural Salinity and Drainage	Prepared by the University of California Irrigation Program to provide technical and practical information on salinity to the layperson
10	An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices	Wetlands research program technical report that outlines an approach for assessing wetland functions in the 404 Regulatory Program as well as other regulatory, planning, and management situations.
11	Analysis of Greater Sage Grouse Lek Data: Trends in Peak Male Counts	Provides an independent analysis of the peak male lek attendance data collected across the range of Sage Grouse, conducts a comparative review of previous analyses conducted, and recommendations for future data collection.
12	Analysis of the Guernsey Reservoir Silt Run - Final Report	Identifies and evaluates alternatives to the existing silt run, selects a preferred alternative and develops a cost estimate and plan for implementation.
13	Appendices for Casper Resource Management Plan	The RMP provides overall direction for management of all resources on BLM-administered land in the Casper Field Office Planning Area.
14	Appendices for PROPOSED Resource Management Plan and FINAL Environmental Impact Statemnet for the Casper Field Office Planning Area	Provides a framework for the future management direction and appropriate use of lands and resources administered by the BLM Casper Field Office.
15	Appendices for Rawlins Resource Management Plan	The RMP provides overall direction for management of all resources on BLM-administered land in the Rawlins Field Office Planning Area.
16	Application for the Small Water Project Program	Application form for the SWPP which includes project description, public benefit, project participants, project readiness, and other general information
17	Assessing Channel Change and Bank Stability Downstream of a Dam, Wyoming	Evaluation of effects of a reservoir on the creek downstream.
18	Assessment of stream intermittency on fishes in Lodgepole Creek, Horse Creek, lower Laramie River, and the Niobrara River in eastern Wyoming	Study was conducted to understand distribution of fish species in four seasonally-intermittent streams in eastern Wyoming, and derive methods to track their status. Aerial surveys were conducted to monitor streamflow, physical barriers to fish movement were cataloged, and intensive fish sampling was conducted.

Item Number	Title	Description
19	Auxiliary Spillway Cross Section & Profile (378-08b)	NRCS Design Drawing for Wetland Standard Auxiliary spillway profile cross section and profile
20	Auxiliary Spillway Cross Section & Profile Example (378-08b)	Example of completed "Auxiliary Spillway Cross Section & Profile" NRCS Wetland Standard Design Drawing
21	Beginner's Guide to Greater Sage Grouse	Provides key points about seasonal habitats, natural history and population trend analyses for the greater Sage Grouse.
22	Big Laramie River Watershed Standards and Guidelines Assessment	Assessment of the rangeland conditions and trend based on standards in geomorphology, wetland/riparian vegetation, species/habitats, water quality, and air quality.
23	Bigmouth Shiner SWAP	State Wildlife Action Plan (SWAP) for bigmouth shiner: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
24	Brassy Minnow SWAP	State Wildlife Action Plan (SWAP) for brassy minnow: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
25	C.M. Pipe Drop Inlet with Pond Drain	NRCS Design Drawing for CMP drop inlet pond
26	Can Stormwater BMPs Remove Bacteria? New Findings from the International Stormwater BMP Database	Provides a brief background regarding bacteria in urban runoff, summarizes the bacteria data available in the BMP Databse, provides analysis results and suggests how these findings may affect the selection and design of BMPs to assist in meeting TMDL goals.
27	Canal Operation and Maintenance: Vegetation	This manual is designed to help operating entities better understand the impacts that vegetation on canals and other conveyance systems. This volume describes how vegetation and root systems can lead to failure(s), types of vegetation commonly encountered, provides an outline for a preventive maintenance program, and how to repair damage caused by vegetation.
28	Canal Seepage Reduction Using Anionic Polyacrylamide - Executive Summary	Determines the effectiveness of high molecular weight, anionic polyacrylamide (PAM) application in decreasing seepage from unlined irrigation canals.
29	Canal Seepage Reduction Using Anionic Polyacrylamide: Field and Bench-Scale Tests - Final Report	Determines the effectiveness of high molecular weight, anionic polyacrylamide (PAM) application in decreasing seepage from unlined irrigation canals.
30	Casper Field Office Review of Potential Wild and Scenic Rivers in the Casper Resource Management Plan Planning Area	Determines if public lands within the Casper RMP planning area meet the WSR eligibility criteria and suitability factors, as identified in the Wild and Scenic Rivers Act (WSRA).
31	Closing Remarks/Workshop Summay (Western Invasive Weed Summit)	Summarizes what is at stake if invasive plants are ignored, and the importance of mitigation efforts.
32	CMP Water Control Structure (587-09)	NRCS Design Drawing for CMP Water Control Structure with two gated pipes
33	CMP Water Control Structure (587-10)	NRCS Design Drawing for CMP Water Control Structure
34	CMP Water Control Structure (587-11a and 587-11)	NRCS Design Drawing for CMP Water Control Structure
35	Commercial Wind Energy Development in Wyoming: A Guide for Landowners	Outlines the process of wind energy development for landowners and highlights some of the key issues that they may face.
36	Common Shiner SWAP	State Wildlife Action Plan (SWAP) for common shiner: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
37	Concrete Ditch Lining (428-01)	NRCS Design Drawing for concrete ditch lining for flows less than 1.5 cfs
38	Concrete Ditch Lining (428-02)	NRCS Design Drawing for concrete ditch lining for flows between 1.5 cfs and 2.5cfs
39	Concrete Water Control Structure (587-07)	NRCS Design Drawing for 4'x4' Concrete box irrigation structure with two gated pipes

Item Number	Title	Description
40	Concrete Water Control Structure (587-08)	NRCS Design Drawing for 4'x4' Concrete box irrigation structure with one gated pipe
41	Consumptive Use of Irrigation Water in Wyoming	Estimating water requirements and consumptive water use based on the Blaney-Criddle Method
42	Corn Creek Irrigation Project - Final Environmental Assessment	Develops and evaluates the economic feasibility of a conceptual plan that would allow for the delivery of water to approximately 15,000 acres in the CCID.
43	Corn Creek Irrigation Project - Interim Report	Alternative configurations and designs were reviewed, and an economic analysis was performed for the preferred system.
44	Corn Creek Irrigation Project - Progress Report	Summarizes all activities to date, defines identified project constraints, and gives an overview of tasks yet to be performed.
45	Crucial Habitat Area Narrative - Lower Laramie and North Laramie Rivers (Aquatic)	Describes the habitat values, reason selected, and conservation solutions
46	Crucial Habitat Area Narrative - Sage Grouse Core Areas (Terrestrial)	Describes the habitat values, reason selected, and conservation solutions
47	Development of Improved Hydrologic Models for Estimating Streamflow Characteristics of Mountainous Basins in Wyoming	Methods for estimating streamflow based on bankfull width and climatic variables.
48	Ditch Rights and Easements	FAQ for legal aspects relating to ditch rights and easements
49	Documentation for the 2008 Update of the United States National Seismic Hazard Maps	Explains the methodology and highlights important changes to the procedures and input parameters used in seismic hazard mapping
50	Early season utilization of mountain meadow riparian pastures	June cattle distribution was examined within 4 experimental pastures located along Stanley Creek, Sawtooth National Recreation Area, Sawtooth National Forest, in central Idaho.
51	Earthquakes and Related Geologic Hazards in Wyoming	Causes, mechanisms, and measuremnet of earthquakes; history and earthquake potential in Wyoming; related geologic hazards
52	Ecological Site and State-and-Transition	ESD definition and significance. Summary and descriptions of predominant ESD's in study area
53	Economic Benefits of Watershed Restoration	Quantifying economic benefits that arise from watershed resotration
54	Effects of a Wind Energy Development on Greater Sage Grouse Habitat Selection and Population Demographics in Southeastern Wyoming	Discerns the relationship between Sage Grouse nest, brood-rearing, and summer habitat selection patterns and survival parameters and the infrastructure of an existing wind energy facility.
55	Embankment Pond Profile & Cross Section (378-08a)	NRCS Design Drawing for Wetland Standard Embankment Pond profile and cross section
56	Embankment Pond Profile & Cross Section Example (378-08a)	Example of completed "Embankment Profile and Cross Section" NRCS Wetland Standard Design Drawing
57	Embrace A Stream Grant Program - 2018 Instructions	Describes program overview, eligibility, review process, application procedures, other information, and a final checklist for EAS project proposals. The application form is at the end of the document.
58	Enhanced sediment delivery in a changing climate in semi-arid mountain basins: Implications for water resource management and aquatic habitat in the northern Rocky Mountains	Synthesizes existing data from central Idaho to explore (1) how sediment yields are likely to respond to climate change in semi-arid basins influenced by wildfire (2) the potential consequences for aquatic habitat and water resource infrastructure, and (3) prospects for mitigating sediment yields in forest basins.
59	Enhancement Habitat Area Narrative - Mixed Mountain Shrub (Terrestrial)	Describes the habitat values, reason selected, and conservation solutions
60	Environment Assessment - Noxious and Invasive Weed Control and Commercial Site Vegetation Control Programs	Assesses the environmental impacts of integrated pest management, and controlling the introduction of proliferation of noxious and invasive species.
61	ESIS User Guide NRCS	Introduction to Ecological Site Information System, ESD Application, and guidance for facilitating an ESD effort in your state
62	Estimating Streamflow from Concurrent Discharge Measurements - Final Report	Details a method for estimating streamflows at ungaged sites in mountainous areas of Wyoming. Documentation and application of the technique was performed as part of an instream flow study for the WWDC
63	Evaluation of Relevance and Importance Criteria for Existing and Proposed ACECs - BLM Rawlins Field Office	Presents the evaluation forms used by the BLM to evaluate all existing and proposed ACECs based on the relevance and importance criteria.

Item Number	Title	Description
64	Evaluation of the State-of-the-Art Stream Stabilization	Assembles and reviews the current literature on streambank stabilization techniques, and compiles a state-of-the-art streambank stabilization bibliography.
65	Executive Order - Greater Sage Grouse Core Area Protection	Includes information on how the core areas were identified, and the permitting process and stipulations for development in core areas
66	Executive Order - Supplement to Greater Sage Grouse Suitable Habitat Definitions	States that wetlands and irrigated riparian meadows should be reclassified from disturbed to suitable habitat for conservation credit purposes. Areas beyond the 275 meter limitation should be reclassified (on a case-by case basis) from disturbed to suitable habitat if there is defensible proof that Sage Grouse use the area
67	Field Manual on Maintenance of Large Woody Debris for Municipal Operation and Maintenance Crews	Demonstrates how to manage an existing LWD structure in an environmentally friendly manner, as well as how to install a LWD structure for erosion control, bank stabilization, and habitat improvement
68	Final Biological Assessment for the Casper Field Office Proposed Resource Management Plan	Provides documentation for the Proposed Plan of the Casper RMP to meet federal requirements and agreements including the Endangered Species Act (ESA). Determines the need for, and type of conferencing and consulation necessary with the USFWS.
69	Final Report on Goshen Irrigation District Rehabilitation Project	Investigates the pipe lateral system (current losses, and the size, location, and cost estimate of replacements), gates (inventory, recommended replacements, cost estimates), and Laramie River Diversion (location and layout, cost estimate).
70	Final Summary of the Management Situation Analysis	Provides an introduction to the Resource Management Plan (RMP) revision topics, and an overview of the current management situation in the Casper Planning Area.
71	Fire and Fuels Managment Contributions to Sage Grouse Conservation	Illustrates the type and responsiveness of efforts being made to manage vegetation and prevent wildland fires. Presents future options and a series of recommendations that may inform future policy and allocation decisions.
72	FIRM (Flood Insurance Rate Map) - Town of Wheatland, Wyoming	Shows 100-yr and 500-yr flood zones for the Town of Wheatland, Wyoming
73	Freeze / Frost Occurrence Data	Probablility of last freeze (spring) date, first freeze (fall) date, freeze free period, and annual freeze/frost probability.
74	Funding Opportunities for Wyoming Sage Grouse Conservation Efforts	A list of potential funding sources that can address various scales of projects ranging from the individual landowner to multi-state efforts.
75	FY 2018 Wyoming Program Guidance and Practice Payment Rates for Eligible Conservation Practices	Provides guidance or limitations for eligibility of conservation practices for program financial assistance.
76	Generalized Potentiometric Surface, Estimated Depth to Water, and Estimated Saturated Thickness of the High Plains Aquifer System, March-June 2009, Laramie County, Wyoming	Presents the generalized potentiometric surface of the High Plains aquifer system in Laramie County, Wyoming, based on measurements made between March and June 2009. Also describes hydrogeologic units and presents depth to water and saturated thickness maps.
77	Geology Groundwater Resources of Goshen County Wyoming	Evaluates groundwater resources of the county by determining the character, thickness, and extent of the water-bearing materials; the source, occurrence, movement, quantity, and quality of the ground water; and the possibility of developing additional ground water.
78	Geology Groundwater Resources of Laramie County Wyoming	Determines the effect of the development of groundwater on the hydrology of the area, and studies the hydraulic properties of the aquifers and potential for additional development
79	Geosynthetic Clay Liners (GCL's)	Applications and product specifications for geosynthetic clay liners.
80	GIS Standards Technical Memorandum	Provides the necessary guidelines for creators and managers of data that is produced for the WWDO. Supporting Geodatabase templates have also been created that should be used to prepare the core datasets to meet the contractual requirements for GIS data delivered to the WWDO.
81	Glossary for Casper Resource Management Plan	The RMP provides overall direction for management of all resources on BLM-administered land in the Casper Field Office Planning Area.
82	Goshen (Lower North Platte) Wetlands Complex	Major purposes of this regional plan are to characterize the landscape and wetlands of the GWC, outline conservation objectives and strategies, identify resources to accomplish those objectives, and enhance collaboration and conservation delivery by key partners.

Item Number	Title	Description
83	Goshen Irrigation District Level II Rehabilitation Project Siphons, Tunnels, and Canal Evaluation [Task B] - Executive Summary	Feasibility study to identify deficiencies in facilities owned and operated by Goshen Irrigation District (GID), specifically the main delivery canal, two tunnels, and four siphons (Task B).
84	Goshen Irrigation District Level II Rehabilitation Project Siphons, Tunnels, and Canal Evaluation [Task B]- Final Report	Feasibility study to identify deficiencies in facilities owned and operated by Goshen Irrigation District (GID), specifically the main delivery canal, two tunnels, and four siphons (Task B).
85	Goshen Irrigation District Master Plan, Level I - Executive Summary	Inventory and assessment of previous investigations, existing structures and facilities, seepage, reservoirs, etc. Also includes conceptual design and costs for improvements, implementation plan, and economic evaluation.
86	Goshen Irrigation District Master Plan, Level I - Final Report	Inventory and assessment of previous investigations, existing structures and facilities, seepage, reservoirs, etc. Also includes conceptual design and costs for improvements, implementation plan, and economic evaluation.
87	Goshen Irrigation District Rehabilitation Project, Level II - Executive Summary	A feasibility study of measures to improve operational management of water deliveries, reduce maintenance, and reduce seepage losses associated with the main canal and laterals of the Goshen Irrigation District.
88	Goshen Irrigation District Rehabilitation Project, Level II - Final Report	A feasibility study of measures to improve operational management of water deliveries, reduce maintenance, and reduce seepage losses associated with the main canal and laterals of the Goshen Irrigation District.
89	Goshen Irrigation District Rehabilitation Project, Level II [Task A] - Executive Summary	Feasibility study to identify deficiencies in facilities owned and operated by Goshen Irrigation District (GID), specifically the Laramie River Pump Station (Task A).
90	Goshen Irrigation District Rehabilitation Project, Level II [Task A] - Final Report	Feasibility study to identify deficiencies in facilities owned and operated by Goshen Irrigation District (GID), specifically the Laramie River Pump Station (Task A).
91	Greater Sage Grouse Comprehensive Conservation Strategy	Outlines the critical need to develop the associations among local, state, provincial, tribal, and federal agencies, non-governmental organizations, and individual citizens to design and implement cooperative actions to support robust populations of Sage Grouse and the landscapes and habitats upon which they depend.
92	Greater Sage Grouse Conservation & the Sagebrush Ecosystem	Highlights selected recent accomplishments of federal agencies and partners in conserving the sagebrush ecosystem and the more than 350 species, including the Greater Sage Grouse, as well as the human traditions and livelihoods that depend on it.
93	Greater Sage Grouse Population Trends: An Analysis of Lek Count Databases	This report represents the most recent analysis of male-count data from 1965–2015 at the range-wide, management zone, and state scales
94	Greater Sage Grouse Record of Decision for Northwest Colorado and Wyoming	This ROD is the culmination of an unprecedented planning effort to conserve Greater Sage Grouse (GRSG) habitat on National Forest System (NFS) lands and BLM-administered lands. The Forest Service, as a cooperating agency with the BLM, has developed a targeted, multi-tiered, collaborative landscape-level conservation strategy.
95	Ground-water Development Potential for the Paleozoic Aquifer Along the Flanks of the Laramie Range and Hartville Uplift	Produces a reconnaissance level evaluation of the potential for ground-water development from the Paleozoic rocks surrounding the Laramie Mountain-Casper Mountain ranges and Hartville Uplift, southeastern Wyoming.
96	Groundwater Quality of Southeastern Wyoming	A summary of groundwater supply and groundwater quality in Platte, Goshen, and Laramie counties.
97	Guernsey Hydraulic Study Level II - Executive Summary	Includes a maintenance and rehabilitation plan for the water storage tank, re-evaluates condition of existing distribution system, investigates areas of new development, groundwater quality, and develops a funding/finiancing plan for recommended improvements.
98	Guernsey Hydraulic Study Level II - Final Report	Includes a maintenance and rehabilitation plan for the water storage tank, re-evaluates condition of existing distribution system, investigates areas of new development, groundwater quality, and develops a funding/finiancing plan for recommended improvements.
99	Guernsey Hydraulic Study Level II - Technical Addendum I	Preliminary plans and distribution analysis based on fire flow scenarios
100	Guernsey Hydraulic Study Level II - Technical Addendum II	Environmental Impact Report which summarizes potential environmental consequences and mitigation efforts for the Guernsey water system improvements.

Item Number	Title	Description
101	Guernsey Master Plan Level I - Executive Summary	Develops a water supply master plan for the Town of Guernsey
102	Guernsey Master Plan Level I - Final Report	Develops a water supply master plan for the Town of Guernsey
103	Guidelines for Determining Flood Flow Frequency (Bulletin #17B)	Provides revised procedures for weighting a station skew value with the results from a generalized skew study, detecting and treating outliers, making two station comparisons, and computing confidence limits about a frequency curve.
104	Gunbarrel Lateral Ditch Studies - Rehabilitation Plan Preferred Alternate B - Executive Summary	Alternatives were investigated for the rehabilitation of the Gunbarrel Ditch on August 8,1995. Alternate B was selected, and conceptual designs, cost estimates, economic analysis, and permitting was further investigated for the alternative.
105	Gunbarrel Lateral Ditch Studies - Rehabilitation Plan Preferred Alternate B - Final Report	Alternatives were investigated for the rehabilitation of the Gunbarrel Ditch on August 8,1995. Alternate B was selected, and conceptual designs, cost estimates, economic analysis, and permitting was further investigated for the alternative.
106	Hornyhead Chub SWAP	State Wildlife Action Plan (SWAP) for hornyhead chub: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
107	Hunting Sage Grouse, Impacts and Management	Reviews scientific information pertaining to impacts of regulated hunting on Sage Grouse populations and describes measures states have taken to minimize potential impacts of Sage Grouse hunting.
108	Hydrogeologic Evaluation of the Casper Aquifer (Drilling Program No 1)	Determines the aquifer characteristics and general development potential of the Casper aquifer.
109	Hydrogeologic Study of the Laramie County Control Area	Informal overview for Laramie County Commission Workshop
110	Hydrologic and Geomorphic Studies of the Platte River Basin	Brings together the results several research studies on historical changes in channel morphology, surface-water hydrology, hydraulic geometry, sediment-transport and bedform processess, ground-water and surface-water relations, stochastic models of streamfow and precipitation, and methods for estimating discharge required to maintain channel width.
111	Hydrology of the Upper Cheyenne River Basin	Includes two parts: A) Hydrology of Stock-Water Reservoirs in Upper Cheyenne River Basin, and B) Sediment Sources and Drainage-Basin Characteristics in Upper Cheyenne River Basin.
112	Impact of WWDC Regional Water System Projects on Land Use: An Analysis of Two Case Studies - Final Report	Evaluates the relationship between regional water projects funded by the WWDC, and community and rural land development for two specific case studies, including the associated positive and negative impacts of water projects on development.
113	Interagency Ecological Site Handbook for Rangelands	Provides a standardized method to be utilized by the BLM, FS, and NRCS to define, delineate, and describe terrestrial ecological sites on rangelands.
114	Invasive Plant Management and Greater Sage Grouse Conservation	A review and status report with strategic recommendations for improvement
115	Iowa Darter SWAP	State Wildlife Action Plan (SWAP) for Iowa darter: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
116	Irrigation System Survey Report	A database of irrigation districts and companies in the State of Wyoming, based on survey data collected approximately every two years
117	Laramie County Aquifer Study - Executive Summary	Characterizes the hydro-geologic state of the High Plains Aquifer in Laramie County, Wyoming. This effort resulted in the preparation of the "Water Resource Atlas of Laramie County, Wyoming."
118	Laramie County Aquifer Study - Final Report	Characterizes the hydro-geologic state of the High Plains Aquifer in Laramie County, Wyoming. This effort resulted in the preparation of the "Water Resource Atlas of Laramie County, Wyoming."
119	Laramie Plains Wetlands Complex - Regional Wetland Conservation Plan	Major purposes of this regional plan are to characterize the landscape and wetlands of the LPWC, outline conservation objectives and strategies, identify resources to accomplish those objectives, and enhance collaboration and conservation delivery by key partners.
120	Linings For Irrigation Canals	Presents instructions, standards and procedures for use in the lining of irrigation canals.

Item Number	Title	Description
121	Livestock Pipeline Appurtenances (516-01)	NRCS Design Drawing for livestock pipeline appurtenances
122	Log Deflector	NRCS Design Drawing for Log Deflector
123	Male Greater Sage Grouse Detectabiltiy in Leks	Describes factors that influence male Sage Grouse detection probabilities during lek counts which will allow managers to more accurately estimate the number of males present on leks
124	Manual and Land Cover Type Descriptions Oregon GAP Gap Analysis 1998 Land Cover for Oregon	Mapping of land cover based on vegetation patterns which reflect the environment, biological diversity patterns and habitat types.
125	Mapping breeding densities of greater Sage Grouse: A tool for range-wide conservation planning	Sage Grouse breeding density and how it is measured
126	Maps for Casper Resource Management Plan	The RMP provides overall direction for management of all resources on BLM-administered land in the Casper Field Office Planning Area.
127	Maps for PROPOSED Resource Management Plan and FINAL Environmental Impact Statemnet for the Casper Field Office Planning Area	Provides a framework for the future management direction and appropriate use of lands and resources administered by the BLM Casper Field Office.
128	Maps for Rawlins Resource Management Plan	The RMP provides overall direction for management of all resources on BLM-administered land in the Rawlins Field Office Planning Area.
129	MBRTB 2016 Monitoring Plan	This planning framework is designed to inform integrated resource management and allows the Forest Service to adapt to changing conditions, including climate change, and improve management based on new information and monitoring.
130	Medicine Bow National Forest Rout National Forest Comprehensive Monitoring And Evaluation Report	This report provides information on the status and trends of resources with a focus on the last 5 years of plan implementation, from 2008 through 2013, for both the Medicine Bow and Routt National Forests (MBR).
131	Medicine Bow Natonal Forest Final Environmental Impact Statement	Documents analysis of seven alternatives developed for programmatic management of approximately 1.1 million acres administered by the Medicine Bow-Routt National Forests and Thunder Basin National Grassland.
132	Medicine Bow Natonal Forest Final Environmental Impact Statement - Executive Summary	Documents analysis of seven alternatives developed for programmatic management of approximately 1.1 million acres administered by the Medicine Bow-Routt National Forests and Thunder Basin National Grassland.
133	Medicine Bow Natonal Forest Final Environmental Impact Statement - Record of Decision	Documents analysis of seven alternatives developed for programmatic management of approximately 1.1 million acres administered by the Medicine Bow-Routt National Forests and Thunder Basin National Grassland.
134	Memorandum of Understanding between WAFWA, USDA-FS, BLM, USFWS, USGS, NRCS, and USDA-FSA	Provides for cooperation among the participating State and federal land, wildlife management and science agencies in the conservation and management of Greater Sage Grouse, sagebrush habitats, and other sagebrush-dependent wildlife
135	Methodology for Identification of Intermittent and Perennial Streams and Their Origins	Manual and field form is intended to guide natural resource professionals in the identification of ephemeral, intermittent and perennial streams using geomorphic, hydrologic and biological stream features
136	Mineral Occurrence and Development Potential Report	Provides an intermediate level of detail for mineral assessments, to support the process of amending the Resource Management Plan (RMP).
137	Modification of The Wyoming Game and Fish Department's System For Classifying Stream Fisheries	Assesses the relative merits of the existing stream classification system as a management tool, and identifies ways to modify the present system to more precisely and defensibly identify the most important recreational fisheries.
138	Modified Pfankuch Channel Stability Rating Procedure Summary	Worksheet for quantifing channel stability based on slope, debris, vegetation, capacity, obstructions, scouring/deposition, etc.
139	Monitoring of Livestock Grazing Effects on Bureau of Land Management Land	Investigation of the availability of livestock grazing-related quantitative monitoring data and qualitative region-specific Land Health Standards (LHS) data across BLM grazing allotments in the western United States
140	Natural Resources Conservation Service Construction Specification - Bentonite Sealant	Construction specifications for timing, material, application, mixing, and compaction of bentonite sealant, in order to reduce seepage in ponds or canals.
141	Near-Term Greater Sage Grouse Conservation Action Plan	Evaluates risks to populations, conservation measures that address those risks, by area; expected outcomes and the resources needed to accomplish those conservation measures and prioritize those actions.
142	NRCS Conservation Practice Standard Descriptions	Conservation practice standards for constructed wetland, dams, diversions, irrigation water management and conveyance, lined waterways, open channels, ponds, sediment basins, spring development, and more.
143	NRCS Conservation Practice Standard: Irrigation Ditch Lining	Best management practices for ditch lining including materials, recommended capacity, maximum velocities, minimum freeboard, recommended side slopes, etc.

Item Number	Title	Description
144	NRCS Design Steel Watering Tank with Concrete Base (614-01)	NRCS Design Drawing for steel watering tank with concrete base
145	Numerical Analysis of River Spanning Rock U-Weirs: Evaluating Effects of Strcuture Geometry on Local Hydraulics	3D numerical model simulations were used to examine the effects of variations in U-weir geometry on local hydraulics (upstream water surface elevations and downstreamvelocity and bed shear stress).
146	Operating Criteria of the Small Water Project Program of the Wyoming Water Development Program	Provides the Wyoming Water Development Commission (WWDC) and the Wyoming Water Development Office (WWDO) with general standards for evaluating and prioritizing applications for funding from the SWPP.
147	Operation Plan (WLCI)	Includes guidance for establishing internal and external involvement in the WLCI, creating a process for planning and prioritizing projects, and identifying actions necessary to accomplish the stated goals of the WLCI.
148	Orangethroat darter SWAP	State Wildlife Action Plan (SWAP) for orangethroat darter: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
149	Outcomes in Conservation Sage Grouse Initiative	Comprehensive evaluation of Sage Grouse Initiative (SGI). What has changed since Sage Grouse was designated as a Candidate for listing in 2010, and with what certainty will conservation efforts continue beyond 2015.
150	Overview of Greater Sage Grouse and Endangered Species Act Activities	A summary of the Endangered Species Act (ASA) petition process, outcome of the Sage Grouse review.
151	Peak-Flow Characteristics of Wyoming Streams	Water Resources Investigations Report on peak-flow characteristics and frequency relations for unregulated streams in Wyoming
152	Plains Topminnow SWAP	State Wildlife Action Plan (SWAP) for plains topminnow: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
153	Plan Layout - Embankment Pond (378-08)	NRCS Design Drawing for Wetland Standard Embankment Pond
154	Plan Layout - Embankment Pond Example (378-08)	Example of completed "Plan Layout - Embankment Pond" NRCS Wetland Standard Design Drawing
155	Platte River Basin	Excerpt from 2017 Wyoming State Wildlife Action Plan (SWAP), which describes aquatic wildlife, threats, conservation efforts specific to the Platte River Basin
156	Platte River Basin Plan	Presents estimated current and estimated future uses of water in Wyoming's Platte River Basin
157	Platte River Basin Plan 2016 Update	Presents estimated current and estimated future uses of water in Wyoming's Platte River Basin. Updates, revises and expands upon the information presented in the 2006 Platte Basin Plan.
158	Platte River Basin Water Plan Update Groundwater Study Level I (2009-2013) - Executive Summary	Available Groundwater Determination Technical Memorandum which updates and expands the Platte River Basin Water Plan (Trihydro et al, 2006) with a new compilation of information and represents the most current assessment of the groundwater resources.
159	Population and Habitat-based Approaches to Management of Sage Grouse	Describes the importance of protecting and improving sagebrush habitats and ecosystems in order to sustain and and enhance populations and distribution of Sage Grouse
160	Predator Control as a Conservation Measure for Sage Grouse	Description of previous studies that evaluate the efficacy of predator control programs, and possible issues that may arise with such programs.
161	Preliminary Results from the Evaluation of Different Seasons and Intensities of Grazing on the Erosion of Intermittent Streams at the San Joaquin Experimental Range	Evaluates the effect of season and grazing intensity on erosion along intermittent streams. Comparison of five treatments: no grazing, dry season moderate, dry season heavy, wet season moderate, and wet season heavy.
162	Proposed Practices for Economic Analysis of River Basin Projects	Report to the Inter-Agency Committee on Water Resources concerning cost-benefit analysis and project/program formulation
163	PROPOSED Resource Management Plan and FINAL Environmental Impact Statemnet for the Casper Field Office Planning Area	Provides a framework for the future management direction and appropriate use of lands and resources administered by the BLM Casper Field Office.
164	Public Water System Survey Report	A survey of all known municipal and non-municipal community public water systems in the State of Wyoming taken during the winter of 2015 into early 2016.
165	Rawlins Field Office Review of Potential Wild and Scenic Rivers in the Rawlins Resource Management Plan Planning Area	Determines if public lands within the Rawlins RMP planning area meet the WSR eligibility criteria and suitability factors, as identified in the Wild and Scenic Rivers Act (WSRA).

Item Number	Title	Description
166	Rawlins Final EIS: Chapter 3 - Affected Environment	Characterizes the existing environment of the Rawlins Resource Management Plan Planning Area.
167	Reasonable Foreseeable Development Scenario for Oil and Gas (Casper Field Office)	Technically analyzes the oil and gas resource occuring within the Casper Field Office area and projects future development potential and activity levels between 2001 and 2020.
168	Recommendations for Managing Mule Deer Habitat in Wyoming	Contains habitat management recommendations focused primarily on diet/nutrition for mule deer in order to sustain and potentially increase populations throughout Wyoming.
169	Record of Decision and Approved Casper Resource Management Plan	The Record of Decision (ROD) approves the Casper Resource Management Plan (RMP). The RMP provides overall direction for management of all resources on BLM-administered land in the Casper Field Office Planning Area.
170	Record of Decision and Approved Rawlins Resource Management Plan	The Record of Decision (ROD) approves the Rawlins Resource Management Plan (RMP). The RMP provides overall direction for management of all resources on BLM-administered land in the Rawlins Field Office Planning Area.
171	Resrouce Conservation and Development Memorandum	Describes Soil Conservation Service policy regarding interest rates to be used in evaluating federal and federally assisted water and related land resource projects.
172	Review of the Forest Service Response: The Bark Beetle Outbreak in Northern Colorado and Southern Wyoming	Examines the ecological conditions and historical land use that contributed to the pine beetle outbreak, management response to the outbreak, suggested new and extended authorities for addressing the outbreak, and what we might expect as we look forward to the “new forest.”
173	Riparian Area Management - Grazing Management for Riparian-Wetland Areas	Presents information from various land managers and researchers to guide livestock management in riparian areas
174	Rock Riprap Streambank Stabilization (580-06)	NRCS Design Drawing for rock riprap streambank stabilization
175	Root Wad	NRCS Design Drawing for Root Wad
176	Rubber Tire Stock Tank Details (614-02)	NRCS Design Drawing for rubber tire watering tank with interior CMP or PE pipe inlet
177	Rubber Tire Stock Tank Details (614-03)	NRCS Design Drawing for rubber tire watering tank with frost free hydrant
178	Rubber Tire Trough	NRCS Design Drawing for Tire Trough
179	Sage Grouse Initiative 2.0 (Investment Strategy, FY 2015-2018)	Combines plans from 11 states into one cohesive, rangewide plan which describes priorities for reducing threats to sage grouse habitat and identifies locations for projects and cost estimates
180	Sage Grouse Initiative Strategic Watershed Action Team Quarterly Report	Reports on the accomplishments of the Sage Grouse Initiative (SGI) Stategic Watershed Action Team (SWAT) from October – December 2017.
181	Sage Grouse hate trees: A range-wide solution for increasing bird benfits through accelerated conifer remova	Maps invasive woody plants at regional scales to evaluate landscape level impacts, drive targeted restoration actions, and monitor restoration outcomes.
182	Sage Grouse Mapping and Priority Habitats	Displays the historic and current range of Sage Grouse, Sage Grouse Management Zones, and the breeding bird density map.
183	Sage Grouse Project Summaries	A list of previous projects which have been awarded Wyoming Sage Grouse Conservation Funds. Includes project descriptions, and the funding amount.
184	Science and Management Integration Plan	Provides guidance for research needs of the WLCI, and maintains adaptive management as the framework for WLCI processes.
185	Scoping Report for the Wyoming Sage Grouse RMP Amendments	Documents the public scoping process for the Bureau of Land Management’s (BLM) Wyoming Field Office Programmatic Sage Grouse Resource Management Plan (RMP) Amendments and Environmental Impact Statement (EIS).
186	Scoping Report for the Wyoming Sage Grouse RMP Amendments - Appendices	Includes public comments, a federal register publication: notice of intent, press releases, project newsletter, scoping meeting materials/posters
187	Seepage Protection Filter (378-07a)	NRCS Design Drawing for seepage protection filter
188	Sheet Piling Structure Capacity and Quantity Computations	NRCS Design Drawing and calculation format for sheet piling structure
189	Sheet Piling Structure with Catwalk	NRCS Design Drawing for sheet piling structure with catwalk
190	Small Water Projects Program 101 (Slideshow)	Describes general SWPP concepts, eligibility, recent criteria changes, project timelines, and steps to project completion.

Item Number	Title	Description
191	Solar Panel Well and Surface Installation (533-01)	NRCS Design Drawing for solar panel well and surface installation
192	Spring Development (574-01)	NRCS Design Spring Development Box with gravity flow supply outlet
193	Spring Development with Pump Manifold Outlet	NRCS Design Spring Development Box with pumping system outlet
194	Standardized Definitions for Seasonal Wildlife Ranges	Statewide definitions for seasonal wildlife ranges, as well as the WGFD process for designating wildlife ranges and updating wildlife range maps.
195	State Water Planning Process Feasibility Report - Executive Summary	Excecutive summary for the feasibility study which conducts the following tasks: Wyoming statewide public opinion survey, a basin advisory group, statewide data inventory, and a consultant feasibility study.
196	State Water Planning Process Feasibility Report - Final Report	Feasibility study which conducts the following tasks: Wyoming statewide public opinion survey, a basin advisory group, statewide data inventory, and a consultant feasibility study.
197	State Wildlife Action Plan 2017	State Wildlife Action Plans (SWAPs) are comprehensive wildlife conservation strategies to maintain the health and diversity of wildlife within a state, including preventing the need for future listings under the Endangered Species Act.
198	Stategic Habitat Plan (2015)	Defines how the WGFD will strive to meet its mission of *Conserving Wildlife and Serving People* by working together with external partners to conserve and improve habitat.
199	Steet Sheet Pile Drop Structure	NRCS Standard design drawing for steel sheet pile drop structure
200	Strategic Habitat Plan	Strategies to promote and maintain the availability of high quality habitat to sustain and enhance wildlife populations in the future.
201	Strategic Habitat Plan (2016 Annual Report)	Detailed plan to promote and maintain the availability of high quality habitat to sustain and enhance wildlife populations in the future.
202	Strategic Habitat Plan (2017 Annual Report)	Detailed plan to promote and maintain the availability of high quality habitat to sustain and enhance wildlife populations in the future.
203	Strategic Plan (WLCI)	Describes the goals and objectives of the WLCI and the strategies needed to successfully accomplish a science-based, landscape-scale initiative.
204	Stream Bank Stablization Rock Riffle Details	NRCS Design Drawing for Rock Riffle Structure
205	Stream Barbs (580-05)	NRCS Design Drawing for stream barbs
206	Stream channel and vegetation responses to late spring cattle grazing	Studies the effects on riparian habitat of no grazing, light grazing (20–25% utilization), and medium grazing (35–50%) during late June.
207	Stream Classification	Presentation on the Rosgen Stream Classification System.
208	Stream Crossing and Livestock Access (578-01)	NRCS Design Drawing for stream crossing and livestock access
209	Stream Restoration Design NEH - Chapter 11 Rosgen Geomorphic Channel Design	Chapter 11 of the National Engineering Handbook. Outlines use of Rosgen's classification system and Natural Channel Design
210	Streamflows in Wyoming	A description of the occurrence and variability of surface waters in Wyoming is presented along with explanations of both streamflow data collection and methods for estimating streamflow characteristics at gaged and ungaged sites
211	Suckermouth Minnow SWAP	State Wildlife Action Plan (SWAP) for suckermouth minnow: description of the species and its habitat, problems, conservation actions, monitoring/research, and recent developments.
212	Summary of State Loan Programs and Associated Loan Loss Reserve Funds	State loan program summaries and loan schedules.
213	Technical Memorandum 2.3 - Water Use for Industrial Purposes	Technical Memo on water use for industrial purposes in support of the Platte River Basin Plan
214	Technical Memorandum 2.6 - Water Use from Storage	Technical Memo on water use from storage in support of the Platte River Basin Plan
215	Technical Notes: Watering Facility Wildlife Escape Structures	Provides approved designs for wildlife escape structures in watering facilities.

Item Number	Title	Description
216	Techniques for estimating streamflow characteristics of Wyoming streams	This report presents relations for estimating peak flows and mean annual flow for natural streams in Wyoming. Two separate techniques for estimating flow characteristics are presented: 1) The channel-geometry method, whereby flow characteristics are related to channel dimensions; and 2) the basin-characteristics method, whereby flow characteristics are related to physiographic and climatic features of the drainage basin.
217	The Cross-Vane, W-Weir and J-Hook Vane Structures. . . Their Description, Design and Application for Stream Stabilization and River Restoration	Includes descriptions, design specifications, placement locations, spacing and various applications of Cross-Vane, W-Weir and J-Hook Vane structures.
218	The Environmental and Recreational Water Use Handbook (Part II of The Environmental and Recreation Water Use Study)	Describes protocols for river basin planning efforts that are relevant to both environmental and recreational water demand estimation. Also includes detailed recommendations for addressing existing and future demands.
219	The Environmental and Recreational Water Use Study - Final Report	Part I: Current estimation of environmental and recreational water demands in the yoming river basin planning process. Part II: Environmental and Recreational Water Use Handbook
220	The Platte River Channel - History and Restoration	Presents past channel habitat trends, their probable causes, and the likely future trends of the river channel, based on a historic review of channel evolution and field data. Considers a river restoration strategy focused on enhancement, or managing causes and mitigating impacts.
221	The Visual Resource Inventory For The Casper Field Office	This inventory consists of a scenic quality analysis evaluation, delineation of distances zones and sensitivity level analysis. It determines visual resource values for the planning area and helps define appropriate VRM class boundaries.
222	Town of Chugwater Water Supply Master Plan Level I - Final Report	Develops a water supply master plan for the Town of Chugwater, projecting water supply needs 25 years into the future.
223	Town of Chugwater Water Supply Study Level II Project - Executive Summary	Refines and develops the preferred alternatives for impoving and expanding the Town of Chugwater's water supply system identified in the Level I Master Plan completed in 1996.
224	Town of Chugwater Water Supply Study Level II Project - Final Report	Refines and develops the preferred alternatives for impoving and expanding the Town of Chugwater's water supply system identified in the Level I Master Plan completed in 1996.
225	Town of Guernsey Groundwater Exploration Grant - Final Report	Summary of the Guernsey Well 2 replacement funded by the WWDC through a Groundwater Grant
226	Town of Guernsey Water Supply Master Plan, Level I - Executive Summary	Determines the condition and remaining useful life of the water supply, storage, transmission, and distribution system for the Town of Guernsey, and to determine the cost of necessary repairs, replacement, or rehabilitation of the system to serve the existing and future demands of the community.
227	Town of Guernsey Water Supply Master Plan, Level I - Final Report	Determines the condition and remaining useful life of the water supply, storage, transmission, and distribution system for the Town of Guernsey, and to determine the cost of necessary repairs, replacement, or rehabilitation of the system to serve the existing and future demands of the community.
228	Town of Wheatland Water Master Plan, Level I - Executive Summary	Provides a complete overview of the Town of Wheatland's water system and advises about any infrastructure, fiscal or operational imporvemnets necessary to sustain the system into the future.
229	Town of Wheatland Water Master Plan, Level I - Final Report	Provides a complete overview of the Town of Wheatland's water system and advises about any infrastructure, fiscal or operational imporvemnets necessary to sustain the system into the future.
230	Visual Resource Inventory BLM Rawlins Field Office	Determines visual (scenic) values within the Rawlins District, via scenic quality evaluation, sensitivity level analysis, and delineation of distance zones. Helps define visual management classes to BLM-administered lands in the RMP process.
231	Vortex Weir	NRCS Design Drawing for vortex weir
232	WAFWA Greater Sage Grouse Management Zone II	Sage Grouse Breeding Density Map
233	Water Management & Conservation Assistance Programs 2014 Directory	An overview of local, state and federal incentive assistance programs
234	Water Resource Atlas of Laramie County, Wyoming	Provides a summary of the development of water resources in Laramie County up to 2008, specifically in the High Plains Aquifer.

Item Number	Title	Description
235	Weed and Pest Declared List (By County) Amended February 2017	Declared weeds and pests listed by county
236	Wetland Profile and Condition Assessment of the Goshen Hole Wetland Complex, Wyoming	Summarizes results of the first basin-wide assessment of wetlands in the Goshen Hole Wetland Complex (GHWC). The study was based on a rigorous field survey protocol applied within a sample of randomly-selected sites.
237	Wetland Profile and Condition Assessment of the Laramie Plains Wetland Complex, Wyoming	Summarizes results of the first basin-wide assessment of wetlands in the Laramie Plains Wetland Complex (LPWC). Models distribution of wetland conditions throughout the basin, and determines key habitat features and resources.
238	Wetlands and Deepwater Habitats Classification	Chart used to classify wetlands and deepwater habitats by system, subsystem, class, and subclass
239	Wheatland Irrigation Canal Improvements Project, Level II Feasibility - Executive Summary	Goal of the study was to find the most feasible solution to reduce or eliminate the safety hazards and maintenance concerns created by Canal No. 2 in its present alignment through Wheatland.
240	Wheatland Irrigation Canal Improvements Project, Level II Feasibility - Final Report	Goal of the study was to find the most feasible solution to reduce or eliminate the safety hazards and maintenance concerns created by Canal No. 2 in its present alignment through Wheatland.
241	Wheatland Irrigation District Conservation Study, Level II - Executive Study	This study develops conceptual design, cost estimates and operational plans for modifications or upgrades to the WID's current irrigation system
242	Wheatland Irrigation District Conservation Study, Level II - Final Report	This study develops conceptual design, cost estimates and operational plans for modifications or upgrades to the WID's current irrigation system
243	Wheatland Irrigation District Conservation Study, Level II Phase 2 - Polyacrylamide - Executive Summary	Used the recommendations of the Level II report to evaluate the effectiveness of a Polyacrylamide (PAM) treatment to sections of canals where significant seepage occurs.
244	Wheatland Irrigation District Conservation Study, Level II Phase 2 - Polyacrylamide - Final Report	Used the recommendations of the Level II report to evaluate the effectiveness of a Polyacrylamide (PAM) treatment to sections of canals where significant seepage occurs.
245	Wheatland Irrigation District Conservation Study, Level II Phase 2 - ReStorage Reservoirs - Executive Summary	Used the recommendations of the Level II report to further evaluate two potential re-storage reservoir sites and perform a geotechnical program to refine the conceptual designs and provide more detailed cost estimates.
246	Wheatland Irrigation District Conservation Study, Level II Phase 2 - ReStorage Reservoirs - Final Report	Used the recommendations of the Level II report to further evaluate two potential re-storage reservoir sites and perform a geotechnical program to refine the conceptual designs and provide more detailed cost estimates.
247	Wheatland Irrigation District Master Plan, Level I - Executive Summary	Includes inventory and assessment of existing facilities, review of system delivery and losses, evaluation of alternatives, conceptual designs, cost estimates, implementation plan, and economic evaluation.
248	Wheatland Irrigation District Master Plan, Level I - Final Report	Includes inventory and assessment of existing facilities, review of system delivery and losses, evaluation of alternatives, conceptual designs, cost estimates, implementation plan, and economic evaluation.
249	Wheatland Irrigation District Tunnel Dam Rehabilitation, Level II Study Final Report	This feasibility study includes a review of existing information, and engineering and geotechnical evaluation of the diversion structure, rehabilitation plan, preliminary design, cost estimates, economic analysis, and environmental and permitting requirements associated with the rehabilitation of Tunnel Dam.
250	Wheatland Reservoir No 1 Rehabilitation Study, Level II Phase II - Executive Summary	The Phase II studies included the development of a remediation plan and feasibility design, based on the evaulation of dam safety. The plan addessses geotechnical, structural, and flood protection concerns.
251	Wheatland Reservoir No 1 Rehabilitation Study, Level II Phase II - Final Report	The Phase II studies included the development of a remediation plan and feasibility design, based on the evaulation of dam safety. The plan addessses geotechnical, structural, and flood protection concerns.
252	Wheatland Reservoir No 2 Rehabilitation Project, Level II Feasibility - Executive Summary	The study evaluates the condition of Wheatland Reservoir No. 2 facilities and identifies and describes those rehabilitation measures which may be necessary for continued safe and efficient operation of the facility. Includes executive summary for both Phase 1 preliminary analysis and Phase 2 conceptual analysis.
253	Wheatland Reservoir No 2 Rehabilitation, Level II Feasibility Project - Phase I Final Report	Phase 1 included a review of previous studies, hydraulic analysis, economic analysis, geotechnical evaluation, safety inspection, alternative development, surveying, and identification of required permits
254	Wheatland Reservoir No 2 Rehabilitation, Level II Feasibility Project - Phase II Final Report	Phase 2 inlcuded evaluation of the existing canal system, canal system alternatives, a prioritized rehabilitation plan for the dam, conceptual design documents, cost estimation, and economic analysis.

Item Number	Title	Description
255	Where the Wild Lands Are: Wyoming	Importance of backcountry areas to wyoming fish, wildlife, hunting and angling
256	Who's on the Lek: a Guide to Players	A guide to some of the stakeholders that have either been important in the long-term management of Sage Grouse and sagebrush, or are actively engaged in affecting conservation.
257	Wildfire and Invasive Species in the West: Challenges that Hinder Current and Future Management and Protection of the Sagebrush-steppe Ecosystem	Summarizes the policy, fiscal and science challenges that land managers encounter related to the control and reduction of the invasive plant/fire complex, especially as it relates to the threaten or endangered species listing status of the Greater Sage Grouse.
258	Wildlife and Invasive Plant Species in the Sagebrush Biome: Challenges that Hinder Current and Future Management and Protection - A Gap Report Update	Collaborative assessment of fire and invasive plant management options for the conservation of sagebrush (Artemisia spp.) habitats across multiple ownerships in the Sagebrush Biome. Overview of remaining work, with recommendations for actions to improve the conservation and management of the Sagebrush Biome.
259	Wildlife Guzzler Type A (636-5)	NRCS Design Drawing for Type A Wildlife Guzzler
260	Wildlife Guzzler Type B (636-2)	NRCS Design Drawing for Type B Wildlife Guzzler
261	Wildlife Guzzler Type C (636-3)	NRCS Design Drawing for Type C Wildlife Guzzler
262	Wildlife Guzzler Type D (636-4)	NRCS Design Drawing for Type D Wildlife Guzzler
263	Wildlife Guzzler Type E (636-5)	NRCS Design Drawing for Type E Wildlife Guzzler
264	WLCI Habitat Project Funding Application (2018)	Funding application form for 2016 habitat project funding through Wyoming Landscape Conservation Initiative (WLCI)
265	WLCI Project Funding Application Addendum	Wyoming Landscape Conservation Initiative (WLCI) funding application addendum
266	WLCI Project Tracking Checklist	List of actions, person/enitity responsible, and date complete from initial site inspection to post-project monitoring/maintenance
267	Wyoming Agricultural Management Assistance - Fiscal Year 2018	Unit costs for components of Agricultural Management Assistance (AMA) projects for fiscal year 2018.
268	Wyoming Environmental Quality Incentives Program - Fiscal Year 2018	Unit costs for components of Environmental Quality Incentives Program (EQIP) projects for fiscal year 2018.
269	Wyoming Framework Water Plan Volume 1	Presents a statewide perspective on water resources, compiled from the results of a seven-basin planning process performed by the Wyoming Water Development Commission (WWDC).
270	Wyoming Game and Fish Department Ungulate Migration Corridor Strategy	Includes action items for the migration corridor strategy followed by background, current knowledge, and science and research needs on the importance of migration.
271	Wyoming GAP Analysis Project Final Report	Describes the cooperative effort between the USGS, and state, federal, and private natural resources groups in Wyoming to produce GIS-databases describing actual land cover type, terrestrial vertebrate species distributions, land stewardship, and land management status.
272	Wyoming Landscape Conservation Initiative - 2014 Project Ranking Score Sheet	Wyoming Landscape Conservation Initiative project ranking scoring system based on goal accomplishment, LPDT priority, funding considerations, and biological considerations
273	Wyoming Landscape Conservation Initiative Habitat Project Funding Application	Application form for WLCI habitat project funding
274	Wyoming Level II Weather Modification Feasibility Study - Executive Summary	Executive Summary of the Level II study which includes a review of previously collected data, climatology of the project areas, preliminary project design, estabilishment of operational critera, cost estimates, and other information pertaining to weather modification feasibility.
275	Wyoming Level II Weather Modification Feasibility Study - Final Report	Includes a review of previously collected data, climatology of the project areas, preliminary project design, estabilishment of operational critera, cost estimates, and other information pertaining to weather modification feasibility.
276	Wyoming NRCS ENG STD 642 - Type III Well	NRCS Design Drawing for Type III Well including wellhead and pump setting details and general notes/dimensions, plus schematic detail and specifications.
277	Wyoming Sage Grouse Conservation Project Proposal Form 2018-2019	Project application criteria and application form for Wyoming Sage Grouse Conservation Funds (WSGCF)
278	Wyoming Species of Greatest Conservation Need	Excerpt from 2017 Wyoming State Wildlife Action Plan (SWAP), which defines Species of Greatest Conservation of Need (SGCN) and the Native Species Staus (NSS) classification. The Wyoming 2017 SGCN are also listed in the document.
279	Wyoming Surface Water Classification List	Surface water classification list based on Water Quality Division Surface Water Standards

Item Number	Title	Description
280	Wyoming Surface Water Quality Standards	Description of water quality regulations promulgated pursuant to Wyoming Statutes (W.S.) 35-11-101 through 35-11-1803, specifically 302(a)(i) and 302(b)(i) and (ii)
281	Wyoming Water Development Program Project Evaluations - Final Report	Provides information bases and analyses on eight potential water development projects in Wyoming: Hawk Springs, Shell Canal, Riverton Valley, La Prele, Willwood, Gooseberry, Westside, and Little Big Horn/Fuller
282	Wyoming Water Law a Summary	Summary of different types of water rights managed by the state.
283	Wyoming Weed & Pest Control Act State Designated Weeds and Pests	Statewide Designated Weeds and Pests
284	Wyoming Wetland Program Plan (2018-2023) - 1st Edition	The overarching objective of this document is to increase effectiveness of ongoing voluntary wetland conservation work and bring greater focus to future efforts.
285	Wyoming Wetlands Conservation Strategy	Delineates important wetland and riparian habitat areas throughout Wyoming and assesses their condition; identifies threats; establishes conservation goals, priorities, and managment strategies; brings together conservation programs that can assist in conservation planning, funding, and collaboration efforts; and provides a technical foundation for the Wyoming SWAP.
286	Wyoming Wildlife and Natural Resource Trust - Application for Funding	Funding applciation form for WWNRT
287	Wyoming's Draft 2016/2018 Integrated 305(b) and 303(d) Report	Contains information on the quality of Wyoming's waters, including those waters that have been identified as not meeting water quality standards. Report submitted to EPA to fulfill requirements under the federal Clean Water Act

APPENDIX 4A

GEOLOGIC UNIT DESCRIPTIONS

Appendix 4A - Geologic Units in the Lower Laramie Watershed
(compiled from Morris and Babcock (1960), Crist (1983), McLaughlin and Harris (2005), VerPloeg and Boyd (2007); and Love and Christiansen (1985).

CENOZOIC GEOLOGIC UNITS

Qa Alluvium and colluvium (Holocene-Pleistocene) - Alluvial deposits - sand, silt, gravel, and clay within flood plains, river channels, and lowest (Holocene) terrace deposits along major rivers and streams, may include minor alluvial fan deposits and colluvium. Thickness up to approximately 40 ft.

Qs Dune sand (Holocene) - Fine-grained, windblown sand; stabilized by prairie vegetation. Thickness up to 50 feet.

Qt Gravel, pediment, and fan deposits (Holocene-Pleistocene) - Mostly locally derived clasts; locally includes some Tertiary gravels.

To Ogalalla Formation (Upper and Middle Miocene) - Unconsolidated to well-cemented sandstone, siltstong, volcanic ash, and conglomerate, interbedded with claystone and thin beds of limestone. The deposits are mostly coarse grained near the Laramie Mountains and become finer to the east. Thickness up to 330 feet.

Tmu Miocene-age deposits undivided - Gray to red loosely consolidated sand, gravel, and arkosic conglomerate interbedded with clayey sand of tuffaceous clay.

Ta Arikaree Formation (Lower Miocene and Upper Oligocene)

Upper Member (“red”) - very fine-grained moderately hard, generally massive, sandstone and silt. Thickness 400 - 850 feet.

Lower Member (“green”) - loosely to well-cemented coarse to very coarse sandstone interbedded with lenses of well-cemented conglomerate. Thickness 88 - 340 feet.

Twr White River Group (Oligocene and Upper Eocene) – White to pale-pink, blocky, tuffaceous claystone and lenticular arkosic conglomerate.

Twrb - Brule Formation - Pale-pink to white blocky tuffaceous claystone and lenticular sandstone. Locally includes the upper conglomerate member. Thickness up to 450 feet.

Twrc - Chadron Formation - Light gray to dark-red, tuffaceous claystone, sandstone, and lenticular conglomerate. Thickness up to 700 feet.

Twb Wagon Bed Formation (Eocene) - Dull-green, siliceous, bentonitic claystone and tuff; giant granite boulder conglomerate in tuffaceous matrix.

Twdr Wind River Formation (Eocene) - Variegated claystone and sandstone; lenticular conglomerate.

MESOZOIC GEOLOGIC UNITS

Mz Mesozoic-age formations undivided (i.e. a combination of those listed below).

Kz Cretaceous-age formations undivided (i.e. a combination of those listed below).

Kla Lance Formation (Upper Cretaceous) - Dark gray shale, inter-bedded gray, very fine-grained sandstone, dark gray carbonaceous shale, coal, and gray, silty dolomite. Thickness up to 200 feet.

Kfh Fox Hills (Upper Cretaceous) - Gray, fine-grained sandstone, tan and gray siltstone, and interbedded dark gray shale. Thickness up to 250 ft.

Kle Lewis Shale (Upper Cretaceous) - Dark gray shale and thin interbedded gray siltstone and sandstone. Thickness up to 600 feet.

Kp Pierre Shale (Upper Cretaceous) - Dark gray shale with thin to moderately thick, sometimes persistent sandstone beds. Thickness about 5,700 feet.

Kmv Mesa Verde Formation (Upper Cretaceous) - Gray to tan sandstone and interbedded dark gray to black siltstone and sandy shale, with some carbonaceous shale in the upper part. Thickness up to 1,600 feet.

Ks Steele Shale (Upper Cretaceous) - Gray marine shale and siltstone, with numerous bentonite beds and thin lenticular sandstones. Thickness 2,300 to 2,500 feet.

Kn Niobrara Shale (Upper Cretaceous) - Black or gray to yellow speckled, calcareous shale, and light-colored limestone and chalk. Thickness approximately 550 feet.

Kmt Mowry and Thermopolis Shale

Mowry Shale (Upper Cretaceous) – Silvery-gray, hard, siliceous shale containing abundant fish scales and bentonite beds. Thickness 80 to 150 feet.

Thermopolis Shale (Lower Cretaceous) – Black soft fissile shale with Muddy Sandstone Member at top of unit.

KJ Cloverly and Morrison Formations (Lower Cretaceous to Jurassic)

Cloverly Formation – Rusty-color sandstone at top, underlain by brightly variegated bentonitic claystone; chert-pebble conglomerate locally at base.

Morrison Formation – Dully variegated, siliceous claystone, nodular white limestone, and gray silty sandstone. KJs Cloverly, Morrison, and Sundance

Formations (Lower Cretaceous to Jurassic)

Js Sundance Formation (Upper Jurassic to Middle Jurassic) – Greenish-gray, glauconitic sandstone and shale, underlain by red and gray non-glauconitic sandstone and shale.

^Pcg Chugwater and Goose Egg Formations
Chugwater Formation (Upper and Lower Triassic) - Red siltstone and shale.
Goose Egg Formation (Permian) – Red sandstone and siltstone, white gypsum, halite, and purple to white dolomite and limestone.

PALEOZOIC GEOLOGIC UNITS

Pz Paleozoic-age formations undivided (i.e. a combination of those listed below).

Pfs Forelle Limestone and Satanka Shale (Permian)
Forelle Limestone – Gray to purple, thin-bedded limestone. Locally a member of the Goose Egg Formation. Thickness 10 to 30 feet.
Satanka Shale – Red siltstone and shale. Thickness 75 to 300 feet.

P*cf Casper and Fountain Formations (Lower Permian-Upper and Middle Pennsylvanian)
Casper Formation – Gray, tan, and red thick-bedded sandstone underlain by interbedded sandstone and pink and gray limestone. May include some Devonian (?) sandstone along east flank of Laramie Mountains.
Fountain Formation – Arkose and red sandstone.

P*h Hartville Formation (Lower Permian-Upper, Middle, and Lower Pennsylvanian) – Red and white sandstone underlain by gray dolomite and limestone, red shale, and red and gray sandstone.

PRECAMBRIAN GEOLOGIC UNITS

p_r Precambrian rocks (Middle Proterozoic through middle Archean) - This group encompasses a wide range of igneous and metamorphic rocks forming the core of the Laramie Range. Commonly classed as “crystalline”, “granitic”, or “basement” rocks, the individual rock types include granite, gneiss, amphibolite, schist, quartzite, monzonite, metaconglomerate, and marble. Ages range from 1,200 to 2,600 million years old.

APPENDIX 4B

WDEQ SURFACE WATER CLASSES AND USES

Appendix 4B. Surface Water Classes and Uses.

The definitions of the stream classes applicable to the watershed are quoted from the Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards (WDEQ, 2013) as follows:

The following water classes are a hierarchical categorization of waters according to existing and designated uses. Except for Class 1 waters, each classification is protected for its specified uses plus all the uses contained in each lower classification. Class 1 designations are based on value determinations rather than use support and are protected for all uses in existence at the time or after designation. There are four major classes of surface water in Wyoming with various subcategories within each class (see *Wyoming Surface Water Classification List* for current classifications).

(a) Class 1, Outstanding Waters. Class 1 waters are those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices. Pursuant to Section 7 of these regulations, the water quality and physical and biological integrity which existed on the water at the time of designation will be maintained and protected. In designating Class 1 waters, the Environmental Quality Council (council) shall consider water quality, aesthetic, scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, archaeological, fish and wildlife, the presence of significant quantities of developable water and other values of present and future benefit to the people.

(b) Class 2, Fisheries and Drinking Water. Class 2 waters are waters, other than those designated as Class 1, that are known to support fish and/or drinking water supplies or where those uses are attainable. Class 2 waters may be perennial, intermittent or ephemeral and are protected for the uses indicated in each subcategory listed below. There are five subcategories of Class 2 waters.

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

(ii) Class 2A. Class 2A waters are those that are not known nor have the potential to support fish but are used for public or domestic drinking water supplies, including their perennial tributaries and adjacent wetlands. Uses designated on Class 2A waters include drinking water, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value.

(iii) Class 2B. Class 2B waters are those known to support or have the potential to support game fish populations or spawning and nursery areas at least seasonally and all their perennial tributaries and adjacent wetlands and where it has been shown that drinking water uses are not attainable pursuant to the provisions of Section 33. Class 2B waters include permanent and seasonal game fisheries and can be either "cold water" or "warm water" depending upon the predominance of cold water or warm water species present. All Class 2B waters are designated as cold water game fisheries unless identified as a warm water game fishery by a "ww" notation in the *Wyoming Surface Water Classification List*. Uses designated on Class 2B waters include game and nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value.

(iv) Class 2C. Class 2C waters are those known to support or have the potential to support only nongame fish populations or spawning and nursery areas at least seasonally including their perennial tributaries and adjacent wetlands. Class 2C waters include all permanent and seasonal nongame fisheries and are considered warm water. Uses designated on Class 2C waters include nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value.

(v) Class 2D. Effluent dependent waters which are known to support fish populations and where the resident fish populations would be significantly degraded in terms of numbers or species diversity if the effluent flows were removed or reduced. Class 2D waters are protected to the extent that the existing fish communities and other designated uses are maintained and that the water quality does not pose a health risk or hazard to humans, livestock or wildlife. Uses designated on Class 2D waters include game or nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value.

(c) Class 3, Aquatic Life Other than Fish. Class 3 waters are waters, other than those designated as Class 1, that are intermittent, ephemeral or isolated waters and because of natural habitat conditions, do not support nor have the potential to support fish populations or spawning, or certain perennial waters which lack the natural water quality to support fish (e.g. geothermal areas). Class 3 waters provide support for invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. Uses designated on Class 3 waters include aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value. Generally, waters suitable for this classification have wetland characteristics, and such characteristics will be a primary indicator used in identifying Class 3 waters. There are four subcategories of Class 3 waters.

(i) Class 3A. Class 3A waters are isolated waters including wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable.

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

(iii) Class 3C. Class 3C waters are perennial streams without the natural water quality potential to support fish or drinking water supplies but do support wetland characteristics. These may include geothermal waters and waters with naturally high concentrations of dissolved salts or metals or pH extremes.

(iv) Class 3D. Effluent dependent waters which are known to support communities of aquatic life other than fish and where the existing aquatic habitat would be significantly reduced in terms of aerial extent, habitat diversity or ecological value if the effluent flows are removed or reduced. Class 3D waters are protected to the extent that the existing aquatic community, habitat and other designated uses are maintained and the water quality does not pose a health risk or hazard to humans, livestock or wildlife.

(d) Class 4, Agriculture, Industry, Recreation and Wildlife. Class 4 waters are waters, other than those designated as Class 1, where it has been determined that aquatic life uses are not attainable pursuant to the provisions of Section 33 of these regulations. Uses designated on Class 4 waters include recreation, wildlife, industry, agriculture and scenic value.

(i) Class 4A. Class 4A waters are artificial canals and ditches that are not known to support fish populations.

(ii) Class 4B. Class 4B waters are intermittent and ephemeral stream channels that have been determined to lack the hydrologic potential to normally support and sustain aquatic life pursuant to the provisions of Section 33(b)(ii) of these regulations. In general, 4B streams are characterized by only infrequent wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 4B waters.

(iii) Class 4C. Class 4C waters are isolated waters that have been determined to lack the potential to normally support and sustain aquatic life pursuant to the provisions of Section 33(b)(i), (iii), (iv), (v) or (vi) of these regulations. Class 4C includes, but is not limited to, off-channel effluent dependent ponds where it has been determined under Section 33(b)(iii) that removing a source of pollution to achieve full attainment of aquatic life uses would cause more environmental damage than leaving the source in place.

(e) Specific stream segment classifications are contained in a separate document entitled *Wyoming Surface Water Classification List* which is published by the department and periodically revised and updated according to the provisions of Sections 4, 33, 34, 35 and Appendix A of this chapter. Class 1 waters are those waters that have been specifically designated by the council. Class 2AB, 2A, 2B and 2C designations are based upon the fisheries information contained in the Wyoming Game and Fish Department's *Streams and Lakes Database* submitted to the department in June 2000. This database represents the best available information and is considered conclusive. Class 2D and 3D designations are based upon use attainability analyses demonstrating that the waters are effluent dependent and do not pose a hazard to humans, wildlife or livestock. Class 4 designations are based upon knowledge that a water body is an artificial, man-made conveyance, or has been determined not to support aquatic life uses through an approved use attainability analysis. All other waters are designated as Class 3A, 3B or 3C. Section 27 of these regulations describes how recreation use designations are made for specific water bodies.

APPENDIX 4C

LANDFIRE DATABASE

APPENDIX 4C: LANDFIRE DATABASE

Lower Laramie Watershed : LANDFIRE						
Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type	Percent of HUC12	Cumulative Percent
Bear Creek-North Laramie River	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	28328.2	4794.94	16.93%	16.9%
Bear Creek-North Laramie River	Rocky Mountain Lodgepole Pine Forest	Conifer	28328.2	3412.73	12.05%	29.0%
Bear Creek-North Laramie River	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	28328.2	3393.91	11.98%	41.0%
Bear Creek-North Laramie River	Northwestern Great Plains Mixedgrass Prairie	Grassland	28328.2	2874.85	10.15%	51.1%
Bear Creek-North Laramie River	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	28328.2	2526.58	8.92%	60.0%
Bear Creek-North Laramie River	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	28328.2	1888.59	6.67%	66.7%
Bear Creek-North Laramie River	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	28328.2	1748.76	6.17%	72.9%
Bear Creek-North Laramie River	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Conifer	28328.2	1564.06	5.52%	78.4%
Bear Creek-North Laramie River	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	28328.2	1079.93	3.81%	82.2%
Bear Creek-North Laramie River	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland	28328.2	973.44	3.44%	85.6%
Bear Creek-North Laramie River	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	28328.2	771.21	2.72%	88.4%
Bear Creek-North Laramie River	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	28328.2	625.77	2.21%	90.6%
Bear Creek-North Laramie River	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	28328.2	552.96	1.95%	92.5%
Bear Creek-North Laramie River	Western Great Plains Sand Prairie Grassland	Grassland	28328.2	438.31	1.55%	94.1%
Bear Creek-North Laramie River	Other	Other	28328.2	1682.17	5.94%	100.0%
Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type	Percent of HUC12	Cumulative Percent
Brush Creek-Sybille Creek	Western Great Plains Shortgrass Prairie	Grassland	26206.1	6415.53	24.48%	24.5%
Brush Creek-Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26206.1	4936.98	18.84%	43.3%
Brush Creek-Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	26206.1	2708.72	10.34%	53.7%
Brush Creek-Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	26206.1	1880.28	7.17%	60.8%
Brush Creek-Sybille Creek	Western Cool Temperate Close Grown Crop	Agricultural	26206.1	1757.22	6.71%	67.5%
Brush Creek-Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	26206.1	1416.10	5.40%	72.9%
Brush Creek-Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	26206.1	1238.18	4.72%	77.7%
Brush Creek-Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	26206.1	1207.81	4.61%	82.3%
Brush Creek-Sybille Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	26206.1	780.68	2.98%	85.3%
Brush Creek-Sybille Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	26206.1	691.94	2.64%	87.9%
Brush Creek-Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	26206.1	518.81	1.98%	89.9%
Brush Creek-Sybille Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	26206.1	490.17	1.87%	91.7%
Brush Creek-Sybille Creek	Western Great Plains Sand Prairie Grassland	Grassland	26206.1	399.83	1.53%	93.3%
Brush Creek-Sybille Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	26206.1	365.02	1.39%	94.7%
Brush Creek-Sybille Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	26206.1	276.99	1.06%	95.7%
Brush Creek-Sybille Creek	Other	Other	26206.1	1121.80	4.28%	100.0%
Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type	Percent of HUC12	Cumulative Percent
Cherry Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	13837.3	3957.82	28.60%	28.6%
Cherry Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	13837.3	2696.57	19.49%	48.1%
Cherry Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	13837.3	1714.14	12.39%	60.5%
Cherry Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	13837.3	604.00	4.36%	64.8%
Cherry Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	13837.3	516.12	3.73%	68.6%
Cherry Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	13837.3	514.81	3.72%	72.3%
Cherry Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	13837.3	510.73	3.69%	76.0%
Cherry Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	13837.3	456.36	3.30%	79.3%
Cherry Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	13837.3	439.77	3.18%	82.5%
Cherry Creek	Western Great Plains Sand Prairie Grassland	Grassland	13837.3	381.16	2.75%	85.2%
Cherry Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	13837.3	380.92	2.75%	88.0%
Cherry Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	13837.3	368.69	2.66%	90.6%
Cherry Creek	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	13837.3	329.60	2.38%	93.0%

Cherry Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	13837.3	257.71	1.86%	94.9%
Cherry Creek	Other	Other	13837.3	708.89	5.12%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chug Spring	Western Great Plains Shortgrass Prairie	Grassland	17393.2	8327.59	47.88%	47.9%
Chug Spring	Western Cool Temperate Developed Ruderal Grassland	Developed	17393.2	2341.02	13.46%	61.3%
Chug Spring	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	17393.2	1481.48	8.52%	69.9%
Chug Spring	Northwestern Great Plains Mixedgrass Prairie	Grassland	17393.2	1035.60	5.95%	75.8%
Chug Spring	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	17393.2	773.32	4.45%	80.3%
Chug Spring	Western Cool Temperate Developed Ruderal Shrubland	Developed	17393.2	768.87	4.42%	84.7%
Chug Spring	Western Cool Temperate Undeveloped Ruderal Shrubland	Developed	17393.2	564.07	3.24%	87.9%
Chug Spring	Western Great Plains Sand Prairie Grassland	Grassland	17393.2	523.79	3.01%	90.9%
Chug Spring	Western Cool Temperate Fallow/Idle Cropland	Agricultural	17393.2	377.87	2.17%	93.1%
Chug Spring	Developed-Roads	Developed-Roads	17393.2	232.56	1.34%	94.4%
Chug Spring	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	17393.2	198.31	1.14%	95.6%
Chug Spring	Other	Other	17393.2	768.69	4.42%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chugwater Creek-Antelope Road	Western Great Plains Shortgrass Prairie	Grassland	20826.8	10317.42	49.54%	49.5%
Chugwater Creek-Antelope Road	Western Cool Temperate Row Crop	Agricultural	20826.8	2201.49	10.57%	60.1%
Chugwater Creek-Antelope Road	Western Cool Temperate Close Grown Crop	Agricultural	20826.8	1973.49	9.48%	69.6%
Chugwater Creek-Antelope Road	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	20826.8	822.72	3.95%	73.5%
Chugwater Creek-Antelope Road	Western Cool Temperate Developed Ruderal Grassland	Developed	20826.8	780.31	3.75%	77.3%
Chugwater Creek-Antelope Road	Northwestern Great Plains Mixedgrass Prairie	Grassland	20826.8	738.91	3.55%	80.8%
Chugwater Creek-Antelope Road	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	20826.8	701.14	3.37%	84.2%
Chugwater Creek-Antelope Road	Western Cool Temperate Developed Ruderal Shrubland	Developed	20826.8	634.90	3.05%	87.2%
Chugwater Creek-Antelope Road	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	20826.8	540.50	2.60%	89.8%
Chugwater Creek-Antelope Road	Western Great Plains Sand Prairie Grassland	Grassland	20826.8	503.71	2.42%	92.3%
Chugwater Creek-Antelope Road	Developed-Roads	Developed-Roads	20826.8	296.68	1.42%	93.7%
Chugwater Creek-Antelope Road	Western Cool Temperate Wheat	Agricultural	20826.8	240.54	1.15%	94.8%
Chugwater Creek-Antelope Road	Western Great Plains Floodplain Forest and Woodland	Riparian	20826.8	226.60	1.09%	95.9%
Chugwater Creek-Antelope Road	Other	Other	20826.8	848.39	4.07%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chugwater Creek-Chugwater	Western Great Plains Shortgrass Prairie	Grassland	36381.2	17156.39	47.16%	47.2%
Chugwater Creek-Chugwater	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	36381.2	3426.77	9.42%	56.6%
Chugwater Creek-Chugwater	Western Great Plains Sand Prairie Grassland	Grassland	36381.2	3178.52	8.74%	65.3%
Chugwater Creek-Chugwater	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	36381.2	1952.92	5.37%	70.7%
Chugwater Creek-Chugwater	Western Cool Temperate Developed Ruderal Grassland	Developed	36381.2	1342.63	3.69%	74.4%
Chugwater Creek-Chugwater	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	36381.2	1313.38	3.61%	78.0%
Chugwater Creek-Chugwater	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	36381.2	1139.05	3.13%	81.1%
Chugwater Creek-Chugwater	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	36381.2	1122.64	3.09%	84.2%
Chugwater Creek-Chugwater	Western Cool Temperate Developed Ruderal Shrubland	Developed	36381.2	936.89	2.58%	86.8%
Chugwater Creek-Chugwater	Western Great Plains Floodplain Forest and Woodland	Riparian	36381.2	843.13	2.32%	89.1%
Chugwater Creek-Chugwater	Northwestern Great Plains Mixedgrass Prairie	Grassland	36381.2	771.78	2.12%	91.2%
Chugwater Creek-Chugwater	Western Cool Temperate Fallow/Idle Cropland	Agricultural	36381.2	668.18	1.84%	93.0%
Chugwater Creek-Chugwater	Developed-Roads	Developed-Roads	36381.2	457.08	1.26%	94.3%
Chugwater Creek-Chugwater	Western Cool Temperate Close Grown Crop	Agricultural	36381.2	401.99	1.10%	95.4%
Chugwater Creek-Chugwater	Other	Other	36381.2	1669.83	4.59%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chugwater Creek-Dry Creek	Western Great Plains Shortgrass Prairie	Grassland	35304.2	17873.48	50.63%	50.63%
Chugwater Creek-Dry Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	35304.2	3100.00	8.78%	59.4%
Chugwater Creek-Dry Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	35304.2	2924.20	8.28%	67.7%

Chugwater Creek-Dry Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	35304.2	2682.43	7.60%	75.3%
Chugwater Creek-Dry Creek	Western Cool Temperate Close Grown Crop	Agricultural	35304.2	1819.58	5.15%	80.4%
Chugwater Creek-Dry Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	35304.2	1160.31	3.29%	83.7%
Chugwater Creek-Dry Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	35304.2	850.30	2.41%	86.1%
Chugwater Creek-Dry Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	35304.2	848.29	2.40%	88.5%
Chugwater Creek-Dry Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	35304.2	799.20	2.26%	90.8%
Chugwater Creek-Dry Creek	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	35304.2	584.54	1.66%	92.5%
Chugwater Creek-Dry Creek	Western Great Plains Sand Prairie Grassland	Grassland	35304.2	356.17	1.01%	93.5%
Chugwater Creek-Dry Creek	Other	Other	35304.2	2305.66	6.53%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chugwater Creek-Dry Creek-Laramie River	Western Great Plains Shortgrass Prairie	Grassland	38250.8	10148.17	26.53%	26.5%
Chugwater Creek-Dry Creek-Laramie River	Northwestern Great Plains Mixedgrass Prairie	Grassland	38250.8	7262.32	18.99%	45.5%
Chugwater Creek-Dry Creek-Laramie River	Western Great Plains Sand Prairie Grassland	Grassland	38250.8	5702.96	14.91%	60.4%
Chugwater Creek-Dry Creek-Laramie River	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	38250.8	4111.58	10.75%	71.2%
Chugwater Creek-Dry Creek-Laramie River	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	38250.8	3309.98	8.65%	79.8%
Chugwater Creek-Dry Creek-Laramie River	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	38250.8	1519.19	3.97%	83.8%
Chugwater Creek-Dry Creek-Laramie River	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	38250.8	1397.85	3.65%	87.5%
Chugwater Creek-Dry Creek-Laramie River	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	38250.8	854.65	2.23%	89.7%
Chugwater Creek-Dry Creek-Laramie River	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	38250.8	843.58	2.21%	91.9%
Chugwater Creek-Dry Creek-Laramie River	Western Great Plains Floodplain Forest and Woodland	Riparian	38250.8	506.37	1.32%	93.2%
Chugwater Creek-Dry Creek-Laramie River	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	38250.8	487.31	1.27%	94.5%
Chugwater Creek-Dry Creek-Laramie River	Other	Other	38250.8	2106.84	5.51%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chugwater Creek-North Chugwater Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	35713.8	14014.30	39.24%	39.2%
Chugwater Creek-North Chugwater Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	35713.8	5212.50	14.60%	53.8%
Chugwater Creek-North Chugwater Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	35713.8	4208.59	11.78%	65.6%
Chugwater Creek-North Chugwater Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	35713.8	3139.51	8.79%	74.4%
Chugwater Creek-North Chugwater Creek	Western Great Plains Shortgrass Prairie	Grassland	35713.8	3078.04	8.62%	83.0%
Chugwater Creek-North Chugwater Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	35713.8	1411.37	3.95%	87.0%
Chugwater Creek-North Chugwater Creek	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	35713.8	1032.70	2.89%	89.9%
Chugwater Creek-North Chugwater Creek	Western Great Plains Sand Prairie Grassland	Grassland	35713.8	615.87	1.72%	91.6%
Chugwater Creek-North Chugwater Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	35713.8	438.64	1.23%	92.8%
Chugwater Creek-North Chugwater Creek	Other	Other	35713.8	2562.24	7.17%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Chugwater Creek-Threemile Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	34582.2	10916.96	31.57%	31.6%
Chugwater Creek-Threemile Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	34582.2	5583.91	16.15%	47.7%
Chugwater Creek-Threemile Creek	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	34582.2	4642.95	13.43%	61.1%
Chugwater Creek-Threemile Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	34582.2	3520.25	10.18%	71.3%
Chugwater Creek-Threemile Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	34582.2	1831.50	5.30%	76.6%
Chugwater Creek-Threemile Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	34582.2	1633.86	4.72%	81.3%
Chugwater Creek-Threemile Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	34582.2	1447.71	4.19%	85.5%
Chugwater Creek-Threemile Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	34582.2	1140.10	3.30%	88.8%
Chugwater Creek-Threemile Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	34582.2	569.50	1.65%	90.5%
Chugwater Creek-Threemile Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	34582.2	503.60	1.46%	91.9%
Chugwater Creek-Threemile Creek	Other	Other	34582.2	2791.90	8.07%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Deadhead Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	26067.0	9540.12	36.60%	36.6%
Deadhead Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	26067.0	2962.09	11.36%	48.0%
Deadhead Creek	Western Great Plains Shortgrass Prairie	Grassland	26067.0	2353.35	9.03%	57.0%
Deadhead Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26067.0	2157.00	8.27%	65.3%

Deadhead Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	26067.0	2097.15	8.05%	73.3%
Deadhead Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	26067.0	1647.99	6.32%	79.6%
Deadhead Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	26067.0	1105.10	4.24%	83.9%
Deadhead Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	26067.0	968.77	3.72%	87.6%
Deadhead Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	26067.0	860.16	3.30%	90.9%
Deadhead Creek	Western Great Plains Sand Prairie Grassland	Grassland	26067.0	663.97	2.55%	93.4%
Deadhead Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	26067.0	472.28	1.81%	95.2%
Deadhead Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	26067.0	403.10	1.55%	96.8%
Deadhead Creek	Other	Other	26067.0	835.93	3.21%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Deer Creek-Laramie River	Western Great Plains Shortgrass Prairie	Grassland	23415.4	13226.04	56.48%	56.5%
Deer Creek-Laramie River	Western Cool Temperate Developed Ruderal Grassland	Developed	23415.4	2240.71	9.57%	66.1%
Deer Creek-Laramie River	Northwestern Great Plains Mixedgrass Prairie	Grassland	23415.4	1870.37	7.99%	74.0%
Deer Creek-Laramie River	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	23415.4	1603.38	6.85%	80.9%
Deer Creek-Laramie River	Western Cool Temperate Wheat	Agricultural	23415.4	1092.13	4.66%	85.6%
Deer Creek-Laramie River	Western Cool Temperate Fallow/Idle Cropland	Agricultural	23415.4	665.33	2.84%	88.4%
Deer Creek-Laramie River	Western Cool Temperate Developed Ruderal Shrubland	Developed	23415.4	581.11	2.48%	90.9%
Deer Creek-Laramie River	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	23415.4	367.60	1.57%	92.4%
Deer Creek-Laramie River	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	23415.4	346.01	1.48%	93.9%
Deer Creek-Laramie River	Other	Other	23415.4	1422.69	6.08%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Dry Laramie River	Western Great Plains Shortgrass Prairie	Grassland	34742.6	13130.80	37.79%	37.8%
Dry Laramie River	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	34742.6	6189.28	17.81%	55.6%
Dry Laramie River	Northwestern Great Plains Mixedgrass Prairie	Grassland	34742.6	3491.35	10.05%	65.7%
Dry Laramie River	Western Great Plains Sand Prairie Grassland	Grassland	34742.6	1524.80	4.39%	70.0%
Dry Laramie River	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	34742.6	1412.02	4.06%	74.1%
Dry Laramie River	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	34742.6	1358.23	3.91%	78.0%
Dry Laramie River	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	34742.6	1226.05	3.53%	81.5%
Dry Laramie River	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	34742.6	1023.05	2.94%	84.5%
Dry Laramie River	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	34742.6	956.94	2.75%	87.2%
Dry Laramie River	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	34742.6	784.88	2.26%	89.5%
Dry Laramie River	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	34742.6	599.53	1.73%	91.2%
Dry Laramie River	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	34742.6	543.85	1.57%	92.8%
Dry Laramie River	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	34742.6	457.95	1.32%	94.1%
Dry Laramie River	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	34742.6	384.29	1.11%	95.2%
Dry Laramie River	Other	Other	34742.6	1659.57	4.78%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Dwery Cemetary	Western Great Plains Shortgrass Prairie	Grassland	20192.0	13322.32	65.98%	66.0%
Dwery Cemetary	Western Cool Temperate Developed Ruderal Grassland	Developed	20192.0	1212.86	6.01%	72.0%
Dwery Cemetary	Northwestern Great Plains Mixedgrass Prairie	Grassland	20192.0	1048.22	5.19%	77.2%
Dwery Cemetary	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	20192.0	984.00	4.87%	82.0%
Dwery Cemetary	Western Cool Temperate Row Crop	Agricultural	20192.0	908.43	4.50%	86.5%
Dwery Cemetary	Western Cool Temperate Close Grown Crop	Agricultural	20192.0	654.67	3.24%	89.8%
Dwery Cemetary	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	20192.0	520.13	2.58%	92.4%
Dwery Cemetary	Developed-Roads	Developed-Roads	20192.0	267.43	1.32%	93.7%
Dwery Cemetary	Western Cool Temperate Developed Ruderal Shrubland	Developed	20192.0	267.03	1.32%	95.0%
Dwery Cemetary	Other	Other	20192.0	1006.90	4.99%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Eagles Nest Canyon	Western Great Plains Shortgrass Prairie	Grassland	15060.8	8751.21	58.11%	58.1%
Eagles Nest Canyon	Western Cool Temperate Developed Ruderal Grassland	Developed	15060.8	1064.03	7.06%	65.2%

Eagles Nest Canyon	Northwestern Great Plains Mixedgrass Prairie	Grassland	15060.8	940.28	6.24%	71.4%
Eagles Nest Canyon	Western Cool Temperate Row Crop	Agricultural	15060.8	897.08	5.96%	77.4%
Eagles Nest Canyon	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	15060.8	763.74	5.07%	82.4%
Eagles Nest Canyon	Western Cool Temperate Wheat	Agricultural	15060.8	437.65	2.91%	85.3%
Eagles Nest Canyon	Western Great Plains Sand Prairie Grassland	Grassland	15060.8	379.44	2.52%	87.9%
Eagles Nest Canyon	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	15060.8	371.43	2.47%	90.3%
Eagles Nest Canyon	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	15060.8	356.46	2.37%	92.7%
Eagles Nest Canyon	Western Cool Temperate Developed Ruderal Shrubland	Developed	15060.8	318.90	2.12%	94.8%
Eagles Nest Canyon	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	15060.8	155.01	1.03%	95.8%
Eagles Nest Canyon	Other	Other	15060.8	625.57	4.15%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Fish Creek-North Laramie River	Western Great Plains Shortgrass Prairie	Grassland	39068.7	18157.05	46.47%	46.5%
Fish Creek-North Laramie River	Northwestern Great Plains Mixedgrass Prairie	Grassland	39068.7	6352.91	16.26%	62.7%
Fish Creek-North Laramie River	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	39068.7	3389.98	8.68%	71.4%
Fish Creek-North Laramie River	Western Great Plains Sand Prairie Grassland	Grassland	39068.7	1950.28	4.99%	76.4%
Fish Creek-North Laramie River	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	39068.7	1492.34	3.82%	80.2%
Fish Creek-North Laramie River	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	39068.7	1462.94	3.74%	84.0%
Fish Creek-North Laramie River	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	39068.7	833.56	2.13%	86.1%
Fish Creek-North Laramie River	Western Cool Temperate Row Crop	Agricultural	39068.7	783.61	2.01%	88.1%
Fish Creek-North Laramie River	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	39068.7	715.09	1.83%	89.9%
Fish Creek-North Laramie River	Western Cool Temperate Close Grown Crop	Agricultural	39068.7	701.59	1.80%	91.7%
Fish Creek-North Laramie River	Western Cool Temperate Developed Ruderal Grassland	Developed	39068.7	666.25	1.71%	93.4%
Fish Creek-North Laramie River	Other	Other	39068.7	2563.13	6.56%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Hunton Creek	Western Great Plains Shortgrass Prairie	Grassland	16799.3	7015.80	41.76%	41.8%
Hunton Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	16799.3	1756.93	10.46%	52.2%
Hunton Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	16799.3	1476.30	8.79%	61.0%
Hunton Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	16799.3	1463.50	8.71%	69.7%
Hunton Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	16799.3	1380.84	8.22%	77.9%
Hunton Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	16799.3	573.50	3.41%	81.4%
Hunton Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	16799.3	458.73	2.73%	84.1%
Hunton Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	16799.3	453.29	2.70%	86.8%
Hunton Creek	Western Great Plains Sand Prairie Grassland	Grassland	16799.3	428.78	2.55%	89.3%
Hunton Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	16799.3	384.71	2.29%	91.6%
Hunton Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	16799.3	223.78	1.33%	93.0%
Hunton Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	16799.3	196.83	1.17%	94.1%
Hunton Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	16799.3	170.40	1.01%	95.1%
Hunton Creek	Other	Other	16799.3	815.88	4.86%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Dodge Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	29165.0	11617.42	39.83%	39.8%
Laramie River-Dodge Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	29165.0	5114.41	17.54%	57.4%
Laramie River-Dodge Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	29165.0	4886.12	16.75%	74.1%
Laramie River-Dodge Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	29165.0	3117.31	10.69%	84.8%
Laramie River-Dodge Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	29165.0	1001.53	3.43%	88.2%
Laramie River-Dodge Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	29165.0	555.31	1.90%	90.1%
Laramie River-Dodge Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	29165.0	516.61	1.77%	91.9%
Laramie River-Dodge Creek	Other	Other	29165.0	2356.29	8.08%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Grayrocks Reservoir	Western Great Plains Shortgrass Prairie	Grassland	42039.9	26970.97	64.16%	64.2%
Laramie River-Grayrocks Reservoir	Open Water	Open Water	42039.9	3051.77	7.26%	71.4%

Laramie River-Grayrocks Reservoir	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	42039.9	2600.91	6.19%	77.6%
Laramie River-Grayrocks Reservoir	Northwestern Great Plains Mixedgrass Prairie	Grassland	42039.9	1809.79	4.30%	81.9%
Laramie River-Grayrocks Reservoir	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	42039.9	855.88	2.04%	83.9%
Laramie River-Grayrocks Reservoir	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	42039.9	846.22	2.01%	86.0%
Laramie River-Grayrocks Reservoir	Western Cool Temperate Developed Ruderal Grassland	Developed	42039.9	816.88	1.94%	87.9%
Laramie River-Grayrocks Reservoir	Western Great Plains Sand Prairie Grassland	Grassland	42039.9	685.16	1.63%	89.5%
Laramie River-Grayrocks Reservoir	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	42039.9	649.30	1.54%	91.1%
Laramie River-Grayrocks Reservoir	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	42039.9	487.31	1.16%	92.2%
Laramie River-Grayrocks Reservoir	Western Cool Temperate Close Grown Crop	Agricultural	42039.9	476.30	1.13%	93.4%
Laramie River-Grayrocks Reservoir	Other	Other	42039.9	2789.35	6.64%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Laramie River Ditch	Western Great Plains Shortgrass Prairie	Grassland	31473.8	9508.38	30.21%	30.2%
Laramie River-Laramie River Ditch	Western Cool Temperate Close Grown Crop	Agricultural	31473.8	5412.76	17.20%	47.4%
Laramie River-Laramie River Ditch	Western Cool Temperate Row Crop	Agricultural	31473.8	4996.81	15.88%	63.3%
Laramie River-Laramie River Ditch	Northwestern Great Plains Mixedgrass Prairie	Grassland	31473.8	2601.75	8.27%	71.6%
Laramie River-Laramie River Ditch	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	31473.8	1766.12	5.61%	77.2%
Laramie River-Laramie River Ditch	Western Cool Temperate Developed Ruderal Grassland	Developed	31473.8	1159.63	3.68%	80.8%
Laramie River-Laramie River Ditch	Western Cool Temperate Developed Ruderal Shrubland	Developed	31473.8	1128.53	3.59%	84.4%
Laramie River-Laramie River Ditch	Barren	Barren	31473.8	735.28	2.34%	86.8%
Laramie River-Laramie River Ditch	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	31473.8	722.42	2.30%	89.1%
Laramie River-Laramie River Ditch	Developed-Roads	Developed-Roads	31473.8	532.99	1.69%	90.8%
Laramie River-Laramie River Ditch	Western Great Plains Sand Prairie Grassland	Grassland	31473.8	528.30	1.68%	92.4%
Laramie River-Laramie River Ditch	Rocky Mountain Wetland-Herbaceous	Riparian	31473.8	493.09	1.57%	94.0%
Laramie River-Laramie River Ditch	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	31473.8	433.57	1.38%	95.4%
Laramie River-Laramie River Ditch	Other	Other	31473.8	1454.18	4.62%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Luman Creek	Western Great Plains Shortgrass Prairie	Grassland	26189.1	11093.06	42.36%	42.4%
Laramie River-Luman Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	26189.1	3239.18	12.37%	54.7%
Laramie River-Luman Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	26189.1	2637.72	10.07%	64.8%
Laramie River-Luman Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26189.1	1947.30	7.44%	72.2%
Laramie River-Luman Creek	Western Great Plains Sand Prairie Grassland	Grassland	26189.1	1582.72	6.04%	78.3%
Laramie River-Luman Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	26189.1	743.23	2.84%	81.1%
Laramie River-Luman Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	26189.1	625.81	2.39%	83.5%
Laramie River-Luman Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	26189.1	550.20	2.10%	85.6%
Laramie River-Luman Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	26189.1	481.70	1.84%	87.4%
Laramie River-Luman Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	26189.1	405.53	1.55%	89.0%
Laramie River-Luman Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	26189.1	391.65	1.50%	90.5%
Laramie River-Luman Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	26189.1	351.10	1.34%	91.8%
Laramie River-Luman Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	26189.1	349.38	1.33%	93.2%
Laramie River-Luman Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	26189.1	294.14	1.12%	94.3%
Laramie River-Luman Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	26189.1	279.49	1.07%	95.4%
Laramie River-Luman Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	26189.1	262.21	1.00%	96.4%
Laramie River-Luman Creek	Other	Other	26189.1	954.67	3.65%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Marble Query Spring	Western Great Plains Shortgrass Prairie	Grassland	26528.4	16426.07	61.92%	61.9%
Laramie River-Marble Query Spring	Northwestern Great Plains Mixedgrass Prairie	Grassland	26528.4	2787.44	10.51%	72.4%
Laramie River-Marble Query Spring	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26528.4	2209.59	8.33%	80.8%
Laramie River-Marble Query Spring	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	26528.4	1468.78	5.54%	86.3%
Laramie River-Marble Query Spring	Western Great Plains Sand Prairie Grassland	Grassland	26528.4	848.82	3.20%	89.5%
Laramie River-Marble Query Spring	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	26528.4	636.79	2.40%	91.9%
Laramie River-Marble Query Spring	Barren	Barren	26528.4	428.01	1.61%	93.5%

Laramie River-Marble Query Spring	Rocky Mountain Wetland-Herbaceous	Riparian	26528.4	342.24	1.29%	94.8%
Laramie River-Marble Query Spring	Other	Other	26528.4	1380.61	5.20%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Preemption Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	20364.8	6367.61	31.27%	31.3%
Laramie River-Preemption Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	20364.8	3874.77	19.03%	50.3%
Laramie River-Preemption Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	20364.8	1897.28	9.32%	59.6%
Laramie River-Preemption Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	20364.8	1759.66	8.64%	68.3%
Laramie River-Preemption Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	20364.8	1032.88	5.07%	73.3%
Laramie River-Preemption Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	20364.8	921.21	4.52%	77.8%
Laramie River-Preemption Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	20364.8	876.54	4.30%	82.2%
Laramie River-Preemption Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	20364.8	825.58	4.05%	86.2%
Laramie River-Preemption Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	20364.8	794.08	3.90%	90.1%
Laramie River-Preemption Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	20364.8	504.84	2.48%	92.6%
Laramie River-Preemption Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	20364.8	263.84	1.30%	93.9%
Laramie River-Preemption Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	20364.8	206.70	1.01%	94.9%
Laramie River-Preemption Creek	Other	Other	20364.8	1039.82	5.11%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Sixmile Creek	Western Great Plains Shortgrass Prairie	Grassland	34860.3	23853.74	68.43%	68.4%
Laramie River-Sixmile Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	34860.3	2450.09	7.03%	75.5%
Laramie River-Sixmile Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	34860.3	2139.85	6.14%	81.6%
Laramie River-Sixmile Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	34860.3	1332.10	3.82%	85.4%
Laramie River-Sixmile Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	34860.3	864.29	2.48%	87.9%
Laramie River-Sixmile Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	34860.3	634.60	1.82%	89.7%
Laramie River-Sixmile Creek	Western Great Plains Sand Prairie Grassland	Grassland	34860.3	573.12	1.64%	91.4%
Laramie River-Sixmile Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	34860.3	394.22	1.13%	92.5%
Laramie River-Sixmile Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	34860.3	392.23	1.13%	93.6%
Laramie River-Sixmile Creek	Other	Other	34860.3	2226.05	6.39%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Laramie River-Slate Creek	Western Great Plains Shortgrass Prairie	Grassland	26155.3	5001.35	19.12%	19.1%
Laramie River-Slate Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	26155.3	4733.63	18.10%	37.2%
Laramie River-Slate Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	26155.3	3558.69	13.61%	50.8%
Laramie River-Slate Creek	Western Great Plains Sand Prairie Grassland	Grassland	26155.3	2334.15	8.92%	59.8%
Laramie River-Slate Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26155.3	2178.91	8.33%	68.1%
Laramie River-Slate Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	26155.3	1908.62	7.30%	75.4%
Laramie River-Slate Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	26155.3	1442.69	5.52%	80.9%
Laramie River-Slate Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	26155.3	1255.27	4.80%	85.7%
Laramie River-Slate Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	26155.3	1206.56	4.61%	90.3%
Laramie River-Slate Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	26155.3	936.20	3.58%	93.9%
Laramie River-Slate Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	26155.3	302.24	1.16%	95.0%
Laramie River-Slate Creek	Other	Other	26155.3	1296.98	4.96%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower Bluegrass Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	28774.5	7355.07	25.56%	25.6%
Lower Bluegrass Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	28774.5	6920.06	24.05%	49.6%
Lower Bluegrass Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	28774.5	3410.87	11.85%	61.5%
Lower Bluegrass Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	28774.5	3142.14	10.92%	72.4%
Lower Bluegrass Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	28774.5	1326.83	4.61%	77.0%
Lower Bluegrass Creek	Western Great Plains Shortgrass Prairie	Grassland	28774.5	1302.55	4.53%	81.5%
Lower Bluegrass Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	28774.5	1185.48	4.12%	85.6%
Lower Bluegrass Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	28774.5	736.59	2.56%	88.2%
Lower Bluegrass Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	28774.5	650.92	2.26%	90.5%

Lower Bluegrass Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	28774.5	628.66	2.18%	92.6%
Lower Bluegrass Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	28774.5	383.43	1.33%	94.0%
Lower Bluegrass Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	28774.5	318.83	1.11%	95.1%
Lower Bluegrass Creek	Other	Other	28774.5	1413.10	4.91%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower Duck Creek-Dry Laramie River	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	24298.3	5979.79	24.61%	24.6%
Lower Duck Creek-Dry Laramie River	Northwestern Great Plains Mixedgrass Prairie	Grassland	24298.3	5539.33	22.80%	47.4%
Lower Duck Creek-Dry Laramie River	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	24298.3	1721.94	7.09%	54.5%
Lower Duck Creek-Dry Laramie River	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	24298.3	1410.55	5.81%	60.3%
Lower Duck Creek-Dry Laramie River	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	24298.3	1335.38	5.50%	65.8%
Lower Duck Creek-Dry Laramie River	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	24298.3	1259.94	5.19%	71.0%
Lower Duck Creek-Dry Laramie River	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	24298.3	1024.24	4.22%	75.2%
Lower Duck Creek-Dry Laramie River	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	24298.3	959.66	3.95%	79.1%
Lower Duck Creek-Dry Laramie River	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	24298.3	807.45	3.32%	82.5%
Lower Duck Creek-Dry Laramie River	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	24298.3	760.54	3.13%	85.6%
Lower Duck Creek-Dry Laramie River	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	24298.3	517.46	2.13%	87.7%
Lower Duck Creek-Dry Laramie River	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	24298.3	497.42	2.05%	89.8%
Lower Duck Creek-Dry Laramie River	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	24298.3	470.99	1.94%	91.7%
Lower Duck Creek-Dry Laramie River	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	24298.3	343.54	1.41%	93.1%
Lower Duck Creek-Dry Laramie River	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	24298.3	264.00	1.09%	94.2%
Lower Duck Creek-Dry Laramie River	Other	Other	24298.3	1406.05	5.79%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower Middle Chugwater Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	27851.5	8573.38	30.78%	30.8%
Lower Middle Chugwater Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	27851.5	8358.52	30.01%	60.8%
Lower Middle Chugwater Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	27851.5	2627.66	9.43%	70.2%
Lower Middle Chugwater Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	27851.5	1759.35	6.32%	76.5%
Lower Middle Chugwater Creek	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	27851.5	1699.89	6.10%	82.6%
Lower Middle Chugwater Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	27851.5	1515.39	5.44%	88.1%
Lower Middle Chugwater Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	27851.5	834.73	3.00%	91.1%
Lower Middle Chugwater Creek	Rocky Mountain Alpine/Montane Sparsely Vegetated Systems	Sparsely Vegetated	27851.5	544.67	1.96%	93.0%
Lower Middle Chugwater Creek	Other	Other	27851.5	1937.90	6.96%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower North Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	20002.5	5456.27	27.28%	27.3%
Lower North Sybille Creek	Western Great Plains Shortgrass Prairie	Grassland	20002.5	3745.68	18.73%	46.0%
Lower North Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	20002.5	2126.38	10.63%	56.6%
Lower North Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	20002.5	2109.63	10.55%	67.2%
Lower North Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	20002.5	1371.12	6.85%	74.0%
Lower North Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	20002.5	1070.46	5.35%	79.4%
Lower North Sybille Creek	Western Great Plains Sand Prairie Grassland	Grassland	20002.5	948.21	4.74%	84.1%
Lower North Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	20002.5	752.89	3.76%	87.9%
Lower North Sybille Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	20002.5	569.99	2.85%	90.7%
Lower North Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	20002.5	552.86	2.76%	93.5%
Lower North Sybille Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	20002.5	293.89	1.47%	95.0%
Lower North Sybille Creek	Other	Other	20002.5	1005.16	5.03%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower Richeau Creek	Western Great Plains Shortgrass Prairie	Grassland	31604.0	13872.52	43.89%	43.9%
Lower Richeau Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	31604.0	2907.26	9.20%	53.1%
Lower Richeau Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	31604.0	2632.09	8.33%	61.4%
Lower Richeau Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	31604.0	2522.44	7.98%	69.4%
Lower Richeau Creek	Western Great Plains Sand Prairie Grassland	Grassland	31604.0	2163.49	6.85%	76.2%

Lower Richeau Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	31604.0	1408.99	4.46%	80.7%
Lower Richeau Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	31604.0	1081.46	3.42%	84.1%
Lower Richeau Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	31604.0	1035.53	3.28%	87.4%
Lower Richeau Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	31604.0	658.85	2.08%	89.5%
Lower Richeau Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	31604.0	549.00	1.74%	91.2%
Lower Richeau Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	31604.0	469.51	1.49%	92.7%
Lower Richeau Creek	Western Cool Temperate Wheat	Agricultural	31604.0	376.18	1.19%	93.9%
Lower Richeau Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	31604.0	340.84	1.08%	95.0%
Lower Richeau Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	31604.0	339.59	1.07%	96.1%
Lower Richeau Creek	Other	Other	31604.0	1246.24	3.94%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower South Chugwater Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	22614.7	9394.54	41.54%	41.5%
Lower South Chugwater Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	22614.7	5674.05	25.09%	66.6%
Lower South Chugwater Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	22614.7	2404.37	10.63%	77.3%
Lower South Chugwater Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	22614.7	1228.04	5.43%	82.7%
Lower South Chugwater Creek	Rocky Mountain Alpine/Montane Sparsely Vegetated Systems	Sparsely Vegetated	22614.7	597.79	2.64%	85.3%
Lower South Chugwater Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	22614.7	418.70	1.85%	87.2%
Lower South Chugwater Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	22614.7	407.71	1.80%	89.0%
Lower South Chugwater Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	22614.7	386.09	1.71%	90.7%
Lower South Chugwater Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	22614.7	331.03	1.46%	92.2%
Lower South Chugwater Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	22614.7	279.51	1.24%	93.4%
Lower South Chugwater Creek	Other	Other	22614.7	1492.83	6.60%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower South Fork Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	27983.1	6963.39	24.88%	24.9%
Lower South Fork Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	27983.1	3621.73	12.94%	37.8%
Lower South Fork Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	27983.1	3371.05	12.05%	49.9%
Lower South Fork Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	27983.1	3115.31	11.13%	61.0%
Lower South Fork Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	27983.1	2797.68	10.00%	71.0%
Lower South Fork Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	27983.1	2674.33	9.56%	80.6%
Lower South Fork Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	27983.1	1808.20	6.46%	87.0%
Lower South Fork Sybille Creek	Western Great Plains Shortgrass Prairie	Grassland	27983.1	1164.41	4.16%	91.2%
Lower South Fork Sybille Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	27983.1	793.73	2.84%	94.0%
Lower South Fork Sybille Creek	Western Great Plains Sand Prairie Grassland	Grassland	27983.1	393.60	1.41%	95.4%
Lower South Fork Sybille Creek	Other	Other	27983.1	1279.70	4.57%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Lower Sybille Creek	Western Great Plains Shortgrass Prairie	Grassland	14579.7	4608.12	31.61%	31.6%
Lower Sybille Creek	Western Cool Temperate Close Grown Crop	Agricultural	14579.7	2308.75	15.84%	47.4%
Lower Sybille Creek	Western Cool Temperate Row Crop	Agricultural	14579.7	1133.38	7.77%	55.2%
Lower Sybille Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	14579.7	949.55	6.51%	61.7%
Lower Sybille Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	14579.7	944.07	6.48%	68.2%
Lower Sybille Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	14579.7	937.50	6.43%	74.6%
Lower Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	14579.7	832.03	5.71%	80.3%
Lower Sybille Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	14579.7	535.63	3.67%	84.0%
Lower Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	14579.7	438.26	3.01%	87.0%
Lower Sybille Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	14579.7	357.80	2.45%	89.5%
Lower Sybille Creek	Developed-Roads	Developed-Roads	14579.7	321.91	2.21%	91.7%
Lower Sybille Creek	Open Water	Open Water	14579.7	254.91	1.75%	93.4%
Lower Sybille Creek	Other	Other	14579.7	957.81	6.57%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Middle Bluegrass Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	34136.0	11165.77	32.71%	32.7%

Middle Bluegrass Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	34136.0	8108.94	23.75%	56.5%
Middle Bluegrass Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	34136.0	4736.15	13.87%	70.3%
Middle Bluegrass Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	34136.0	4366.89	12.79%	83.1%
Middle Bluegrass Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	34136.0	1590.52	4.66%	87.8%
Middle Bluegrass Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	34136.0	1265.50	3.71%	91.5%
Middle Bluegrass Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	34136.0	599.37	1.76%	93.3%
Middle Bluegrass Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	34136.0	418.93	1.23%	94.5%
Middle Bluegrass Creek	Other	Other	34136.0	1883.91	5.52%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Middle North Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	20514.4	6944.51	33.85%	33.9%
Middle North Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	20514.4	4365.87	21.28%	55.1%
Middle North Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	20514.4	1312.06	6.40%	61.5%
Middle North Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	20514.4	1038.02	5.06%	66.6%
Middle North Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	20514.4	999.90	4.87%	71.5%
Middle North Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	20514.4	916.54	4.47%	75.9%
Middle North Sybille Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	20514.4	841.57	4.10%	80.0%
Middle North Sybille Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	20514.4	763.32	3.72%	83.8%
Middle North Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	20514.4	751.24	3.66%	87.4%
Middle North Sybille Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	20514.4	713.62	3.48%	90.9%
Middle North Sybille Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	20514.4	327.04	1.59%	92.5%
Middle North Sybille Creek	Western Great Plains Sand Prairie Grassland	Grassland	20514.4	271.37	1.32%	93.8%
Middle North Sybille Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	20514.4	269.24	1.31%	95.1%
Middle North Sybille Creek	Other	Other	20514.4	1000.07	4.87%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Middle Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	19791.5	6593.74	33.32%	33.3%
Middle Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	19791.5	4842.59	24.47%	57.8%
Middle Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	19791.5	1962.57	9.92%	67.7%
Middle Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	19791.5	1456.35	7.36%	75.1%
Middle Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	19791.5	1222.53	6.18%	81.2%
Middle Sybille Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	19791.5	925.32	4.68%	85.9%
Middle Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	19791.5	855.38	4.32%	90.2%
Middle Sybille Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	19791.5	606.71	3.07%	93.3%
Middle Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	19791.5	490.91	2.48%	95.8%
Middle Sybille Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	19791.5	201.90	1.02%	96.8%
Middle Sybille Creek	Other	Other	19791.5	633.47	3.20%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Mule Creek-Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	15615.3	5796.71	37.12%	37.1%
Mule Creek-Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	15615.3	1655.26	10.60%	47.7%
Mule Creek-Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	15615.3	1390.78	8.91%	56.6%
Mule Creek-Sybille Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	15615.3	1051.21	6.73%	63.4%
Mule Creek-Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	15615.3	970.69	6.22%	69.6%
Mule Creek-Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	15615.3	940.32	6.02%	75.6%
Mule Creek-Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	15615.3	760.51	4.87%	80.5%
Mule Creek-Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	15615.3	686.35	4.40%	84.9%
Mule Creek-Sybille Creek	Western Great Plains Shortgrass Prairie	Grassland	15615.3	518.75	3.32%	88.2%
Mule Creek-Sybille Creek	Western Great Plains Sand Prairie Grassland	Grassland	15615.3	518.26	3.32%	91.5%
Mule Creek-Sybille Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	15615.3	369.60	2.37%	93.9%
Mule Creek-Sybille Creek	Western Cool Temperate Pasture and Hayland	Agricultural	15615.3	157.24	1.01%	94.9%
Mule Creek-Sybille Creek	Other	Other	15615.3	799.67	5.12%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**

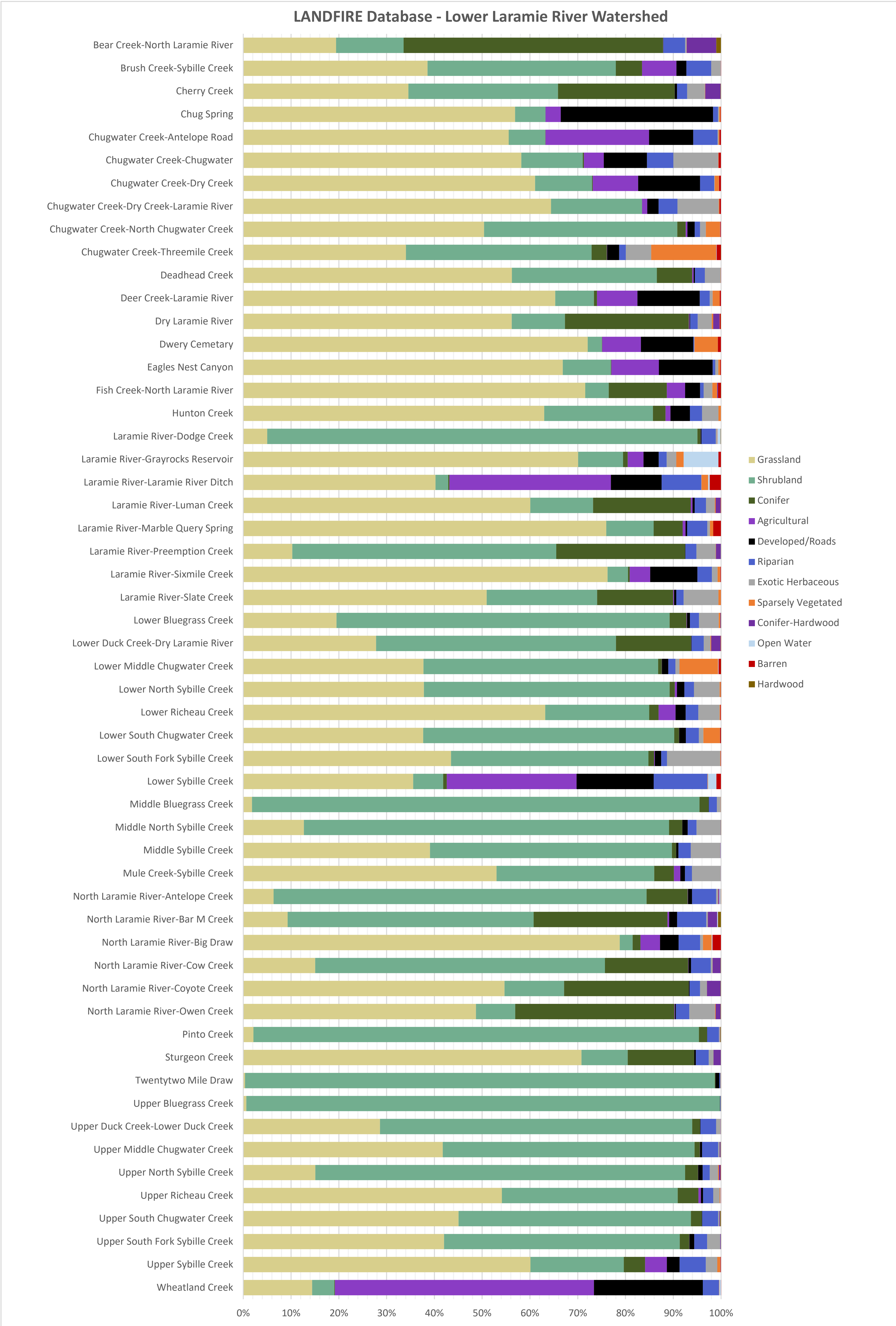
North Laramie River-Antelope Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	20210.5	9571.01	47.36%	47.4%
North Laramie River-Antelope Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	20210.5	3676.42	18.19%	65.5%
North Laramie River-Antelope Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	20210.5	1242.92	6.15%	71.7%
North Laramie River-Antelope Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	20210.5	829.67	4.11%	75.8%
North Laramie River-Antelope Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	20210.5	824.25	4.08%	79.9%
North Laramie River-Antelope Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	20210.5	655.77	3.24%	83.1%
North Laramie River-Antelope Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	20210.5	606.90	3.00%	86.1%
North Laramie River-Antelope Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	20210.5	438.25	2.17%	88.3%
North Laramie River-Antelope Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	20210.5	297.49	1.47%	89.8%
North Laramie River-Antelope Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	20210.5	272.27	1.35%	91.1%
North Laramie River-Antelope Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	20210.5	252.32	1.25%	92.4%
North Laramie River-Antelope Creek	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	20210.5	228.93	1.13%	93.5%
North Laramie River-Antelope Creek	Other	Other	20210.5	1314.26	6.50%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
North Laramie River-Bar M Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	26956.5	12667.24	46.99%	47.0%
North Laramie River-Bar M Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	26956.5	3779.29	14.02%	61.0%
North Laramie River-Bar M Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	26956.5	1303.46	4.84%	65.8%
North Laramie River-Bar M Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	26956.5	1023.72	3.80%	69.6%
North Laramie River-Bar M Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	26956.5	1019.45	3.78%	73.4%
North Laramie River-Bar M Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	26956.5	981.18	3.64%	77.1%
North Laramie River-Bar M Creek	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland	26956.5	679.97	2.52%	79.6%
North Laramie River-Bar M Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	26956.5	630.28	2.34%	81.9%
North Laramie River-Bar M Creek	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Conifer	26956.5	522.96	1.94%	83.9%
North Laramie River-Bar M Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	26956.5	522.31	1.94%	85.8%
North Laramie River-Bar M Creek	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	26956.5	476.97	1.77%	87.6%
North Laramie River-Bar M Creek	Rocky Mountain Lodgepole Pine Forest	Conifer	26956.5	447.22	1.66%	89.2%
North Laramie River-Bar M Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	26956.5	432.28	1.60%	90.8%
North Laramie River-Bar M Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26956.5	345.54	1.28%	92.1%
North Laramie River-Bar M Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	26956.5	302.30	1.12%	93.2%
North Laramie River-Bar M Creek	Other	Other	26956.5	1822.36	6.76%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
North Laramie River-Big Draw	Western Great Plains Shortgrass Prairie	Grassland	32490.9	22363.62	68.83%	68.83%
North Laramie River-Big Draw	Northwestern Great Plains Mixedgrass Prairie	Grassland	32490.9	2178.14	6.70%	75.5%
North Laramie River-Big Draw	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	32490.9	1005.81	3.10%	78.6%
North Laramie River-Big Draw	Western Great Plains Sand Prairie Grassland	Grassland	32490.9	956.48	2.94%	81.6%
North Laramie River-Big Draw	Western Cool Temperate Close Grown Crop	Agricultural	32490.9	822.68	2.53%	84.1%
North Laramie River-Big Draw	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	32490.9	757.40	2.33%	86.4%
North Laramie River-Big Draw	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	32490.9	585.49	1.80%	88.2%
North Laramie River-Big Draw	Barren	Barren	32490.9	578.20	1.78%	90.0%
North Laramie River-Big Draw	Western Cool Temperate Developed Ruderal Grassland	Developed	32490.9	488.70	1.50%	91.5%
North Laramie River-Big Draw	Western Cool Temperate Row Crop	Agricultural	32490.9	476.64	1.47%	93.0%
North Laramie River-Big Draw	Western Cool Temperate Developed Ruderal Shrubland	Developed	32490.9	460.72	1.42%	94.4%
North Laramie River-Big Draw	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	32490.9	413.75	1.27%	95.7%
North Laramie River-Big Draw	Western Great Plains Floodplain Forest and Woodland	Riparian	32490.9	348.32	1.07%	96.8%
North Laramie River-Big Draw	Other	Other	32490.9	1054.92	3.25%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
North Laramie River-Cow Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	33573.9	12137.53	36.15%	36.2%
North Laramie River-Cow Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	33573.9	4850.59	14.45%	50.6%
North Laramie River-Cow Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	33573.9	3094.06	9.22%	59.8%
North Laramie River-Cow Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	33573.9	1637.57	4.88%	64.7%
North Laramie River-Cow Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	33573.9	1536.59	4.58%	69.3%

North Laramie River-Cow Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	33573.9	1393.72	4.15%	73.4%
North Laramie River-Cow Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	33573.9	1253.55	3.73%	77.2%
North Laramie River-Cow Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	33573.9	1051.51	3.13%	80.3%
North Laramie River-Cow Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	33573.9	1027.93	3.06%	83.3%
North Laramie River-Cow Creek	Rocky Mountain Lodgepole Pine Forest	Conifer	33573.9	742.97	2.21%	85.6%
North Laramie River-Cow Creek	Western Great Plains Sand Prairie Grassland	Grassland	33573.9	646.79	1.93%	87.5%
North Laramie River-Cow Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	33573.9	561.56	1.67%	89.2%
North Laramie River-Cow Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	33573.9	549.62	1.64%	90.8%
North Laramie River-Cow Creek	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	33573.9	502.21	1.50%	92.3%
North Laramie River-Cow Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	33573.9	466.11	1.39%	93.7%
North Laramie River-Cow Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	33573.9	380.95	1.13%	94.8%
North Laramie River-Cow Creek	Other	Other	33573.9	1740.66	5.18%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
North Laramie River-Coyote Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	28998.2	9853.87	33.98%	34.0%
North Laramie River-Coyote Creek	Western Great Plains Sand Prairie Grassland	Grassland	28998.2	2972.83	10.25%	44.2%
North Laramie River-Coyote Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	28998.2	2850.21	9.83%	54.1%
North Laramie River-Coyote Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	28998.2	2774.07	9.57%	63.6%
North Laramie River-Coyote Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	28998.2	2530.04	8.72%	72.4%
North Laramie River-Coyote Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	28998.2	1391.76	4.80%	77.2%
North Laramie River-Coyote Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	28998.2	1075.88	3.71%	80.9%
North Laramie River-Coyote Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	28998.2	1040.13	3.59%	84.4%
North Laramie River-Coyote Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	28998.2	884.37	3.05%	87.5%
North Laramie River-Coyote Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	28998.2	824.78	2.84%	90.3%
North Laramie River-Coyote Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	28998.2	798.46	2.75%	93.1%
North Laramie River-Coyote Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	28998.2	417.84	1.44%	94.5%
North Laramie River-Coyote Creek	Other	Other	28998.2	1584.00	5.46%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
North Laramie River-Owen Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	37609.7	7647.48	20.33%	20.3%
North Laramie River-Owen Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	37609.7	6426.12	17.09%	37.4%
North Laramie River-Owen Creek	Western Great Plains Shortgrass Prairie	Grassland	37609.7	5131.39	13.64%	51.1%
North Laramie River-Owen Creek	Western Great Plains Sand Prairie Grassland	Grassland	37609.7	3852.53	10.24%	61.3%
North Laramie River-Owen Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	37609.7	2863.30	7.61%	68.9%
North Laramie River-Owen Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	37609.7	2575.86	6.85%	75.8%
North Laramie River-Owen Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	37609.7	2032.66	5.40%	81.2%
North Laramie River-Owen Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	37609.7	1230.06	3.27%	84.4%
North Laramie River-Owen Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	37609.7	1178.59	3.13%	87.6%
North Laramie River-Owen Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	37609.7	824.64	2.19%	89.8%
North Laramie River-Owen Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	37609.7	641.74	1.71%	91.5%
North Laramie River-Owen Creek	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	37609.7	459.33	1.22%	92.7%
North Laramie River-Owen Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	37609.7	406.49	1.08%	93.8%
North Laramie River-Owen Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	37609.7	402.29	1.07%	94.8%
North Laramie River-Owen Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	37609.7	381.70	1.01%	95.9%
North Laramie River-Owen Creek	Other	Other	37609.7	1555.56	4.14%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Pinto Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	16921.2	5521.40	32.63%	32.6%
Pinto Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	16921.2	3894.64	23.02%	55.6%
Pinto Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	16921.2	3347.20	19.78%	75.4%
Pinto Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	16921.2	2288.84	13.53%	89.0%
Pinto Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	16921.2	415.15	2.45%	91.4%
Pinto Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	16921.2	217.83	1.29%	92.7%
Pinto Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	16921.2	211.85	1.25%	93.9%

Pinto Creek	Other	Other	16921.2	1024.24	6.05%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Sturgeon Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	19236.8	6825.69	35.48%	35.5%
Sturgeon Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	19236.8	3843.50	19.98%	55.5%
Sturgeon Creek	Western Great Plains Sand Prairie Grassland	Grassland	19236.8	2762.76	14.36%	69.8%
Sturgeon Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	19236.8	1103.57	5.74%	75.6%
Sturgeon Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	19236.8	1097.22	5.70%	81.3%
Sturgeon Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	19236.8	1042.85	5.42%	86.7%
Sturgeon Creek	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Conifer-Hardwood	19236.8	291.63	1.52%	88.2%
Sturgeon Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	19236.8	233.56	1.21%	89.4%
Sturgeon Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	19236.8	193.55	1.01%	90.4%
Sturgeon Creek	Other	Other	19236.8	1842.52	9.58%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Twentytwo Mile Draw	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	36933.1	20311.68	55.00%	55.0%
Twentytwo Mile Draw	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	36933.1	9195.54	24.90%	79.9%
Twentytwo Mile Draw	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	36933.1	4413.21	11.95%	91.8%
Twentytwo Mile Draw	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	36933.1	1171.46	3.17%	95.0%
Twentytwo Mile Draw	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	36933.1	824.51	2.23%	97.2%
Twentytwo Mile Draw	Other	Other	36933.1	1016.70	2.75%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper Bluegrass Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	26391.6	15239.71	57.74%	57.7%
Upper Bluegrass Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	26391.6	6302.05	23.88%	81.6%
Upper Bluegrass Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	26391.6	3639.15	13.79%	95.4%
Upper Bluegrass Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	26391.6	402.30	1.52%	96.9%
Upper Bluegrass Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	26391.6	267.37	1.01%	97.9%
Upper Bluegrass Creek	Other	Other	26391.6	541.06	2.05%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper Duck Creek-Lower Duck Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	27231.7	7427.52	27.28%	27.3%
Upper Duck Creek-Lower Duck Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	27231.7	4467.54	16.41%	43.7%
Upper Duck Creek-Lower Duck Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	27231.7	4203.17	15.43%	59.1%
Upper Duck Creek-Lower Duck Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	27231.7	3949.13	14.50%	73.6%
Upper Duck Creek-Lower Duck Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	27231.7	1866.49	6.85%	80.5%
Upper Duck Creek-Lower Duck Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	27231.7	1270.53	4.67%	85.1%
Upper Duck Creek-Lower Duck Creek	Western Great Plains Sand Prairie Grassland	Grassland	27231.7	1234.08	4.53%	89.7%
Upper Duck Creek-Lower Duck Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	27231.7	465.03	1.71%	91.4%
Upper Duck Creek-Lower Duck Creek	Rocky Mountain Wetland-Herbaceous	Riparian	27231.7	368.63	1.35%	92.7%
Upper Duck Creek-Lower Duck Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	27231.7	313.13	1.15%	93.9%
Upper Duck Creek-Lower Duck Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	27231.7	278.67	1.02%	94.9%
Upper Duck Creek-Lower Duck Creek	Other	Other	27231.7	1387.81	5.10%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper Middle Chugwater Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	32221.3	13315.16	41.32%	41.3%
Upper Middle Chugwater Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	32221.3	5978.16	18.55%	59.9%
Upper Middle Chugwater Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	32221.3	5438.97	16.88%	76.8%
Upper Middle Chugwater Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	32221.3	1846.72	5.73%	82.5%
Upper Middle Chugwater Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	32221.3	1812.27	5.62%	88.1%
Upper Middle Chugwater Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	32221.3	788.73	2.45%	90.6%
Upper Middle Chugwater Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	32221.3	695.40	2.16%	92.7%
Upper Middle Chugwater Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	32221.3	411.73	1.28%	94.0%
Upper Middle Chugwater Creek	Rocky Mountain Wetland-Herbaceous	Riparian	32221.3	390.18	1.21%	95.2%

Upper Middle Chugwater Creek	Other	Other	32221.3	1543.97	4.79%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper North Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	21773.9	11018.82	50.61%	50.6%
Upper North Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	21773.9	2796.59	12.84%	63.4%
Upper North Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	21773.9	1590.18	7.30%	70.8%
Upper North Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	21773.9	867.28	3.98%	74.7%
Upper North Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	21773.9	772.01	3.55%	78.3%
Upper North Sybille Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	21773.9	688.24	3.16%	81.4%
Upper North Sybille Creek	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrubland	21773.9	682.80	3.14%	84.6%
Upper North Sybille Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	21773.9	628.83	2.89%	87.5%
Upper North Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	21773.9	476.13	2.19%	89.7%
Upper North Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	21773.9	372.87	1.71%	91.4%
Upper North Sybille Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	21773.9	245.01	1.13%	92.5%
Upper North Sybille Creek	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Conifer	21773.9	236.07	1.08%	93.6%
Upper North Sybille Creek	Other	Other	21773.9	1399.09	6.43%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper Richeau Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	34032.3	11825.21	34.75%	34.7%
Upper Richeau Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	34032.3	5928.26	17.42%	52.2%
Upper Richeau Creek	Western Great Plains Shortgrass Prairie	Grassland	34032.3	3851.22	11.32%	63.5%
Upper Richeau Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	34032.3	3209.97	9.43%	72.9%
Upper Richeau Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	34032.3	2077.65	6.10%	79.0%
Upper Richeau Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	34032.3	1641.15	4.82%	83.8%
Upper Richeau Creek	Western Great Plains Sand Prairie Grassland	Grassland	34032.3	1104.98	3.25%	87.1%
Upper Richeau Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	34032.3	1097.16	3.22%	90.3%
Upper Richeau Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	34032.3	534.58	1.57%	91.9%
Upper Richeau Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	34032.3	452.68	1.33%	93.2%
Upper Richeau Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	34032.3	441.90	1.30%	94.5%
Upper Richeau Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	34032.3	411.61	1.21%	95.7%
Upper Richeau Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	34032.3	345.87	1.02%	96.7%
Upper Richeau Creek	Other	Other	34032.3	1110.10	3.26%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper South Chugwater Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	25505.3	9664.26	37.89%	37.9%
Upper South Chugwater Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	25505.3	7711.21	30.23%	68.1%
Upper South Chugwater Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	25505.3	2122.05	8.32%	76.4%
Upper South Chugwater Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	25505.3	1491.81	5.85%	82.3%
Upper South Chugwater Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	25505.3	875.19	3.43%	85.7%
Upper South Chugwater Creek	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland	25505.3	781.80	3.07%	88.8%
Upper South Chugwater Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	25505.3	545.66	2.14%	90.9%
Upper South Chugwater Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	25505.3	484.26	1.90%	92.8%
Upper South Chugwater Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	25505.3	457.53	1.79%	94.6%
Upper South Chugwater Creek	Other	Other	25505.3	1371.53	5.38%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper South Fork Sybille Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	18912.6	5092.57	26.93%	26.9%
Upper South Fork Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	18912.6	4156.14	21.98%	48.9%
Upper South Fork Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	18912.6	3092.53	16.35%	65.3%
Upper South Fork Sybille Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	18912.6	2012.12	10.64%	75.9%
Upper South Fork Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	18912.6	866.85	4.58%	80.5%
Upper South Fork Sybille Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	18912.6	698.19	3.69%	84.2%
Upper South Fork Sybille Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	18912.6	650.52	3.44%	87.6%
Upper South Fork Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	18912.6	532.16	2.81%	90.4%

Upper South Fork Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	18912.6	517.04	2.73%	93.2%
Upper South Fork Sybille Creek	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	18912.6	214.79	1.14%	94.3%
Upper South Fork Sybille Creek	Other	Other	18912.6	1079.67	5.71%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Upper Sybille Creek	Western Great Plains Shortgrass Prairie	Grassland	31407.7	11465.80	36.51%	36.5%
Upper Sybille Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	31407.7	4242.92	13.51%	50.0%
Upper Sybille Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	31407.7	4099.24	13.05%	63.1%
Upper Sybille Creek	Western Great Plains Sand Prairie Grassland	Grassland	31407.7	2538.71	8.08%	71.2%
Upper Sybille Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	31407.7	1338.96	4.26%	75.4%
Upper Sybille Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	31407.7	941.29	3.00%	78.4%
Upper Sybille Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	31407.7	834.59	2.66%	81.1%
Upper Sybille Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	31407.7	770.84	2.45%	83.5%
Upper Sybille Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	31407.7	763.09	2.43%	86.0%
Upper Sybille Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	31407.7	751.80	2.39%	88.3%
Upper Sybille Creek	Western Cool Temperate Close Grown Crop	Agricultural	31407.7	621.11	1.98%	90.3%
Upper Sybille Creek	Western Cool Temperate Row Crop	Agricultural	31407.7	596.03	1.90%	92.2%
Upper Sybille Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	31407.7	320.49	1.02%	93.2%
Upper Sybille Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	31407.7	314.88	1.00%	94.2%
Upper Sybille Creek	Other	Other	31407.7	1808.00	5.76%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type**	**Percent of HUC12**	**Cumulative Percent**
Wheatland Creek	Western Cool Temperate Close Grown Crop	Agricultural	35849.9	10365.71	28.91%	28.9%
Wheatland Creek	Western Cool Temperate Row Crop	Agricultural	35849.9	7474.31	20.85%	49.8%
Wheatland Creek	Western Great Plains Shortgrass Prairie	Grassland	35849.9	4439.73	12.38%	62.1%
Wheatland Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	35849.9	2387.26	6.66%	68.8%
Wheatland Creek	Developed-Roads	Developed-Roads	35849.9	1746.76	4.87%	73.7%
Wheatland Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	35849.9	1700.00	4.74%	78.4%
Wheatland Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	35849.9	1507.41	4.20%	82.6%
Wheatland Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	35849.9	782.21	2.18%	84.8%
Wheatland Creek	Western Cool Temperate Wheat	Agricultural	35849.9	716.09	2.00%	86.8%
Wheatland Creek	Western Cool Temperate Urban Herbaceous	Developed	35849.9	646.95	1.80%	88.6%
Wheatland Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	35849.9	638.47	1.78%	90.4%
Wheatland Creek	Western Cool Temperate Urban Shrubland	Developed	35849.9	549.95	1.53%	91.9%
Wheatland Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	35849.9	481.47	1.34%	93.3%
Wheatland Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	35849.9	450.44	1.26%	94.5%
Wheatland Creek	Developed-Low Intensity	Developed-Low Intensity	35849.9	449.42	1.25%	95.8%
Wheatland Creek	Other	Other	35849.9	1513.69	4.22%	100.0%



LANDFIRE Database - Lower Laramie River Watershed
Bear Creek-North Laramie River
Brush Creek-Sybille Creek
Cherry Creek
Chug Spring
Chugwater Creek-Antelope Road
Chugwater Creek-Chugwater
Chugwater Creek-Dry Creek
Chugwater Creek-Dry Creek-Laramie River
Chugwater Creek-North Chugwater Creek
Chugwater Creek-Threemile Creek
Deadhead Creek
Deer Creek-Laramie River
Dry Laramie River
Dwery Cemetary
Eagles Nest Canyon
Fish Creek-North Laramie River
Hunton Creek
Laramie River-Dodge Creek
Laramie River-Grayrocks Reservoir
Laramie River-Laramie River Ditch
Laramie River-Luman Creek
Laramie River-Marble Query Spring
Laramie River-Preemption Creek
Laramie River-Sixmile Creek
Laramie River-Slate Creek
Lower Bluegrass Creek
Lower Duck Creek-Dry Laramie River
Lower Middle Chugwater Creek
Lower North Sybille Creek
Lower Richeau Creek
Lower South Chugwater Creek
Lower South Fork Sybille Creek
Lower Sybille Creek
Middle Bluegrass Creek
Middle North Sybille Creek
Middle Sybille Creek
Mule Creek-Sybille Creek
North Laramie River-Antelope Creek
North Laramie River-Bar M Creek
North Laramie River-Big Draw
North Laramie River-Cow Creek
North Laramie River-Coyote Creek
North Laramie River-Owen Creek
Pinto Creek
Sturgeon Creek
Twentytwo Mile Draw
Upper Bluegrass Creek
Upper Duck Creek-Lower Duck Creek
Upper Middle Chugwater Creek
Upper North Sybille Creek
Upper Richeau Creek
Upper South Chugwater Creek
Upper South Fork Sybille Creek
Upper Sybille Creek
Wheatland Creek
Grassland
Shrubland
Conifer
Agricultural
Developed/Roads
Riparian
Exotic Herbaceous
Sparsely Vegetated
Conifer-Hardwood
Open Water
Barren
Hardwood
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Total HUC12 Area

APPENDIX 4D

WYOMING NATURAL DIVERSITY DATABASE
VEGETATION

Wyoming Natural Diversity Database: Wildlife Species of Concern in the Bitter Creek Watershed								
Common Name	Scientific Name	USFWS Listing Status	WYBLM Sensitive Species	USFS Sensitive Species	WGFD Native Species Status	Global Heritage Rank	State Heritage Rank	WYNDD Status
Plant								
Laramie chickensage	Artemisia simplex		Sensitive			G2	S2	Species of Concern (SOC)
fragrant flatsedge	Cyperus odoratus					G5	S1	Species of Concern (SOC)
Bigelow's tansyaster	Dieteria bigelovii var. bigelovii					G4G5T3T4	S2	Species of Concern (SOC)
Colorado butterfly plant	Oenothera coloradensis ssp. coloradensis	Listed Threatened (LT)				G3T2	S2	Species of Concern (SOC)
Laramie columbine	Aquilegia laramiensis		Sensitive	USFS-R2		G2G3	S2S3	Species of Concern (SOC)
great blue lobelia	Lobelia siphilitica var. ludoviciana					G5T5?	S1	Species of Concern (SOC)
redroot flatsedge	Cyperus erythrorhizos					G5	S1	Species of Concern (SOC)
sixangle spurge	Euphorbia hexagona					G5	S1	Species of Concern (SOC)
slender flatsedge	Cyperus bipartitus					G5	S1	Species of Concern (SOC)
winged lythrum	Lythrum alatum var. alatum					G5T5	S1	Species of Concern (SOC)
Emory's sedge	Carex emoryi					G5	S2	Species of Concern (SOC)
yellow ragweed	Amauriopsis dissecta					G5	S2	
teal lovegrass	Eragrostis hypnoides					G5	S1	Species of Concern (SOC)
broadleaf arrowhead	Sagittaria latifolia					G5	S1	Species of Concern (SOC)
brownplume wirelettuce	Stephanomeria pauciflora					G5	S1	Species of Concern (SOC)
rosy palafox	Palafoxia rosea					G5	S1	Species of Concern (SOC)
leechleaf blazingstar	Mentzelia sinuata					G3	S2	Species of Concern (SOC)
awned halfchaff sedge	Lipocarpha aristulata					G5?	S1	Species of Concern (SOC)
chaffweed	Anagallis minima					G5	S1	Species of Concern (SOC)
Andean prairie clover	Dalea cylindriceps					G3G4	S2	Species of Concern (SOC)
showy prairie-gentian	Eustoma grandiflorum					G5	S1	Species of Concern (SOC)
James' nailwort	Paronychia jamesii					G4	S1	Species of Concern (SOC)
bigseed dodder	Cuscuta indecora var. neuropetala					G5T5	S1	Species of Concern (SOC)
tufted loosestrife	Lysimachia thyrsiflora					G5	S1	Species of Concern (SOC)
elliptic spikerush	Eleocharis elliptica					G5	S1S2	Species of Concern (SOC)
tapertip flatsedge	Cyperus acuminatus					G5	S1	Species of Concern (SOC)

APPENDIX 4E

WYOMING NATURAL DIVERSITY DATABASE WILDLIFE

Wyoming Natural Diversity Database: Wildlife Species of Concern in the Bitter Creek Watershed								
Common Name	Scientific Name	USFWS Listing Status	WYBLM Sensitive Species	USFS Sensitive Species	WGFD Native Species Status	Global Heritage Rank	State Heritage Rank	WYNDD Status
Amphibian								
Northern Leopard Frog	Lithobates pipiens	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Bc), Tier 2	G5	S3	Species of Concern (SOC)
Plains Spadefoot	Spea bombifrons				NSS4(Bc), Tier 2	G5	S4	Species of Concern (SOC)
Western Tiger Salamander	Ambystoma mavortium				NSS4(Bc), Tier 3	G5	S4	Species of Potential Concern (SOPC)
Bird								
American Avocet	Recurvirostra americana					G5	S3B	Species of Potential Concern (SOPC)
American Dipper	Cinclus mexicanus					G5	S4	Species of Potential Concern (SOPC)
American Kestrel	Falco sparverius				NSS4(Bc), Tier 3	G5	S5B	
American Three-toed Woodpecker	Picoides dorsalis			USFS-R4		G5	S3	Species of Concern (SOC)
American White Pelican	Pelecanus erythrorhynchos				NSS4(Bc), Tier 2	G4	S1B	Species of Concern (SOC)
Ash-throated Flycatcher	Myiarchus cinerascens				NSS3(Bb), Tier 2	G5	S3B	Species of Potential Concern (SOPC)
Bald Eagle	Haliaeetus leucocephalus	Delisted, formally monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb), Tier 2	G5	S3BS5N	Species of Concern (SOC)
Barn Owl	Tyto alba					G5	S2	Species of Potential Concern (SOPC)
Black Tern	Chlidonias niger			USFS-R2	NSS3(Bb), Tier 2	G4	S1	Species of Concern (SOC)
Black-billed Cuckoo	Coccyzus erythropthalmus				NSS4(Bc), Tier 2	G5	S2	Species of Concern (SOC)
Black-crowned Night-Heron	Nycticorax nycticorax				NSS3(Bb), Tier 2	G5	S3B	Species of Potential Concern (SOPC)
Black-throated Gray Warbler	Setophaga nigrescens				NSS4(Bc), Tier 2	G5	S2	Species of Concern (SOC)
Blue Grosbeak	Passerina caerulea				NSS4(Bc), Tier 3	G5	S3B	Species of Potential Concern (SOPC)
Blue-gray Gnatcatcher	Polioptila caerulea				NSS4(Bc), Tier 3	G5	S3?B	
Brewer's Sparrow	Spizella breweri		Sensitive	USFS-R2	NSS4(Bc), Tier 2	G5	S5	Species of Potential Concern (SOPC)
Bufflehead	Bucephala albeola					G5	S2B	Species of Potential Concern (SOPC)
Burrowing Owl	Athene cunicularia		Sensitive	USFS-R2	NSSU(U), Tier 1	G4	S4B	Species of Concern (SOC)
California Gull	Larus californicus					G5	S2B	Species of Potential Concern (SOPC)
Calliope Hummingbird	Selasphorus calliope				NSS4(Bc), Tier 2	G5	S3	Species of Concern (SOC)
Canyon Wren	Catherpes mexicanus				NSS4(Bc), Tier 3	G5	S2S3	Species of Potential Concern (SOPC)
Caspian Tern	Hydroprogne caspia				NSS3(Bb), Tier 2	G5	S1	Species of Concern (SOC)
Cassin's Sparrow	Peucaea cassinii			USFS-R2		G5	SNA	Species of Potential Concern (SOPC)
Cattle Egret	Bubulcus ibis				NSS3(Bb), Tier 2	G5	SNA	
Chestnut-collared Longspur	Calcarius ornatus			USFS-R2	NSS4(Bc), Tier 2	G5	S1	Species of Concern (SOC)
Chimney Swift	Chaetura pelagica					G5	S3B	Species of Potential Concern (SOPC)
Clark's Nutcracker	Nucifraga columbiana				NSS4(Bc), Tier 2	G5	S5BS5N	
Clay-colored Sparrow	Spizella pallida					G5	S3B	Species of Potential Concern (SOPC)
Common Goldeneye	Bucephala clangula					G5	S3B	Species of Potential Concern (SOPC)
Common Loon	Gavia immer			USFS-R4	NSS1(Aa), Tier 1	G5	S1BS2N	Species of Concern (SOC)
Common Nighthawk	Chordeiles minor				NSS4(Bc), Tier 3	G5	S5BS5N	
Common Yellowthroat	Geothlypis trichas				NSS4(Bc), Tier 3	G5	S4BS4N	
Dark-eyed Junco	Junco hyemalis					G5	S5BS5N	Species of Concern (SOC)
Eastern Screech-Owl	Megascops asio					G5	S3	Species of Potential Concern (SOPC)
Ferruginous Hawk	Buteo regalis	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb), Tier 2	G4	S4BS5N	Species of Concern (SOC)
Forster's Tern	Sterna forsteri				NSS3(Bb), Tier 2	G5	S1	Species of Concern (SOC)
Franklin's Gull	Leucophaeus pipixcan				NSSU(U), Tier 2	G4G5	SHB	
Golden Eagle	Aquila chrysaetos				NSS4(Bc), Tier 2	G5	S4BS4N	Species of Potential Concern (SOPC)
Golden-crowned Kinglet	Regulus satrapa					G5	S3BS4N	Species of Potential Concern (SOPC)

Wyoming Natural Diversity Database: Wildlife Species of Concern in the Bitter Creek Watershed								
Common Name	Scientific Name	USFWS Listing Status	WYBLM Sensitive Species	USFS Sensitive Species	WGFD Native Species Status	Global Heritage Rank	State Heritage Rank	WYNDD Status
Grasshopper Sparrow	Ammodramus savannarum			USFS-R2	NSS4(Bc), Tier 2	G5	S4	Species of Potential Concern (SOPC)
Great Blue Heron	Ardea herodias				NSS4(Bc), Tier 2	G5	S4B	
Greater Sage-Grouse	Centrocercus urophasianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS4(Bc), Tier 2	G3G4	S3S4	Species of Concern (SOC)
Hammond's Flycatcher	Empidonax hammondii					G5	S4	Species of Potential Concern (SOPC)
Herring Gull	Larus argentatus					G5	SNA	Species of Potential Concern (SOPC)
Indigo Bunting	Passerina cyanea					G5	S3B	Species of Potential Concern (SOPC)
Least Tern	Sternula antillarum	Listed Endangered (LE)				G4	SNA	
Lewis's Woodpecker	Melanerpes lewis			USFS-R2	NSSU(U), Tier 2	G4	S2	Species of Concern (SOC)
Loggerhead Shrike	Lanius ludovicianus		Sensitive	USFS-R2	NSS4(Bc), Tier 2	G4	S3	Species of Concern (SOC)
Long-billed Curlew	Numenius americanus		Sensitive	USFS-R2	NSS3(Bb), Tier 2	G5	S3B	Species of Concern (SOC)
MacGillivray's Warbler	Geothlypis tolmiei				NSS4(Bc), Tier 2	G5	S5BS5N	
McCown's Longspur	Rhynchophanes mccownii			USFS-R2	NSS4(Bc), Tier 2	G4	S2	Species of Concern (SOC)
Merlin	Falco columbarius				NSSU(U), Tier 3	G5	S3BS4N	Species of Potential Concern (SOPC)
Mountain Plover	Charadrius montanus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSSU(U), Tier 1	G3	S2BS3N	Species of Concern (SOC)
Northern Bobwhite	Colinus virginianus					G5	S1	Species of Potential Concern (SOPC)
Northern Goshawk	Accipiter gentilis	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSSU(U), Tier 1	G5	S2BS3N	Species of Concern (SOC)
Northern Harrier	Circus hudsonius			USFS-R2		G5	S4BS5N	
Olive-sided Flycatcher	Contopus cooperi			USFS-R2		G4	S4B	Species of Potential Concern (SOPC)
Osprey	Pandion haliaetus					G5	S3B	Species of Potential Concern (SOPC)
Peregrine Falcon	Falco peregrinus	Delisted, formally monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb), Tier 2	G4	S2	Species of Concern (SOC)
Pygmy Nuthatch	Sitta pygmaea				NSS3(Bb), Tier 2	G5	S2	Species of Concern (SOC)
Red Crossbill	Loxia curvirostra				NSS4(Bc), Tier 2	G5	S5BS5N	
Red-eyed Vireo	Vireo olivaceus				NSS4(Bc), Tier 2	G5	S3B	Species of Potential Concern (SOPC)
Red-headed Woodpecker	Melanerpes erythrocephalus				NSS4(Bc), Tier 2	G5	S3B	
Red-necked Phalarope	Phalaropus lobatus					G4G5	S3N	Species of Potential Concern (SOPC)
Ring-billed Gull	Larus delawarensis					G5	S2	Species of Potential Concern (SOPC)
Rose-breasted Grosbeak	Pheucticus ludovicianus					G5	S1	Species of Potential Concern (SOPC)
Sage Thrasher	Oreoscoptes montanus		Sensitive		NSS4(Bc), Tier 2	G5	S5	Species of Potential Concern (SOPC)
Sagebrush Sparrow	Artemisiospiza nevadensis		Sensitive	USFS-R2	NSS4(Bc), Tier 2	G5	S3	Species of Concern (SOC)
Sandhill Crane	Antigone canadensis					G5	S3BS5N	Species of Potential Concern (SOPC)
Short-eared Owl	Asio flammeus				NSS4(Bc), Tier 2	G5	S2	Species of Concern (SOC)
Snowy Plover	Charadrius nivosus				NSSU(U), Tier 3	G3	SNA	Species of Concern (SOC)
Swainson's Hawk	Buteo swainsoni				NSSU(U), Tier 2	G5	S4B	
Townsend's Warbler	Setophaga townsendi					G5	SNA	Species of Potential Concern (SOPC)
Trumpeter Swan	Cygnus buccinator	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS2(Ba), Tier 2	G4	S3BS3N	Species of Concern (SOC)
Tundra Swan	Cygnus columbianus					G5	S2N	Species of Potential Concern (SOPC)
Upland Sandpiper	Bartramia longicauda				NSSU(U), Tier 2	G5	S3B	
Virginia's Warbler	Oreothlypis virginiae				NSSU(U), Tier 2	G5	S1	Species of Concern (SOC)
Western Grebe	Aechmophorus occidentalis				NSSU(U), Tier 2	G5	S4B	
White-faced Ibis	Plegadis chihi		Sensitive		NSS3(Bb), Tier 2	G5	S1B	Species of Concern (SOC)
White-winged Crossbill	Loxia leucoptera					G5	S2	Species of Potential Concern (SOPC)
Williamson's Sapsucker	Sphyrapicus thyroideus				NSS3(Bb), Tier 2	G5	S2	Species of Concern (SOC)
Yellow-billed Cuckoo	Coccyzus americanus		Sensitive	USFS-R2, USFS-R4	NSSU(U), Tier 2	G5	S1	Species of Concern (SOC)

Wyoming Natural Diversity Database: Wildlife Species of Concern in the Bitter Creek Watershed								
Common Name	Scientific Name	USFWS Listing Status	WYBLM Sensitive Species	USFS Sensitive Species	WGFD Native Species Status	Global Heritage Rank	State Heritage Rank	WYNDD Status
Fish								
Bigmouth Shiner	Notropis dorsalis				NSS4(Cb), Tier 3	G5	S5	
Brassy Minnow	Hybognathus hankinsoni				NSS4(Bc), Tier 3	G5	S5	
Common Shiner	Luxilus cornutus				NSS4(Bc), Tier 3	G5	S3S4	Species of Potential Concern (SOPC)
Hornyhead Chub	Nocomis biguttatus		Sensitive	USFS-R2	NSS1(Aa), Tier 1	G5	S1	Species of Concern (SOC)
Iowa Darter	Etheostoma exile				NSS3(Bb), Tier 2	G5	S3S4	Species of Potential Concern (SOPC)
Northern Plains Killifish	Fundulus kansae				NSS3(Bb), Tier 2	G5	S5	
Orangethroat Darter	Etheostoma spectabile				NSS3(Bb), Tier 2	G5	S1	Species of Concern (SOC)
Plains Topminnow	Fundulus sciadicus	Not Warranted for Listing (NW)		USFS-R2	NSS3(Bb), Tier 2	G4	S3?	Species of Potential Concern (SOPC)
Suckermouth Minnow	Phenacobius mirabilis				NSS2(Ab), Tier 2	G5	S2	Species of Concern (SOC)
Mammal								
Bighorn Sheep	Ovis canadensis			USFS-R2, USFS-R4	NSS4(Bc), Tier 2	G4	S3S4	Species of Potential Concern (SOPC)
Black-footed Ferret	Mustela nigripes	Endangered - Nonessential Experimental Population (LEXN)			NSS1(Aa), Tier 1	G1	S1	Species of Concern (SOC)
Black-tailed Prairie Dog	Cynomys ludovicianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb), Tier 2	G4	S2	Species of Concern (SOC)
Bobcat	Lynx rufus	Not Warranted for Listing (NW)				G5	S5	
Dwarf Shrew	Sorex nanus				NSS3(Bb), Tier 2	G4	S4	Species of Potential Concern (SOPC)
Eastern Cottontail	Sylvilagus floridanus					G5	S3	Species of Potential Concern (SOPC)
Eastern Red Bat	Lasiurus borealis				NSS4(Bc), Tier 3	G5	SNA	
Eastern Spotted Skunk	Spilogale putorius				NSS3(Bb), Tier 2	G4	S3	Species of Potential Concern (SOPC)
Fringed Myotis	Myotis thysanodes		Sensitive	USFS-R2	NSS3(Bb), Tier 2	G4	S2	Species of Concern (SOC)
Gray Wolf	Canis lupus	Delisted, formally monitored (DM)		USFS-R4		G4G5	S1	Species of Concern (SOC)
Hispid Pocket Mouse	Chaetodipus hispidus				NSSU(U), Tier 3	G5	S2	
Hoary Bat	Lasiurus cinereus			USFS-R2		G5	S4	Species of Potential Concern (SOPC)
Little Brown Myotis	Myotis lucifugus	Petition Under Review (UR)			NSS3(Bb), Tier 2	G3	S3	Species of Potential Concern (SOPC)
Long-eared Myotis	Myotis evotis		Sensitive		NSS4(Cb), Tier 3	G5	S4	Species of Potential Concern (SOPC)
Long-legged Myotis	Myotis volans				NSS4(Cb), Tier 3	G5	S3B	Species of Potential Concern (SOPC)
Pallid Bat	Antrozous pallidus				NSS3(Bb), Tier 2	G5	S1	Species of Concern (SOC)
Plains Spotted Skunk	Spilogale putorius interrupta	Petition Under Review (UR)			NSS3(Bb), Tier 2	G4T4	S3	Species of Potential Concern (SOPC)
Preble's Meadow Jumping Mouse	Zapus hudsonius preblei	Listed Threatened (LT)	Sensitive		NSS3(Bb), Tier 2	G5T2	S1	Species of Concern (SOC)
Silver-haired Bat	Lasionycteris noctivagans					G5	S3B	Species of Potential Concern (SOPC)
Spotted Ground Squirrel	Xerospermophilus spilosoma				NSS4(Bc), Tier 3	G5	S3	
Swift Fox	Vulpes velox	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb), Tier 2	G3	S2	Species of Concern (SOC)
Thirteen-lined Ground Squirrel	Ictidomys tridecemlineatus					G5	S5	Species of Concern (SOC)
Townsend's Big-eared Bat	Corynorhinus townsendii		Sensitive	USFS-R2, USFS-R4	NSS3(Bb), Tier 2	G3G4	S2	Species of Concern (SOC)
Western Small-footed Myotis	Myotis ciliolabrum				NSS4(Cb), Tier 2	G5	S3B	Species of Potential Concern (SOPC)
White-tailed Prairie Dog	Cynomys leucurus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb), Tier 2	G4	S3	Species of Concern (SOC)
Wyoming Ground Squirrel	Urocitellus elegans					G5	S3S4	Species of Potential Concern (SOPC)
Mollusk								
Ash Gyro	Gyraulus parvus				NSSU(U), Tier 3	G5	S4	Species of Concern (SOC)
Creeping Ancylid	Ferrissia rivularis				NSSU(U), Tier 3	G5Q	S4	Species of Concern (SOC)
Cylindrical Papershell	Anodontoides ferussacianus				NSS2(Ab), Tier 2	G5	S3	Species of Concern (SOC)
Indecisive Vallonia	Vallonia albula				NSSU(U), Tier 2	G4Q	SNR	Species of Concern (SOC)

Wyoming Natural Diversity Database: Wildlife Species of Concern in the Bitter Creek Watershed								
Common Name	**Scientific Name**	**USFWS Listing Status**	**WYBLM Sensitive Species**	**USFS Sensitive Species**	**WGFD Native Species Status**	**Global Heritage Rank**	**State Heritage Rank**	**WYNDD Status**
Pewter Physa	Physa acuta				NSSU(U), Tier 3	G5Q	S4	Species of Concern (SOC)
Plain Pocketbook	Lampsilis cardium				NSS1(Aa), Tier 1	G5	S3	Species of Concern (SOC)
Tadpole Physa	Physa gyrina				NSSU(U), Tier 3	G5	S4	Species of Concern (SOC)
Reptile								
Bullsnake	Pituophis catenifer sayi					G5T5	S4	Species of Potential Concern (SOPC)
Eastern Spiny Softshell	Apalone spinifera spinifera				NSS2(Ba), Tier 2	G5T5	S4	Species of Potential Concern (SOPC)
Eastern Yellow-bellied Racer	Coluber constrictor flaviventris					G5T5	S4	Species of Potential Concern (SOPC)
Great Plains Earless Lizard	Holbrookia maculata maculata				NSSU(U), Tier 3	G5TNR	S2	Species of Concern (SOC)
Greater Short-horned Lizard	Phrynosoma hernandesi				NSS4(Bc), Tier 2	G5	S4	
Northern Many-lined Skink	Plestiodon multivirgatus multivirgatus				NSSU(U), Tier 2	G5T5	S1	Species of Concern (SOC)
Plains Black-headed Snake	Tantilla nigriceps				NSSU(U), Tier 3	G5	SNR	Species of Concern (SOC)
Plains Gartersnake	Thamnophis radix				NSSU(U), Tier 3	G5	S5	Species of Potential Concern (SOPC)
Plains Hog-nosed Snake	Heterodon nasicus				NSSU(U), Tier 2	G5	S4	
Plateau Fence Lizard	Sceloporus tristichus				NSS4(Bc), Tier 3	G5	S1	Species of Concern (SOC)
Prairie Lizard	Sceloporus consobrinus				NSSU(U), Tier 2	G5	S1	Species of Concern (SOC)
Prairie Racerunner	Aspidoscelis sexlineata viridis				NSSU(U), Tier 2	G5T5	S2	Species of Concern (SOC)
Prairie Rattlesnake	Crotalus viridis				NSS4(Bc), Tier 3	G5	S5	
Smooth Greensnake	Opheodrys vernalis				NSS3(Bb), Tier 2	G5	S2	Species of Concern (SOC)
Valley Gartersnake	Thamnophis sirtalis fitchi				NSSU(U), Tier 3	G5TNR	S2	Species of Potential Concern (SOPC)
Western Milksnake	Lampropeltis gentilis				NSS3(Bb), Tier 2	G5	S3	Species of Potential Concern (SOPC)
Western Painted Turtle	Chrysemys picta bellii				NSS4(Bc), Tier 3	G5T5	S4	

APPENDIX 4F

STOCK RESERVOIR EVALUATION

ACE ID	mprovement Typ	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
1	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.320	-105.64	North Laramie River-Bar M Creek	DEER CREEK	027N	073W	7
2	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.329	-105.6342	North Laramie River-Bar M Creek	DEER CREEK	027N	073W	7
3	Reservoir	ACE	Unknown	breached	No	Non-Functional	Private	42.327	-105.6319	North Laramie River-Bar M Creek	DEER CREEK	027N	073W	8
4	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.306	-105.7081	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	15
5	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	Forest Service	42.291	-105.6617	North Laramie River-Bar M Creek	WINDY MOUNTAIN	027N	074W	24
6	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.299	-105.6392	North Laramie River-Bar M Creek	WINDY MOUNTAIN	027N	073W	19
7	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.281	-105.6597	North Laramie River-Bar M Creek	BAR M	027N	074W	25
8	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.280	-105.7128	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	28
9	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.289	-105.7162	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	28
10	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.269	-105.7257	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	33
11	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.262	-105.7214	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	33
12	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.266	-105.7045	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	34
13	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.262	-105.4888	Bear Creek-North Laramie River	EAGLE PEAK	027N	072W	33
14	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.263	-105.4889	Bear Creek-North Laramie River	EAGLE PEAK	027N	072W	33
15	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.246	-105.4629	Bear Creek-North Laramie River	LARAMIE PEAK	026N	072W	10
16	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.246	-105.4631	Bear Creek-North Laramie River	LARAMIE PEAK	026N	072W	10
17	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.257	-105.4922	Bear Creek-North Laramie River	EAGLE PEAK	026N	072W	4
18	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.254	-105.4882	Bear Creek-North Laramie River	EAGLE PEAK	026N	072W	4
19	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.245	-105.7225	North Laramie River-Bar M Creek	BAR M MOUNTAIN	026N	074W	9
20	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.270	-105.2381	Fish Creek-North Laramie River	Not in Allotment	027N	070W	34
21	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.258	-105.2824	Fish Creek-North Laramie River	Not in Allotment	026N	070W	6
22	Reservoir	ACE	Unknown	Dry in 2012, 2017 wet in 2015.No visible defects	Potential	Potential	Private	42.250	-105.2469	Fish Creek-North Laramie River	Not in Allotment	026N	070W	4
23	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	42.248	-105.196	Fish Creek-North Laramie River	DAYLE BUTNER	026N	070W	12
24	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.248	-105.0711	Fish Creek-North Laramie River	Not in Allotment	026N	069W	12
25	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.248	-105.0693	Fish Creek-North Laramie River	Not in Allotment	026N	069W	12
26	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.235	-105.0976	Fish Creek-North Laramie River	FISH CREEK	026N	069W	11
27	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.242	-105.2178	Fish Creek-North Laramie River	Not in Allotment	026N	070W	11
28	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.246	-105.2424	Fish Creek-North Laramie River	Not in Allotment	026N	070W	9
29	Reservoir	ACE	Unknown	Dry in 2012, 2017, wet in 2015.No visible defects	Potential	Potential	Private	42.234	-105.2737	Fish Creek-North Laramie River	Not in Allotment	026N	070W	8
30	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.236	-105.2886	Fish Creek-North Laramie River	Not in Allotment	026N	070W	7
31	Reservoir	ACE	Unknown	dry in 2012, 2015, 2017 potential breach on west side	No	Non-Functional	State	42.225	-104.9023	Dwery Cemetary	Not in Allotment	026N	067W	16
32	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	42.225	-104.9287	Dwery Cemetary	Not in Allotment	026N	067W	18
33	Reservoir	ACE	Unknown	dry in 2012, 2015, 2017, breach on south side, erosion evident	No	Non-Functional	Private	42.226	-104.9508	Dwery Cemetary	Not in Allotment	026N	068W	13
34	Reservoir	ACE	Unknown	Dry in 2012, 2015, 2017.No visible defects	Potential	Potential	Private	42.215	-104.9947	Fish Creek-North Laramie River	Not in Allotment	026N	068W	22
35	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.214	-105.0701	Fish Creek-North Laramie River	MUD SPRINGS	026N	069W	24
36	Reservoir	ACE	Unknown	dry in all photography, possibly purposely breached on west side	No	Non-Functional	State	42.229	-105.0959	Fish Creek-North Laramie River	FISH CREEK	026N	069W	14
37	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.227	-105.1152	Fish Creek-North Laramie River	Not in Allotment	026N	069W	15
38	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.214	-105.1369	North Laramie River-Big Draw	Not in Allotment	026N	069W	21
39	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.213	-105.2077	North Laramie River-Owen Creek	Not in Allotment	026N	070W	23
40	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.232	-105.2914	Fish Creek-North Laramie River	Not in Allotment	026N	070W	18
41	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.215	-105.729	North Laramie River-Antelope Creek	ROGERS CREEK	026N	074W	21
42	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.180	-105.3991	North Laramie River-Owen Creek	Not in Allotment	026N	071W	31
43	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.186	-105.2142	North Laramie River-Owen Creek	RABBIT CREEK 3	026N	070W	35
44	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	42.181	-105.1933	North Laramie River-Owen Creek	RABBIT CREEK 3	026N	070W	36
45	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.193	-105.1533	North Laramie River-Big Draw	MITCHELL	026N	069W	29
46	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.191	-105.1272	North Laramie River-Big Draw	Not in Allotment	026N	069W	28
47	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.190	-105.1266	North Laramie River-Big Draw	Not in Allotment	026N	069W	33
48	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Department of Defense	42.180	-104.8538	Laramie River-Grayrocks Reservoir	GRAY ROCKS 4	026N	067W	35
49	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	42.183	-104.7187	Laramie River-Sixmile Creek	Not in Allotment	026N	066W	36
50	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.168	-104.7333	Laramie River-Grayrocks Reservoir	GRAY ROCKS	025N	066W	2

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51	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.154	-105.0393	North Laramie River-Big Draw	Not in Allotment	025N	068W	8
52	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.154	-105.0342	North Laramie River-Big Draw	Not in Allotment	025N	068W	8
53	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.154	-105.1252	North Laramie River-Big Draw	DRY LARAMIE RIVER	025N	069W	9
54	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.152	-105.0992	North Laramie River-Big Draw	Not in Allotment	025N	069W	11
55	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.151	-105.0964	North Laramie River-Big Draw	Not in Allotment	025N	069W	11
56	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.152	-105.081	North Laramie River-Big Draw	Not in Allotment	025N	069W	12
57	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.173	-105.247	North Laramie River-Owen Creek	PROSSER	025N	070W	4
58	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.151	-105.2681	North Laramie River-Owen Creek	PROSSER	025N	070W	8
59	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.153	-105.2568	North Laramie River-Owen Creek	PROSSER	025N	070W	9
60	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.148	-105.2659	Dry Laramie River	PROSSER	025N	070W	8
61	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.148	-105.3475	North Laramie River-Owen Creek	Not in Allotment	025N	071W	10
62	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.146	-105.3448	North Laramie River-Owen Creek	Not in Allotment	025N	071W	15
63	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.150	-105.3361	North Laramie River-Owen Creek	Not in Allotment	025N	071W	11
64	Reservoir	ACE	Unknown	Dry in 2012, 2015, 2017.No visible defects	Potential	Potential	Private	42.124	-105.7538	Twentytwo Mile Draw	TWENTYTWO MILE	025N	074W	19
65	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.123	-105.7502	Twentytwo Mile Draw	TWENTYTWO MILE	025N	074W	20
66	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.139	-105.3921	Sturgeon Creek	MERRIL DRAW	025N	071W	17
67	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.131	-105.406	Sturgeon Creek	MERRIL DRAW	025N	071W	19
68	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.126	-105.3775	North Laramie River-Owen Creek	Not in Allotment	025N	071W	21
69	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.142	-105.3381	North Laramie River-Owen Creek	Not in Allotment	025N	071W	14
70	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.143	-105.2706	Dry Laramie River	PROSSER	025N	070W	17
71	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.136	-105.2795	Dry Laramie River	PROSSER	025N	070W	17
72	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.145	-105.2126	Dry Laramie River	PROSSER	025N	070W	14
73	Reservoir	ACE	Unknown	Dry in 2012 and 2017, wet in 2015.No visible defects	Potential	Potential	Private	42.120	-105.2146	Dry Laramie River	PROSSER	025N	070W	23
74	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	42.118	-105.1972	Dry Laramie River	PROSSER	025N	070W	24
75	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.142	-105.1488	Dry Laramie River	Not in Allotment	025N	069W	17
76	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	42.135	-105.1378	Dry Laramie River	Not in Allotment	025N	069W	16
77	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.145	-105.0505	North Laramie River-Big Draw	Not in Allotment	025N	068W	18
78	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.129	-104.9765	Laramie River-Laramie River Ditch	Not in Allotment	025N	068W	23
79	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.132	-104.9575	North Laramie River-Big Draw	Not in Allotment	025N	068W	24
80	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.102	-104.9009	Laramie River-Laramie River Ditch	Not in Allotment	025N	067W	33
81	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	Private	42.095	-104.9135	Laramie River-Laramie River Ditch	Not in Allotment	025N	067W	32
82	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.093	-104.9763	Laramie River-Laramie River Ditch	Not in Allotment	025N	068W	35
83	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.090	-104.9979	Laramie River-Laramie River Ditch	Not in Allotment	025N	068W	34
84	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.110	-105.0518	Laramie River-Laramie River Ditch	Not in Allotment	025N	068W	30
85	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.102	-105.139	Dry Laramie River	Not in Allotment	025N	069W	33
86	Reservoir	ACE	Unknown	Dry in 2012, 2015, wet in 2017.No visible defects	Potential	Potential	Private	42.110	-105.1421	Dry Laramie River	Not in Allotment	025N	069W	28
87	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.113	-105.1553	Dry Laramie River	Not in Allotment	025N	069W	29
88	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.113	-105.1759	Dry Laramie River	Not in Allotment	025N	069W	30
89	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.095	-105.2218	Dry Laramie River	MARBLE QUARRY SPRING	025N	070W	35
90	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.090	-105.2224	Dry Laramie River	MARBLE QUARRY SPRING	025N	070W	35
91	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	42.099	-105.4278	Sturgeon Creek	OWEN CREEK	025N	072W	36
92	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.089	-105.462	Sturgeon Creek	PALMER CANYON	025N	072W	34
93	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.104	-105.4567	Sturgeon Creek	N LARAMIE-N CR.	025N	072W	27
94	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.109	-105.4889	Sturgeon Creek	N LARAMIE-N CR.	025N	072W	28
95	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	42.088	-105.5385	North Laramie River-Cow Creek	ANTELOPE BASIN	024N	073W	1
96	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	42.091	-105.5573	North Laramie River-Cow Creek	SELLERS MTN.	025N	073W	35
97	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.108	-105.6917	Twentytwo Mile Draw	TWENTYMILE DRAW	025N	074W	27
98	Reservoir	ACE	Twenty Mile Reservoir	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.089	-105.7465	Twentytwo Mile Draw	TWENTYMILE DRAW	025N	074W	32
99	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017, Cows visible in 2015	Yes	Functional	Private	42.109	-105.8246	Twentytwo Mile Draw	BONE CREEK	025N	075W	27
100	Reservoir	ACE	Unknown	Breached	No	Non-Functional	Private	42.061	-105.749	Twentytwo Mile Draw	TWENTYMILE DRAW	024N	074W	7

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101	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2015	Yes	Functional	Private	42.067	-105.7423	Twentytwo Mile Draw	TWENTYMILE DRAW	024N	074W	7
102	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2015	Yes	Functional	Private	42.072	-105.7388	Twentytwo Mile Draw	TWENTYMILE DRAW	024N	074W	8
103	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.065	-105.7278	Twentytwo Mile Draw	TWENTYMILE DRAW	024N	074W	8
104	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2015	Yes	Functional	Private	42.073	-105.702	Pinto Creek	TWENTYMILE DRAW	024N	074W	9
105	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.085	-105.7082	Twentytwo Mile Draw	TWENTYMILE DRAW	024N	074W	4
106	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.082	-105.6252	North Laramie River-Cow Creek	SELLERS MTN.	024N	073W	5
107	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.076	-105.5367	North Laramie River-Cow Creek	ANTELOPE BASIN	024N	073W	1
108	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.081	-105.5232	North Laramie River-Cow Creek	WILLIAM GOODRICH	024N	072W	6
109	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	42.075	-105.4651	Sturgeon Creek	PALMER CANYON	024N	072W	10
110	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.067	-105.3842	Lower Duck Creek-Dry Laramie River	Not in Allotment	024N	071W	8
111	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.077	-105.3692	Laramie River-Luman Creek	Not in Allotment	024N	071W	5
112	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.069	-105.1778	Laramie River-Marble Query Spring	Not in Allotment	024N	070W	12
113	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	42.082	-105.1998	Laramie River-Marble Query Spring	MARBLE QUARRY SPRING	024N	070W	2
114	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.065	-105.103	Laramie River-Marble Query Spring	PROSSER	024N	069W	10
115	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017. Unknown Uses due to private property, labeled potential	Potential	Potential	Private	42.082	-105.0469	Laramie River-Laramie River Ditch	Not in Allotment	024N	068W	6
116	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017. Unknown Uses due to private property, labeled potential	Potential	Potential	Private	42.080	-105.0467	Laramie River-Laramie River Ditch	Not in Allotment	024N	068W	6
117	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017. Unknown Uses due to private property, labeled potential	Potential	Potential	Private	42.077	-105.0479	Laramie River-Laramie River Ditch	Not in Allotment	024N	068W	6
118	Reservoir	ACE	Festo Lake	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.077	-104.9958	Wheatland Creek	Not in Allotment	024N	068W	3
119	Reservoir	ACE	Unknown	Wet in 2012, Dry in 2015, 2017. No visible defects	Potential	Potential	Private	42.071	-104.7425	Eagles Nest Canyon	Not in Allotment	024N	066W	11
120	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.050	-104.8052	Eagles Nest Canyon	EAGLE NEST CANYON	024N	066W	17
121	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	Private	42.036	-104.945	Wheatland Creek	Not in Allotment	024N	068W	24
122	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	42.034	-105.1303	Laramie River-Marble Query Spring	LARAMIE RIVER 3	024N	069W	21
123	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.035	-105.1776	Laramie River-Luman Creek	Not in Allotment	024N	070W	24
124	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.035	-105.1749	Laramie River-Luman Creek	Not in Allotment	024N	069W	19
125	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.050	-105.2225	Laramie River-Luman Creek	LUMAN CREEK	024N	070W	15
126	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	42.051	-105.2098	Laramie River-Luman Creek	LUMAN CREEK	024N	070W	14
127	Reservoir	ACE	Unknown	Dry in 2012, 2017 wet in 2015. no visible defects	Potential	Potential	State	42.049	-105.2418	Laramie River-Luman Creek	CANYON CREEK	024N	070W	16
128	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.030	-105.3572	Cherry Creek	Not in Allotment	024N	071W	28
129	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.053	-105.4911	Upper Duck Creek-Lower Duck Creek	ANTELOPE BASIN	024N	072W	17
130	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.038	-105.6995	Pinto Creek	PINTO CREEK	024N	074W	22
131	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.045	-105.7491	Twentytwo Mile Draw	ELK HORN	024N	074W	19
132	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.038	-105.7813	Twentytwo Mile Draw	ELK HORN	024N	075W	23
133	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.031	-105.8032	Twentytwo Mile Draw	MUD SPRINGS	024N	075W	27
134	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.025	-105.6971	Pinto Creek	PINTO CREEK	024N	074W	27
135	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.023	-105.6832	Pinto Creek	PINTO CREEK	024N	074W	27
136	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.021	-105.6765	Pinto Creek	PINTO CREEK	024N	074W	26
137	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.022	-105.6874	Pinto Creek	PINTO CREEK	024N	074W	27
138	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	42.014	-105.6456	Upper Duck Creek-Lower Duck Creek	DODGE CREEK RANCH	024N	074W	36
139	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.018	-105.6364	Upper Duck Creek-Lower Duck Creek	PINTO ROCKS	024N	073W	30
140	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.012	-105.5005	Upper Duck Creek-Lower Duck Creek	Not in Allotment	024N	072W	32
141	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	42.014	-105.252	Laramie River-Slate Creek	PARADISE CREEK	024N	070W	33
142	Reservoir	ACE	Unknown	breached on north side	No	Non-Functional	Private	42.023	-105.2455	Laramie River-Slate Creek	PARADISE CREEK	024N	070W	28
143	Reservoir	ACE	Unknown	breached between 2012 and 2015	No	Non-Functional	Private	42.015	-105.2251	Laramie River-Slate Creek	PARADISE CREEK	024N	070W	34
144	Reservoir	ACE	Unknown	breached between 2012 and 2015	No	Non-Functional	Private	42.017	-105.2288	Laramie River-Slate Creek	PARADISE CREEK	024N	070W	27
145	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.010	-105.23	Laramie River-Slate Creek	PARADISE CREEK	024N	070W	34
146	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	42.024	-105.2114	Laramie River-Slate Creek	MERTZ DITCH 2	024N	070W	26
147	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.004	-105.2095	Laramie River-Slate Creek	PARADISE CREEK	024N	070W	35
148	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.024	-104.9006	Chugwater Creek-Antelope Road	Not in Allotment	024N	067W	28
149	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.983	-104.8464	Chug Spring	Not in Allotment	023N	067W	12
150	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.996	-105.1737	Laramie River-Luman Creek	LARAMIE RIVER 4	023N	069W	6

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151	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	41.981	-105.1869	Laramie River-Luman Creek	COONEY HILLS	023N	070W	12
152	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.990	-105.216	Laramie River-Slate Creek	Not in Allotment	023N	070W	3
153	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.990	-105.2277	Laramie River-Slate Creek	Not in Allotment	023N	070W	3
154	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.982	-105.257	Laramie River-Slate Creek	LARAMIE RIVER 2	023N	070W	8
155	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.982	-105.4874	Laramie River-Dodge Creek	HOLMAN	023N	072W	8
156	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.974	-105.5093	Laramie River-Dodge Creek	Not in Allotment	023N	072W	18
157	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.976	-105.5389	Laramie River-Dodge Creek	Not in Allotment	023N	073W	12
158	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.990	-105.5403	Upper Duck Creek-Lower Duck Creek	Not in Allotment	023N	073W	12
159	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.998	-105.5801	Upper Duck Creek-Lower Duck Creek	PINTO ROCKS	023N	073W	3
160	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.954	-105.5639	Laramie River-Dodge Creek	Not in Allotment	023N	073W	23
161	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.968	-105.5593	Laramie River-Dodge Creek	Not in Allotment	023N	073W	14
162	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.960	-105.5396	Laramie River-Dodge Creek	Not in Allotment	023N	073W	24
163	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.949	-105.5381	Laramie River-Dodge Creek	Not in Allotment	023N	073W	24
164	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.958	-105.4655	Laramie River-Preemption Creek	Not in Allotment	023N	072W	22
165	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.966	-105.2217	Laramie River-Slate Creek	REED CREEK	023N	070W	15
166	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	41.948	-105.1948	Laramie River-Luman Creek	SQUAW MT.	023N	070W	24
167	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.968	-104.9565	Chugwater Creek-Dry Creek	Not in Allotment	023N	068W	13
168	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.932	-104.8923	Chugwater Creek-Dry Creek	Not in Allotment	023N	067W	28
169	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.937	-104.9552	Chugwater Creek-Dry Creek	DRY CREEK	023N	068W	25
170	Reservoir	ACE	Unknown	sediment	No	Non-Functional	Private	41.934	-105.0096	Wheatland Creek	Not in Allotment	023N	068W	28
171	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.943	-105.0348	Wheatland Creek	Not in Allotment	023N	068W	29
172	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.935	-105.0628	Brush Creek-Sybille Creek	Not in Allotment	023N	069W	25
173	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.928	-105.0959	Upper Sybille Creek	Not in Allotment	023N	069W	35
174	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	41.938	-105.1458	Upper Sybille Creek	JOHNSON	023N	069W	29
175	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.937	-105.1438	Upper Sybille Creek	JOHNSON	023N	069W	29
176	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.916	-105.1747	Upper Sybille Creek	SQUAW MT.	023N	069W	31
177	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	41.923	-105.1631	Upper Sybille Creek	SQUAW MT.	023N	069W	31
178	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	41.920	-105.2921	Upper Sybille Creek	CROSS C RANCH	023N	071W	36
179	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.920	-105.2876	Upper Sybille Creek	Not in Allotment	023N	070W	31
180	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.922	-105.2823	Upper Sybille Creek	Not in Allotment	023N	070W	31
181	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.914	-105.383	Lower Bluegrass Creek	WHEATLAND TUNNEL	022N	071W	5
182	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.924	-105.4242	Laramie River-Preemption Creek	WHEATLAND TUNNEL	023N	072W	36
183	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.940	-105.4423	Laramie River-Preemption Creek	GIBBS PLACE	023N	072W	26
184	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.941	-105.4402	Laramie River-Preemption Creek	GIBBS PLACE	023N	072W	26
185	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.917	-105.4738	Middle Bluegrass Creek	BULL CAMP PEAK	023N	072W	33
186	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.919	-105.49	Middle Bluegrass Creek	BULL CAMP PEAK	023N	072W	32
187	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	41.924	-105.5293	Laramie River-Dodge Creek	BULL CAMP PEAK	023N	073W	36
188	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.922	-105.525	Laramie River-Dodge Creek	BULL CAMP PEAK	023N	072W	31
189	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.917	-105.5174	Laramie River-Dodge Creek	BULL CAMP PEAK	023N	072W	31
190	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.924	-105.5434	Laramie River-Dodge Creek	BULL CAMP PEAK	023N	073W	36
191	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.926	-105.6054	Laramie River-Dodge Creek	BULL CAMP PEAK	023N	073W	33
192	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.837	-105.6558	Laramie River-Dodge Creek	WHEATLAND RES #2	022N	074W	36
193	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.888	-105.5113	Middle Bluegrass Creek	BULL CAMP PEAK	022N	072W	7
194	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.914	-105.4834	Middle Bluegrass Creek	BULL CAMP PEAK	022N	072W	4
195	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.909	-105.4724	Middle Bluegrass Creek	BULL CAMP PEAK	022N	072W	4
196	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.911	-105.3223	Lower Bluegrass Creek	CROSS C RANCH	022N	071W	2
197	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.913	-105.3246	Lower Bluegrass Creek	CROSS C RANCH	022N	071W	2
198	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.901	-105.2609	Upper Sybille Creek	SQUAW ROCK	022N	070W	5
199	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.904	-105.1735	Upper Sybille Creek	SQUAW MT.	022N	069W	6
200	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Bureau of Land Management	41.903	-105.1684	Upper Sybille Creek	SQUAW MT.	022N	069W	6

ACE ID	mprovement Typ	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
201	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.896	-105.0353	Brush Creek-Sybille Creek	Not in Allotment	022N	068W	8
202	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.914	-104.9764	Chugwater Creek-Dry Creek	Not in Allotment	022N	068W	2
203	Reservoir	ACE	Unknown	Wet in 2012, 2015	Yes	Functional	Private	41.894	-104.9753	Chugwater Creek-Dry Creek	SQUAW HILL	022N	068W	11
204	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.899	-104.8378	Chugwater Creek-Dry Creek	Not in Allotment	022N	067W	12
205	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.913	-104.8198	Chugwater Creek-Dry Creek	Not in Allotment	022N	066W	6
206	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.864	-104.9326	Hunton Creek	Not in Allotment	022N	067W	19
207	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.864	-104.967	Hunton Creek	SQUAW HILL	022N	068W	23
208	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.873	-104.9747	Hunton Creek	SQUAW HILL	022N	068W	14
209	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.881	-104.976	Hunton Creek	SQUAW HILL	022N	068W	14
210	Reservoir	ACE	Unknown	sediment	No	Non-Functional	Private	41.880	-105.0235	Brush Creek-Sybille Creek	Not in Allotment	022N	068W	17
211	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.884	-105.0465	Brush Creek-Sybille Creek	Not in Allotment	022N	068W	18
212	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.885	-105.059	Brush Creek-Sybille Creek	Not in Allotment	022N	068W	18
213	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.877	-105.0738	Brush Creek-Sybille Creek	Not in Allotment	022N	069W	13
214	Reservoir	ACE	Unknown	Wet in 2015, dry in 2012, 2017, no visible defects	Potential	Potential	Private	41.870	-105.3517	Lower Bluegrass Creek	HALLECK CANYON	022N	071W	21
215	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.857	-105.3779	Lower Bluegrass Creek	HALLECK CANYON	022N	071W	20
216	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.830	-105.5364	Middle Bluegrass Creek	BLUEGRASS	022N	073W	36
217	Reservoir	ACE	Unknown	Wet in 2015, dry in 2012, 2017. no visible defects	Potential	Potential	Private	41.846	-105.425	Middle Bluegrass Creek	BLUEGRASS	022N	072W	25
218	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.852	-105.242	Lower North Sybille Creek	RED MOUNTAIN	022N	070W	28
219	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.843	-105.0959	Brush Creek-Sybille Creek	Not in Allotment	022N	069W	35
220	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.848	-105.0739	Brush Creek-Sybille Creek	Not in Allotment	022N	069W	25
221	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	41.840	-105.0692	Brush Creek-Sybille Creek	NORTH RICHEAU HILLS	022N	069W	36
222	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.842	-105.0684	Brush Creek-Sybille Creek	NORTH RICHEAU HILLS	022N	069W	36
223	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.843	-105.0563	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	31
224	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.844	-105.0456	Hunton Creek	Not in Allotment	022N	068W	30
225	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.850	-105.041	Hunton Creek	Not in Allotment	022N	068W	30
226	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.849	-105.03	Hunton Creek	Not in Allotment	022N	068W	29
227	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.843	-105.0347	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	32
228	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.843	-105.046	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	31
229	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.844	-105.034	Hunton Creek	Not in Allotment	022N	068W	29
230	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.856	-105.0328	Hunton Creek	Not in Allotment	022N	068W	29
231	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.851	-105.0159	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	28
232	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.848	-105.0132	Hunton Creek	Not in Allotment	022N	068W	28
233	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.853	-105.0119	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	28
234	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.855	-105.0048	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	28
235	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.838	-105.0072	Lower Richeau Creek	Not in Allotment	022N	068W	33
236	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.831	-105.0089	Lower Richeau Creek	SQUAW HILL	022N	068W	33
237	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.829	-105.0055	Lower Richeau Creek	SQUAW HILL	022N	068W	33
238	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.853	-104.9977	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	27
239	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.848	-104.9947	Hunton Creek	NORTH RICHEAU HILLS	022N	068W	27
240	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.839	-104.993	Lower Richeau Creek	Not in Allotment	022N	068W	34
241	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.843	-104.985	Lower Richeau Creek	Not in Allotment	022N	068W	34
242	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.829	-104.9741	Lower Richeau Creek	Not in Allotment	022N	068W	35
243	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	State	41.840	-104.9608	Lower Richeau Creek	Not in Allotment	022N	068W	36
244	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.845	-104.954	Lower Richeau Creek	Not in Allotment	022N	068W	25
245	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.846	-104.9544	Lower Richeau Creek	Not in Allotment	022N	068W	25
246	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.845	-104.9385	Lower Richeau Creek	Not in Allotment	022N	067W	30
247	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.830	-104.8922	Lower Richeau Creek	Not in Allotment	022N	067W	33
248	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.842	-104.8845	Lower Richeau Creek	Not in Allotment	022N	067W	34
249	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.845	-104.8675	Chugwater Creek-Chugwater	Not in Allotment	022N	067W	27
250	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.835	-104.8661	Chugwater Creek-Chugwater	Not in Allotment	022N	067W	34

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251	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.845	-104.865	Chugwater Creek-Chugwater	CHUGWATER CREEK	022N	067W	26
252	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	State	41.835	-104.8426	Chugwater Creek-Chugwater	Not in Allotment	022N	067W	36
253	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.810	-104.8127	Chugwater Creek-Chugwater	Not in Allotment	021N	066W	7
254	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.802	-104.8732	Chugwater Creek-Chugwater	Not in Allotment	021N	067W	10
255	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.822	-104.8953	Lower Richeau Creek	Not in Allotment	021N	067W	4
256	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.819	-104.8969	Lower Richeau Creek	Not in Allotment	021N	067W	4
257	Reservoir	ACE	Unknown	breached	No	Non-Functional	Private	41.817	-104.9856	Upper Richeau Creek	RICHEAU HILLS	021N	068W	3
258	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.822	-105.1166	Brush Creek-Sybille Creek	BRUSH CREEK 2	021N	069W	3
259	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.808	-105.2315	Lower South Fork Sybille Creek	Not in Allotment	021N	070W	10
260	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.806	-105.548	Upper Bluegrass Creek	IRVINE JE AND GA	021N	073W	11
261	Reservoir	ACE	Unknown	sediment	No	Non-Functional	Private	41.809	-105.5891	Upper Bluegrass Creek	IRVINE JE AND GA	021N	073W	9
262	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.775	-105.5884	Upper Bluegrass Creek	IONE LAKE	021N	073W	21
263	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.782	-105.5786	Upper Bluegrass Creek	IONE LAKE	021N	073W	22
264	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.782	-105.5928	Upper Bluegrass Creek	IONE LAKE	021N	073W	21
265	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.794	-105.5774	Upper Bluegrass Creek	IONE LAKE	021N	073W	15
266	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.797	-105.5596	Upper Bluegrass Creek	SPRINGFIELD RANCH	021N	073W	14
267	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.781	-105.5045	Middle Bluegrass Creek	IONE LAKE	021N	072W	20
268	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.800	-105.4765	Middle Bluegrass Creek	Not in Allotment	021N	072W	16
269	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.778	-105.2711	Lower South Fork Sybille Creek	SYBILLE CR.	021N	070W	20
270	Reservoir	ACE	Unknown	Wet in 2012, 2015	Yes	Functional	Private	41.795	-105.2677	Lower South Fork Sybille Creek	PR5 RANCH	021N	070W	17
271	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.772	-105.107	Upper Richeau Creek	RICHEAU HILLS	021N	069W	22
272	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.794	-105.0367	Upper Richeau Creek	SQUAW HILL	021N	068W	17
273	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.787	-105.0318	Upper Richeau Creek	SQUAW HILL	021N	068W	17
274	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.779	-105.0137	Upper Richeau Creek	RICHEAU HILLS	021N	068W	21
275	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.789	-104.9921	Upper Richeau Creek	RICHEAU HILLS	021N	068W	15
276	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.786	-104.914	Lower Richeau Creek	Not in Allotment	021N	067W	17
277	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.797	-104.9081	Lower Richeau Creek	Not in Allotment	021N	067W	17
278	Reservoir	ACE	Unknown	Wet in 2012, Dry in 2015, 2017. No visible defects	Potential	Potential	Private	41.784	-104.8751	Chugwater Creek-Chugwater	Not in Allotment	021N	067W	22
279	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.783	-104.8796	Chugwater Creek-Chugwater	Not in Allotment	021N	067W	22
280	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.784	-104.883	Chugwater Creek-Chugwater	Not in Allotment	021N	067W	22
281	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.769	-104.9398	Lower Richeau Creek	Not in Allotment	021N	067W	30
282	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.749	-104.9422	Lower Richeau Creek	Not in Allotment	021N	067W	31
283	Reservoir	ACE	Unknown	Dry in 2012, 2015, 2017. Breach visible in ESRI World Clarity imagery	No	Non-Functional	Private	41.759	-104.9382	Lower Richeau Creek	Not in Allotment	021N	067W	30
284	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.740	-104.984	Upper Richeau Creek	RICHEAU HILLS	020N	068W	3
285	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.767	-105.0071	Upper Richeau Creek	RICHEAU HILLS	021N	068W	28
286	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.765	-104.9933	Upper Richeau Creek	RICHEAU HILLS	021N	068W	27
287	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.755	-104.9992	Upper Richeau Creek	RICHEAU HILLS	021N	068W	34
288	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.743	-105.001	Upper Richeau Creek	RICHEAU HILLS	021N	068W	34
289	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.742	-104.9979	Upper Richeau Creek	RICHEAU HILLS	021N	068W	34
290	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.742	-105.0122	Upper Richeau Creek	RICHEAU HILLS	021N	068W	33
291	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.742	-105.0398	Upper Richeau Creek	RICHEAU HILLS	021N	068W	32
292	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.741	-105.0352	Upper Richeau Creek	RICHEAU HILLS	021N	068W	32
293	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.743	-105.0319	Upper Richeau Creek	RICHEAU HILLS	021N	068W	32
294	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.753	-105.1027	Upper Richeau Creek	RICHEAU HILLS	021N	069W	34
295	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	State	41.746	-105.148	Deadhead Creek	MULE CREEK	021N	069W	32
296	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.750	-105.1237	Deadhead Creek	MULE CREEK	021N	069W	33
297	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.746	-105.1681	Deadhead Creek	MULE CREEK	021N	069W	31
298	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.766	-105.2449	Lower South Fork Sybille Creek	MULE CREEK	021N	070W	28
299	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.749	-105.5144	Upper Bluegrass Creek	PINE RIDGE	021N	072W	31
300	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.764	-105.5117	Upper Bluegrass Creek	IONE LAKE	021N	072W	30

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301	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.761	-105.519	Upper Bluegrass Creek	IONE LAKE	021N	072W	30
302	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.760	-105.5397	Upper Bluegrass Creek	IONE LAKE	021N	073W	25
303	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.747	-105.5408	Upper Bluegrass Creek	PINE RIDGE	021N	073W	36
304	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.753	-105.5455	Upper Bluegrass Creek	PINE RIDGE	021N	073W	35
305	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.743	-105.565	Upper Bluegrass Creek	PINE RIDGE	021N	073W	34
306	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.760	-105.576	Upper Bluegrass Creek	IONE LAKE	021N	073W	27
307	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.751	-105.5991	Upper Bluegrass Creek	PINE RIDGE	021N	073W	33
308	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.723	-105.5213	Upper North Sybille Creek	PINE RIDGE	020N	073W	12
309	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.736	-105.3076	Lower South Fork Sybille Creek	IRON MOUNTAIN CR.	020N	071W	2
310	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.731	-105.303	Lower South Fork Sybille Creek	IRON MOUNTAIN CR.	020N	071W	1
311	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.736	-105.2658	Lower South Fork Sybille Creek	MARTIN TRUST	020N	070W	5
312	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.740	-105.2622	Lower South Fork Sybille Creek	MARTIN TRUST	020N	070W	5
313	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.741	-105.2592	Lower South Fork Sybille Creek	MARTIN TRUST	020N	070W	5
314	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.721	-105.1201	Deadhead Creek	RICHEAU HILLS	020N	069W	9
315	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.738	-105.0831	Upper Richeau Creek	RICHEAU HILLS	020N	069W	2
316	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.730	-105.085	Upper Richeau Creek	RICHEAU HILLS	020N	069W	2
317	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.717	-105.0743	Upper Richeau Creek	RICHEAU HILLS	020N	069W	12
318	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.729	-105.0238	Upper Richeau Creek	RICHEAU HILLS	020N	068W	5
319	Reservoir	ACE	Unknown	Wet in 2012, 2015	Yes	Functional	Private	41.731	-104.9703	Lower Richeau Creek	Not in Allotment	020N	068W	2
320	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.741	-104.9426	Lower Richeau Creek	Not in Allotment	020N	068W	1
321	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.706	-104.998	Chugwater Creek-Dry Creek-Laramie River	Not in Allotment	020N	068W	15
322	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.702	-105.0107	Chugwater Creek-Dry Creek-Laramie River	RICHEAU HILLS	020N	068W	16
323	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.703	-105.0018	Chugwater Creek-Dry Creek-Laramie River	RICHEAU HILLS	020N	068W	16
324	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.695	-104.9991	Chugwater Creek-Dry Creek-Laramie River	RICHEAU HILLS	020N	068W	22
325	Reservoir	ACE	Unknown	Wet in 2012, 2015	Yes	Functional	Private	41.703	-105.0438	Upper Richeau Creek	RICHEAU HILLS	020N	068W	18
326	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.711	-105.1456	Deadhead Creek	CHUGWATER	020N	069W	17
327	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.712	-105.126	Deadhead Creek	Not in Allotment	020N	069W	16
328	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.692	-105.1423	Chugwater Creek-North Chugwater Creek	CHUGWATER	020N	069W	20
329	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.693	-105.234	Mule Creek-Sybille Creek	CHUGWATER	020N	070W	21
330	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.702	-105.2549	Mule Creek-Sybille Creek	CHUGWATER	020N	070W	17
331	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.700	-105.2986	Lower South Fork Sybille Creek	SYBILLE SCHOOL	020N	071W	13
332	Reservoir	ACE	Unknown	Wet in 2017, built between 2015 and 2017	Yes	Functional	Private	41.688	-105.4063	Middle Sybille Creek	Not in Allotment	020N	072W	24
333	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.660	-105.4567	Upper North Sybille Creek	PLUMBAGO CANYON	020N	072W	34
334	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.670	-105.4008	Middle Sybille Creek	Not in Allotment	020N	071W	31
335	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.672	-105.3746	Upper South Fork Sybille Creek	Not in Allotment	020N	071W	29
336	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.675	-105.3347	Upper South Fork Sybille Creek	TIMBER CANYON	020N	071W	27
337	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.657	-105.2507	Chugwater Creek-Threemile Creek	SPRING CREEK	020N	070W	32
338	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.661	-105.2473	Chugwater Creek-Threemile Creek	SPRING CREEK	020N	070W	33
339	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.676	-105.2329	Chugwater Creek-North Chugwater Creek	CHUGWATER	020N	070W	28
340	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.681	-105.1963	Chugwater Creek-North Chugwater Creek	CHUGWATER	020N	070W	26
341	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.678	-105.1183	Chugwater Creek-North Chugwater Creek	Not in Allotment	020N	069W	28
342	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.662	-105.1256	Chugwater Creek-Threemile Creek	Not in Allotment	020N	069W	33
343	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.669	-105.1103	Chugwater Creek-North Chugwater Creek	Not in Allotment	020N	069W	34
344	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	State	41.677	-104.9596	Chugwater Creek-Dry Creek-Laramie River	RICHEAU HILLS	020N	068W	25
345	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	State	41.677	-104.9577	Chugwater Creek-Dry Creek-Laramie River	RICHEAU HILLS	020N	068W	25
346	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.627	-104.9694	Chugwater Creek-Dry Creek-Laramie River	Not in Allotment	019N	068W	11
347	Reservoir	ACE	Unknown	Dry in 2012, 2015, 2017. No visible defects	Potential	Potential	Private	41.640	-104.9687	Chugwater Creek-Dry Creek-Laramie River	Not in Allotment	019N	068W	11
348	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.645	-105.0388	Chugwater Creek-North Chugwater Creek	Not in Allotment	019N	068W	6
349	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.653	-105.0592	Chugwater Creek-North Chugwater Creek	Not in Allotment	019N	069W	1
350	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.644	-105.1482	Chugwater Creek-Threemile Creek	Not in Allotment	019N	069W	5

ACE ID	mprovement Typ	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
351	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.648	-105.2465	Chugwater Creek-Threemile Creek	THREEMILE	019N	070W	4
352	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.655	-105.2484	Chugwater Creek-Threemile Creek	SPRING CREEK	019N	070W	4
353	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.642	-105.3166	Upper South Fork Sybille Creek	TIMBER CANYON	019N	071W	2
354	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.633	-105.3182	Upper South Fork Sybille Creek	TIMBER CANYON	019N	071W	11
355	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.645	-105.3442	Upper South Fork Sybille Creek	TIMBER CANYON	019N	071W	3
356	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.646	-105.3651	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	5
357	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.630	-105.3678	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	8
358	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.627	-105.3666	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	17
359	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.626	-105.3619	Upper Middle Chugwater Creek	Not in Allotment	019N	071W	16
360	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.628	-105.3633	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	9
361	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.629	-105.392	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	7
362	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.640	-105.3822	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	8
363	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.640	-105.3792	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	8
364	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.603	-105.4184	Upper Middle Chugwater Creek	Not in Allotment	019N	072W	24
365	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.618	-105.4184	Upper Middle Chugwater Creek	PLUMBAGO CANYON	019N	072W	13
366	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.626	-105.349	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	16
367	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	State	41.627	-105.3468	Upper South Fork Sybille Creek	Not in Allotment	019N	071W	16
368	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.611	-105.296	Lower Middle Chugwater Creek	IRON MOUNTAIN	019N	071W	24
369	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	State	41.608	-105.096	Chugwater Creek-Threemile Creek	Not in Allotment	019N	069W	22
370	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017. No visible defects	Potential	Potential	Private	41.623	-104.981	Chugwater Creek-Dry Creek-Laramie River	Not in Allotment	019N	068W	15
371	Reservoir	ACE	Unknown	Wet in 2012, 2017	Yes	Functional	Private	41.589	-105.0833	Chugwater Creek-North Chugwater Creek	Not in Allotment	019N	069W	26
372	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.584	-105.356	Upper Middle Chugwater Creek	IRON MOUNTAIN	019N	071W	33
373	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.584	-105.3564	Upper Middle Chugwater Creek	IRON MOUNTAIN	019N	071W	33
374	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.591	-105.4193	Upper Middle Chugwater Creek	Not in Allotment	019N	072W	25
375	Reservoir	ACE	Unknown	Wet in 2015, 2017	Yes	Functional	Private	41.595	-105.411	Upper Middle Chugwater Creek	Not in Allotment	019N	072W	25
376	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.578	-105.4386	Upper Middle Chugwater Creek	THE BUTTES	019N	072W	35
377	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.591	-105.3596	Upper Middle Chugwater Creek	IRON MOUNTAIN	019N	071W	28
378	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.559	-105.437	Upper Middle Chugwater Creek	THE BUTTES	018N	072W	2
379	Reservoir	ACE	Unknown	Wet in 2015, Dry in 2012, 2017, No visible defects	Potential	Potential	Private	41.550	-105.2696	Lower South Chugwater Creek	Not in Allotment	018N	070W	7
380	Reservoir	ACE	Unknown	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.465	-105.4571	Upper South Chugwater Creek	Not in Allotment	017N	072W	10
381	Reservoir	BLM	Prosser Res	BLM Project Number 960702. Dry in 2012, 2017, wet in 2015. No visible defects	Potential	Potential	Bureau of Land Management	42.074	-105.1513	Laramie River-Marble Query Spring	MARBLE QUARRY SPRING	024N	069W	8
382	Reservoir	BLM	Mylett Res	BLM Project Number 961057, Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.876	-104.9983	Hunton Creek	HUNTON CREEK	022N	068W	15
383	Reservoir	BLM	Mylet Res	BLM Project Number 961113, sediment	No	Non-Functional	Bureau of Land Management	41.885	-104.9846	Hunton Creek	HUNTON CREEK	022N	068W	15
384	Reservoir	BLM	Rosenstreter Res	BLM Project Number 961172, Wet in 2012, 2015	Yes	Functional	Bureau of Land Management	41.767	-105.127	Deadhead Creek	MULE CREEK	021N	069W	28
385	Reservoir	BLM	Rosenstreter Res	BLM Project Number 961172, Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.773	-105.1312	Deadhead Creek	MULE CREEK	021N	069W	21
386	Reservoir	BLM	Preasit Dam	BLM Project Number 961769, no visible reservoir	No	Non-Functional	Bureau of Land Management	42.103	-104.8284	Laramie River-Grayrocks Reservoir	GRAY ROCKS 2	025N	066W	31
387	Reservoir	BLM	Ronentreter Res	BLM Project Number 964789, sediment	No	Non-Functional	Bureau of Land Management	41.741	-105.1468	Deadhead Creek	MULE CREEK	020N	069W	5
388	Reservoir	BLM	Miller Reservoirs	BLM Project Number 964803, Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.726	-105.1533	Deadhead Creek	CHUGWATER	020N	069W	8
389	Reservoir	BLM	Miller Reservoirs	BLM Project Number 964803, No visible reservoir	No	Non-Functional	Bureau of Land Management	41.727	-105.1422	Deadhead Creek	CHUGWATER	020N	069W	8
390	Reservoir	BLM	Miller Reservoirs	BLM Project Number 964803, No visible reservoir	No	Non-Functional	Bureau of Land Management	41.728	-105.137	Deadhead Creek	CHUGWATER	020N	069W	8
391	Reservoir	BLM	Miller Reservoirs	BLM Project Number 964803, No visible reservoir	No	Non-Functional	Bureau of Land Management	41.728	-105.1383	Deadhead Creek	CHUGWATER	020N	069W	8
392	Reservoir	BLM	Miller Reservoirs	BLM Project Number 964803, no visible reservoir	No	Non-Functional	Bureau of Land Management	41.722	-105.1389	Deadhead Creek	CHUGWATER	020N	069W	8
393	Reservoir	BLM	Miller Reservoirs	BLM Project Number 964803, no visible reservoir	No	Non-Functional	Bureau of Land Management	41.723	-105.1352	Deadhead Creek	CHUGWATER	020N	069W	8
394	Reservoir	BLM	Miller Res	BLM Project Number 964806, no visible reservoir	No	Non-Functional	Bureau of Land Management	41.706	-105.2578	Mule Creek-Sybille Creek	CHUGWATER	020N	070W	17
395	Reservoir	BLM	Miller Res	No visible reservoir. BLM Project Number 964808	No	Non-Functional	Bureau of Land Management	41.763	-105.1828	Deadhead Creek	CHUGWATER	021N	070W	25
396	Reservoir	SEO	ENLARGED WYOMING DEVELOPMENT COMPANY NO ONE RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.000	-105.0452	Lower Sybille Creek	Not in Allotment	023N	068W	6
397	Reservoir	SEO	STRONG NO. 2 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.582	-105.4672	Upper Middle Chugwater Creek	Not in Allotment	019N	072W	33
398	Reservoir	SEO	BLISS NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.559	-105.4455	Upper Middle Chugwater Creek	THE BUTTES	018N	072W	3
399	Reservoir	SEO	STRONG NO 4 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.606	-105.3982	Upper Middle Chugwater Creek	Not in Allotment	019N	071W	19
400	Reservoir	SEO	BELL RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.574	-105.293	Lower Middle Chugwater Creek	IRON MOUNTAIN	019N	071W	36

ACE ID	mprovement Typ	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
401	Reservoir	SEO	ENO RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.619	-105.4389	Upper Middle Chugwater Creek	PLUMBAGO CANYON	019N	072W	14
402	Reservoir	SEO	PARKER NO 1 RESERVOIR	moved to imagery by ACE. wet in 2012, dry in 2015, 2017, breached	No	Non-Functional	Private	42.199	-105.4285	North Laramie River-Coyote Creek	NORTH LARAMIE RIVER	026N	072W	25
403	Reservoir	SEO	PARKER NO 2 RESERVOIR	no visible reservoir	No	Non-Functional	Forest Service	42.201	-105.4357	North Laramie River-Coyote Creek	NORTH LARAMIE RIVER	026N	072W	25
404	Reservoir	SEO	STURGEON NO. 3 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.098	-105.6029	North Laramie River-Cow Creek	SELLERS MTN.	025N	073W	33
405	Reservoir	SEO	BAR M NO. 3 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.245	-105.6658	North Laramie River-Bar M Creek	BAR M	026N	074W	12
406	Reservoir	SEO	PHILLIPS NO. ONE RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	42.288	-105.6826	North Laramie River-Bar M Creek	Not in Allotment	027N	074W	26
407	Reservoir	SEO	BELL AND SCRANTON NO. TWO RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	State	42.317	-105.6307	North Laramie River-Bar M Creek	Not in Allotment	027N	073W	17
408	Reservoir	SEO	BELL AND SCRANTON NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.295	-105.7036	North Laramie River-Bar M Creek	BELL-OTTE RANCH	027N	074W	22
409	Reservoir	SEO	DOBSON 29 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.108	-105.7339	Twentytwo Mile Draw	TWENTYMILE DRAW	025N	074W	29
410	Reservoir	SEO	BAR M NO. ONE RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.233	-105.6901	North Laramie River-Bar M Creek	HAY DRAW	026N	074W	11
411	Reservoir	SEO	PINTO RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	State	42.097	-105.6628	Pinto Creek	TWENTYMILE DRAW	025N	074W	36
412	Reservoir	SEO	TWENTY MILE NO. 1 RESERVOIR	Dry in 2012, 2015 2017. No visible defects	Potential	Potential	Private	42.096	-105.7204	Twentytwo Mile Draw	TWENTYMILE DRAW	025N	074W	33
413	Reservoir	SEO	NEWELL RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.195	-105.6584	North Laramie River-Antelope Creek	Not in Allotment	026N	074W	25
414	Reservoir	SEO	KAFKA NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.258	-105.7138	North Laramie River-Bar M Creek	BELL-OTTE RANCH	026N	074W	4
415	Reservoir	SEO	WHITE RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.075	-105.6939	Pinto Creek	TWENTYMILE DRAW	024N	074W	3
416	Reservoir	SEO	ATKINSON NO. 2 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.207	-105.6673	North Laramie River-Antelope Creek	JAMES ATKINSON	026N	074W	24
417	Reservoir	SEO	TOLTEC RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.205	-105.7184	North Laramie River-Antelope Creek	HAY DRAW	026N	074W	21
418	Reservoir	SEO	WEISER RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.966	-105.0136	Wheatland Creek	Not in Allotment	023N	068W	16
419	Reservoir	SEO	OLIND RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.074	-105.0635	Lower Sybille Creek	Not in Allotment	024N	069W	12
420	Reservoir	SEO	MILLER STOCK	Wet in 2015, 2017	Yes	Functional	Private	41.864	-105.2127	Lower North Sybille Creek	Not in Allotment	022N	070W	23
421	Reservoir	SEO	SANDSTROM POND RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.937	-105.0617	Brush Creek-Sybille Creek	Not in Allotment	023N	069W	25
422	Reservoir	SEO	STANDIE STOCK	No visible reservoir	No	Non-Functional	Private	41.941	-105.2413	Laramie River-Luman Creek	Not in Allotment	023N	070W	28
423	Reservoir	SEO	GROSSMAN 1	No visible reservoir	No	Non-Functional	Private	41.953	-105.2385	Laramie River-Slate Creek	Not in Allotment	023N	070W	21
424	Reservoir	SEO	GROSSMAN 2	No visible reservoir	No	Non-Functional	Private	41.954	-105.2375	Laramie River-Slate Creek	Not in Allotment	023N	070W	21
425	Reservoir	SEO	GROSSMAN 3	No visible reservoir	No	Non-Functional	Private	41.955	-105.2352	Laramie River-Slate Creek	Not in Allotment	023N	070W	21
426	Reservoir	SEO	NAFFZIGER RESERVOIR	Dry in 2012, 2015, 2017 No visible defects	Potential	Potential	State	42.116	-105.1807	Dry Laramie River	Not in Allotment	025N	069W	30
427	Reservoir	SEO	PORTER RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.762	-104.8435	Chugwater Creek-Chugwater	Not in Allotment	021N	067W	25
428	Reservoir	SEO	PINE RIDGE NO. 1 RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.739	-105.5077	Upper Bluegrass Creek	PINE RIDGE	020N	072W	6
429	Reservoir	SEO	NO. 2 RESERVOIR	sediment	No	Non-Functional	Private	41.978	-104.8515	Chug Spring	Not in Allotment	023N	067W	11
430	Reservoir	SEO	CLAY NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.698	-105.1968	Mule Creek-Sybille Creek	CHUGWATER	020N	070W	23
431	Reservoir	SEO	FIRST ENL. ESHOM RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.978	-105.1711	Laramie River-Luman Creek	COONEY HILLS	023N	069W	7
432	Reservoir	SEO	MILLER NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.681	-105.2033	Chugwater Creek-North Chugwater Creek	CHUGWATER	020N	070W	26
433	Reservoir	SEO	STURGEON NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	42.089	-105.4415	Sturgeon Creek	PALMER CANYON	025N	072W	35
434	Reservoir	SEO	CANTEEN RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.677	-105.3354	Upper South Fork Sybille Creek	TIMBER CANYON	020N	071W	27
435	Reservoir	SEO	FIRST ENL. MILLER NO. 2 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.693	-105.1579	Chugwater Creek-North Chugwater Creek	CHUGWATER	020N	069W	19
436	Reservoir	SEO	IRON MOUNTAIN NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.682	-105.2968	Upper South Fork Sybille Creek	WAECHTER CANYON	020N	071W	25
437	Reservoir	SEO	RICHARD NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.752	-105.004	Upper Richeau Creek	RICHEAU HILLS	021N	068W	33
438	Reservoir	SEO	ELLA RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.628	-105.4475	Middle Sybille Creek	PLUMBAGO CANYON	019N	072W	10
439	Reservoir	SEO	HALLECK CREEK RESERVOIR NUMBER THREE	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.847	-105.3902	Lower Bluegrass Creek	HALLECK CANYON	022N	071W	30
440	Reservoir	SEO	NUMBER THREE RESERVOIR	Wet in 2015, 2017	Yes	Functional	Private	42.106	-105.1292	Dry Laramie River	Not in Allotment	025N	069W	28

APPENDIX 4G

PLANT COMMUNITY DESCRIPTIONS

United States Department of Agriculture Natural Resources Conservation Service Ecological Site Description

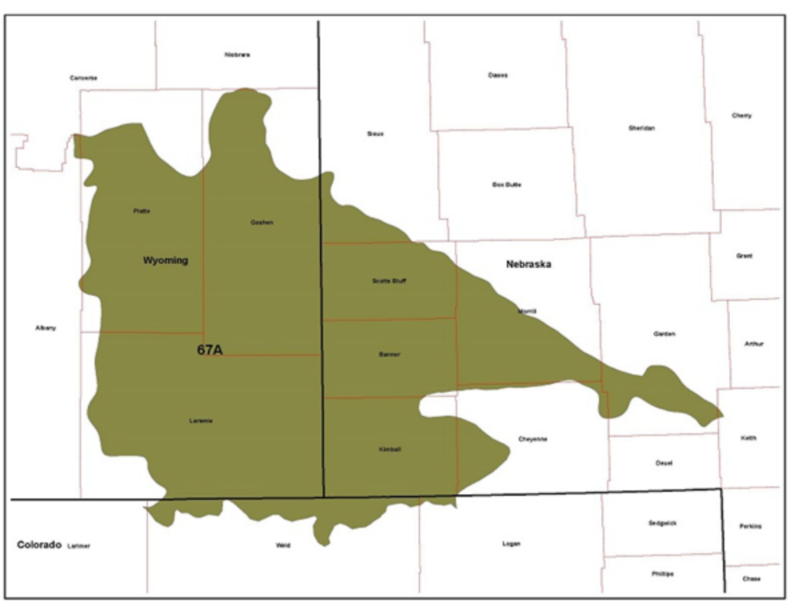
Section I: Ecological Site Characteristics

Ecological Site Identification and Concept

Site stage: **Provisional**

Provisional: an ESD at the provisional status represents the lowest tier of documentation that is releasable to the public. It contains a grouping of soil units that respond similarly to ecological processes. The ESD contains 1) enough information to distinguish it from similar and associated ecological sites and 2) a draft state and transition model capturing the ecological processes and vegetative states and community phases as they are currently conceptualized. The provisional ESD has undergone both quality control and quality assurance protocols. It is expected that the provisional ESD will continue refinement towards an approved status.

Site name: **Sandy (Sy) 12-17" PZ**
/ *Artemisia filifolia* / *Hesperostipa comata* - *Calamovilfa longifolia*
(/ sand sagebrush / needle and thread - prairie sandreed)
Site type: Rangeland
Site ID: R067AY150WY
Major land resource area (MLRA): 067A-Central High Plains, Northern Part



MLRA 67A Central High Plains, Northern Part

MLRA 67A-Central High Plains, Northern Part is located in southeastern Wyoming (58 percent), the southwestern portion of the Nebraska panhandle (38 percent), and extreme northeastern Colorado (4 percent). It is comprised of rolling plains, upland breaks, and river valleys. The major rivers are the North Platte and Laramie. The headwaters of these systems are in the Rocky Mountains. Other tributaries include Crow, Horse, and Lodgepole Creeks. This MLRA is traversed by I-25 and I-80, U.S. Highways 26, 30 and 85. Major land uses include rangeland (71 percent), cropland (21 percent), pasture and hayland (1 percent), urban (3 percent), and miscellaneous land occupy approximately (4 percent) of the remainder. Cities in this area include Cheyenne, Torrington, and Wheatland, WY; and Kimball, Oshkosh, and Scottsbluff, NE. Land ownership is mostly private. Areas of interest include Scotts Bluff National Monument, Chimney Rock and Fort Laramie National Historic Sites; Hawk Springs, Lake Minatare, and Wildcat Hills State Recreation Areas; Ash Hollow and Guernsey State Parks.
Elevations range from approximately 3,300 to 6,200 feet. The average annual precipitation ranges from 13-17 inches per year, but may increase up to 18 inches per year, in localized areas. Precipitation occurs mostly during the growing season, often during rapidly developing thunderstorms. Mean annual air temperature is ranges from 47 °F in the western part to 52°F in the eastern part. Summer temperatures may exceed 100°F. Winter temperatures may drop to sub-zero, and snowfall varies from 20 to 50 inches per year.

Ecological Site Concept

The Sandy 12-17” PZ site occurs on nearly level to gentle slopes on uplands or dissected plains. It is a warm-season and cool-season co-dominant, mixed-grass prairie (short- and midgrasses) with a minor component of forbs and shrubs.

Plant Communities

Ecological Dynamics of the Site

The information in this ESD, including the state-and-transition (STM) model diagram, was developed using archeological and historical data, professional experience, and scientific studies. The information is representative of a dynamic set of plant communities that represent the complex interaction of several ecological processes. The plant composition has been determined by study of rangeland relic areas, areas protected from excessive disturbance, seasonal use pastures, short duration/time controlled grazing strategies, and historical accounts.

The Sandy 12-17” PZ ecological site is characterized by four states: Reference, Sod-bound, Increased Bare Ground, and Tilled. The Reference State is characterized by cool-season mid bunchgrasses (needle and thread), warm-season mid rhizomatous grasses (prairie sandreed), and warm-season mid bunchgrass (little bluestem). Secondary grasses are warm-season tall bunchgrass (sand bluestem), and warm-season shortgrass (blue grama). Other grasses and grass-likes include western wheatgrass, Indian ricegrass, prairie Junegrass, sand dropseed, and threadleaf sedge. A minor component of forbs and shrubs are also present. The Sod-bound State is characterized by warm-season shortgrass (blue grama) and grasslikes (threadleaf sedge). The Increased Bare Ground State is characterized by annual grasses (sixweeks fescue), forbs (spreading buckwheat and annuals), and shrubs (broom snakeweed, and pricklypear). Invasives include cheatgrass.

The degree of grazing has a significant impact on the ecological dynamics of the site. This region was historically occupied by large grazing animals such as bison and elk, along with pronghorn and mule deer. Grazing by these large herbivores, along with climatic fluctuations, had a major influence on the ecological dynamics of this site. Deer and pronghorn are widely distributed throughout the MLRA. Secondary influences of herbivory by species such as small rodents, insects and root-feeding organisms have impacted the vegetation and continues today.

Historically, it is believed that, due to the migratory nature of the herds of large ungulates, herbivory consisted of very short grazing events followed by long rest/recovery periods lasting several months or longer. In addition to natural grazing and rest periods, these migrating herds significantly impacted the ecological processes of nutrient and hydrologic cycles. Herd behavior and movements were likely affected by water and forage availability, fire, drought, and predators. Prescribed grazing that typically mimics the historic grazing of herds of migratory herbivores has been shown to result in desired improvements based on management goals for this ecological site.

This is an important site for livestock grazing, especially beef cattle. Today the management of livestock grazing by humans has been a major influence on the ecological dynamics of the site. This management, coupled with the effects of annual climatic variations, largely dictates the plant communities for the site.

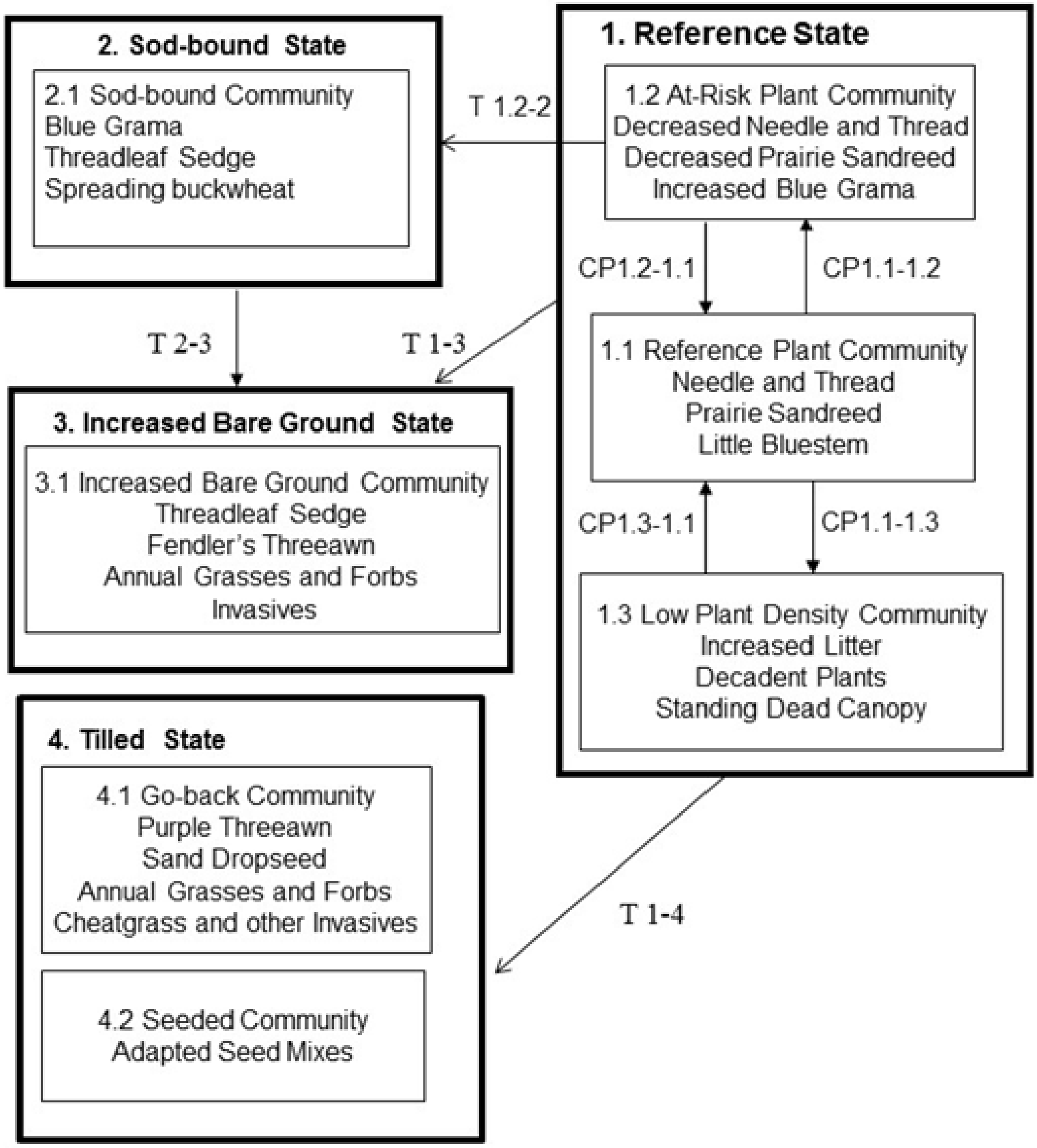
Recurrent drought has historically impacted the vegetation of this region. Changes in species composition and production, will vary depending upon the duration and severity of the drought cycle, and prior grazing management.

This site developed with occasional fire as part of the ecological processes. Historic fire frequency (pre-industrial), is estimated at 10-12 years (Guyette, 2012), randomly distributed, and started by lightning at various times throughout the growing season. It is thought that early human inhabitants also were likely to start fires for various reasons (deliberate or accidental). It is believed that fires were set as a management tool for attracting herds of large migratory herbivores (Stewart, 2002). The impact of fire over the past 100 years has been relatively insignificant due to the human control of wildfires and the lack of acceptance of prescribed fire as a management tool.

As this site begins to deteriorate from a combination of frequent and severe grazing during the growing season, bunchgrasses such as needle and thread and green needlegrass will decrease in both frequency and production. Grasses such as blue grama and threadleaf sedge will increase. Under continued frequent and severe defoliation, with no rest periods, rhizomatous wheatgrasses will also begin to decrease. Forbs and shrubs such as curlycup gumweed, western ragweed, hairy false goldenaster, spreading buckwheat, pricklypear, and broom snakeweed will also increase. If continued, the plant community will become sod-bound, and all midgrasses can eventually be removed from the plant community. Over the long-term, this continuous use in combination with high stock densities, will result in a broken sod, with areas of bare ground developing, and species such as broom snakeweed and annual bromes (cheatgrass), invading.

The following diagram illustrates the common plant communities that can occur on the site and the community pathways (CP) among plant communities. Plant Communities are identified by 1.1, 1.2 etc. and are described in the narrative. Bold lines surrounding each state represent ecological thresholds. Transitions (T) indicate the transition across an ecological threshold to another state. Once a threshold has been crossed into another state, it may not be feasible to return to the original state, even with significant management inputs and practices. The ecological processes plant communities, community pathways, transition and/or restoration pathways will be discussed in more detail in the plant community descriptions following the diagram.

State-and-Transition Diagram



CP- Community Pathway
CP1.1-1.2 Continuous grazing and/or frequent defoliation without adequate recovery, extended drought
CP1.1-1.3 Non-use, no fire
CP1.2-1.1 Prescribed grazing with adequate recovery and proper stocking, drought followed by normal precipitation
CP 1.3-1.1 Prescribed grazing with adequate recovery, fire
T1.2-2 – Continuous Grazing and/or frequent defoliation without adequate recovery
T1-3 – Long-term heavy continuous grazing, and/or excessive defoliation
T1-4 – Tillage
T2-3 Long-term continuous grazing with over-stocking, and/or excessive defoliation

State and Transition Diagram (Sandy 12-17" PZ)

Sod-bound Plant Community

This plant community develops under long-term frequent and severe defoliation. This typically occurs when the community has been continuously grazed with heavy stocking rates, throughout the growing season over a period of many years. Initially, this plant community is dominated by sod-forming grasses and grasslikes, such as blue grama and threadleaf sedge, with remnants of mid-grasses such as prairie sandreed, sand dropseed, and some rhizomatous wheatgrass. Forbs include Cuman ragweed (western ragweed), lemon scurfpea, hairy false goldenaster, cudweed sagewort, and skeletonplant. Shrubs such as spreading buckwheat, broom snakeweed, fringed sagewort, and pricklypear continue to increase. Under long-term frequent and severe defoliation, Blue grama and threadleaf sedge have become sod-bound in localized colonies, and exhibit a mosaic appearance. Other minor grasses are sand dropseed, Fendler's threeawn, and annuals. The midgrasses and palatable forbs have been eliminated. Plant diversity is very low.

Energy flow, water cycle and mineral cycle have been negatively affected. Litter levels are very low and unevenly distributed.

In the 12 to 14" PZ, the total annual production (air-dry weight) is about 500 pounds per acre during an average year, but it can range from about 350 pounds per acre in unfavorable years to about 650 pounds per acre in above average years.

In the 15 to 17" PZ, the total annual production (air-dry weight) is about 600 pounds per acre during an average year, but it can range from about 400 pounds per acre in unfavorable years to about 800 pounds per acre in above average years.

This plant community is extremely resistant to change. Many plant species are missing and a seed source is not readily available. Also, sod-forming grasses tend to maintain themselves due to their resistance to any further overgrazing.

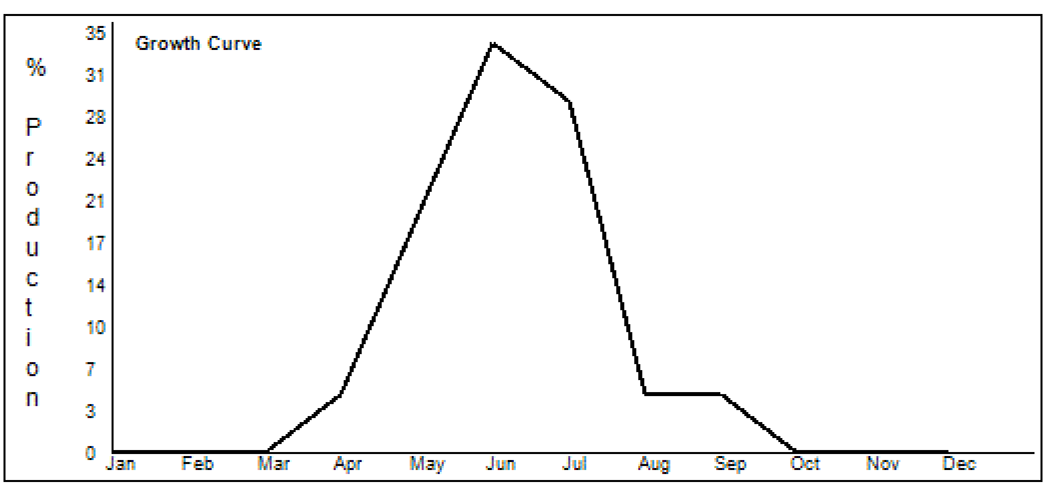
Transitions or pathways leading to other plant communities are as follows:

Plant Growth Curve

Growth curve number:	WY1104
Growth curve name:	12-14SP upland sites w/ warm
Growth curve description:	12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0



Increased Bare Ground Plant Community

This plant community occurs where the rangeland is grazed year-round, at high stock densities. Physical impact such as trampling, soil compaction, and trailing typically contribute to this transition. The plant composition is made of annuals with a few species of perennial forbs and grasses that are very tolerant to frequent and severe defoliation. The dominant grasses include blue grama, threadleaf sedge, and Fendler's threeawn. Annual grasses and forbs such as cheatgrass, sixweeks fescue, Russian thistle, and kochia have increased or invaded. The dominant forbs include curlycup gumweed, Cuman (western) ragweed, and hairy false goldenaster. Broom snakeweed, spreading buckwheat and pricklypear are increasing.

In the 12 to 14" PZ, the total annual production (air-dry weight) is about 500 pounds per acre during an average year, but it can range from about 350 pounds per acre in unfavorable years to about 650 pounds per acre in above average years.

In the 15 to 17" PZ, the total annual production (air-dry weight) is about 600 pounds per acre during an average year, but it can range from about 400 pounds per acre in unfavorable years to about 800 pounds per acre in above average years.

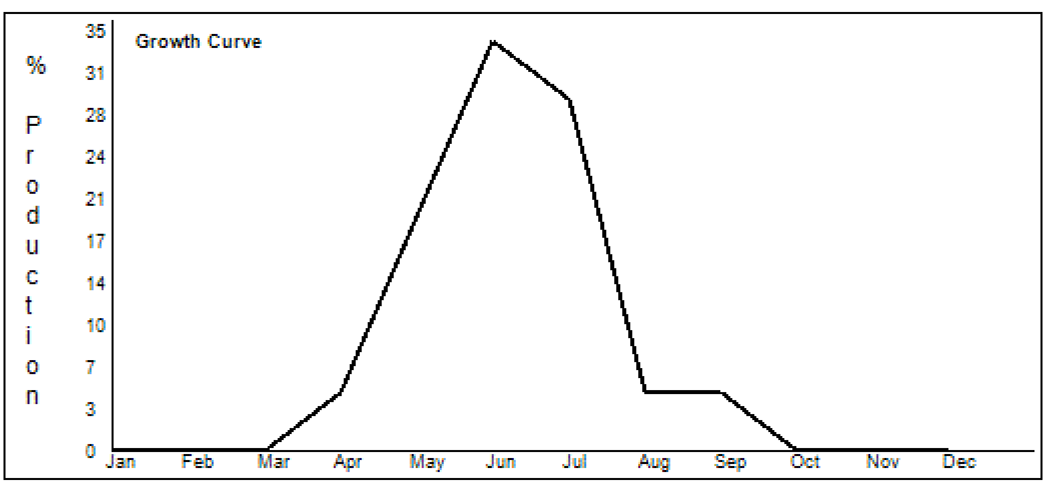
Soil erosion hazard has increased due to the increase of bare ground. Runoff is typically high and infiltration is low. All ecological functions are impaired. Desertification is advanced.

Plant Growth Curve

Growth curve number:	WY1104
Growth curve name:	12-14SP upland sites w/ warm
Growth curve description:	12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0



Go-back Plant Community

Go-back land is created when the soil is tilled or farmed (sodbusted) and abandoned. All of the native plants are destroyed, soil organic matter is reduced, soil structure is changed, and a plowpan or compacted layer is formed. Residual synthetic chemicals often remain from past farming operations, and erosion processes may be active.

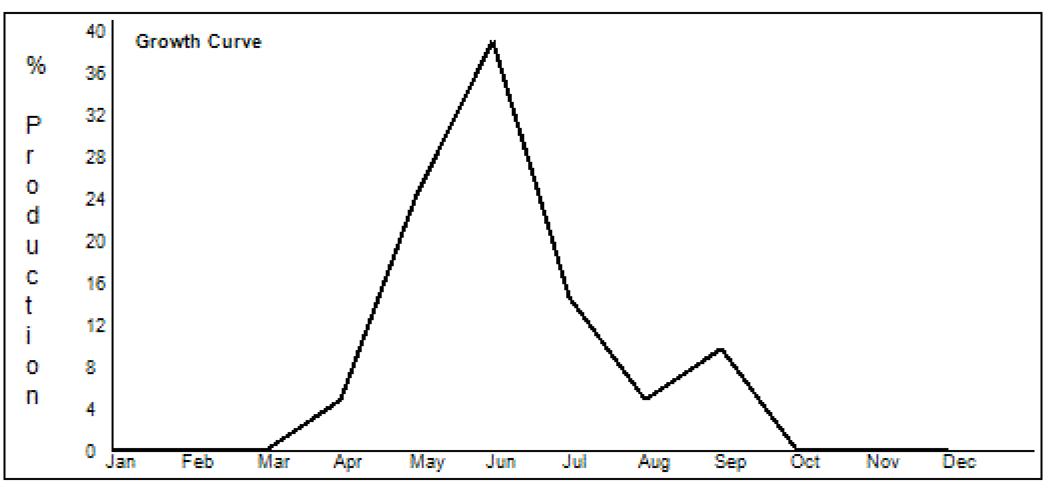
Go-back land evolves through several plant communities beginning with an early annual plant community, which initiates the revegetation process. Plants such as Russian thistle, kochia, sixweeks fescue, cheatgrass, and other annuals begin to establish. These plants give some protection from erosion and start to build minor levels of soil organic matter. Purple threeawn, sand dropseed, and several other early perennials can dominate the plant community for five to eight years or more. Eventually western wheatgrass, little bluestem, needle and thread, and other natives become re-established. Blue grama and threadleaf sedge are absent. Forbs can include annual sunflower, tenpetal blazingstar (mentzelia), and rocky mountain beeplant. Where go-back land has eroded to parent material, the slow process of soil development and re-establishment of vegetation will start. This is a very slow process (100 years or more). A new eco-site may evolve depending on severity of soil and parent material erosion, and parent material.

Plant Growth Curve

Growth curve number:	WY1101
Growth curve name:	12-14SP Upland sites w/o warm seasons
Growth curve description:	12-14" Precipitation Zone, Southern Plains (SP) without warm season (grass) species

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	15	5	10	0	0	0



Reference Plant Community

Sandy 12-17" PZ, Cheyenne County, NE

This is the interpretive plant community for this site. This community developed with grazing by large herbivores and is suited to grazing by domestic livestock. Historically, fires likely occurred infrequently, and were randomly distributed. This plant community can be found on areas where grazed plants receive adequate periods of recovery during the growing season. The potential vegetation is about 70-95% grasses and grass-likes, 5-15% forbs and 0-15% woody plants.

In the western portion of the MLRA, the plant community is predominately cool-season mid-grasses, with a significant component of warm-season mid-grasses. In the eastern portion of the MLRA, the plant community is predominantly warm-season with a significant cool-season component.

This plant community is predominantly needle and thread, prairie sandreed, and little bluestem. Secondary grasses are sand bluestem, Indian ricegrass, blue grama and western wheatgrass. Minor grasses and grasslikes that may occur include streambank (thickspike) wheatgrass, sideoats grama, prairie Junegrass, and sand dropseed. A variety of forbs such as scarlet globemallow, lemon scurfpea, prairie spiderwort, and purple prairie clover; half-shrubs such as silver- and sand sagebrush; and shrubs such as western sandcherry also occur. Plant diversity is high.

In the 12 to 14” Precipitation Zone (PZ), the total annual production (air-dry weight) is about 1,300 pounds per acre during an average year, but it can range from about 750 pounds per acre in unfavorable years to about 1,750 pounds per acre in above-average years.

In the 15 to 17” PZ, the total annual production (air-dry weight) is about 1,500 pounds per acre during an average year, but it can range from about 1,000 pounds per acre in unfavorable years to about 2,000 pounds per acre in above-average years.

Community dynamics (nutrient cycle and water cycles, and energy flow) are functioning properly. Infiltration rates are moderate, and soil erosion is low. Litter is properly distributed where vegetative cover is continuous. Decadence and natural plant mortality is low. This community is resistant to many disturbances except continuous grazing, tillage and/or development into urban or other uses.

Reference Plant Community Plant Species Composition

Grass/Grasslike

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
1	-12"-14"				195	650
		sand bluestem	ANHA	*Andropogon hallii*	0	195
		prairie sandreed	CALO	*Calamovilfa longifolia*	130	390
		little bluestem	SCSC	*Schizachyrium scoparium*	65	260
2	-12"-14"				195	520
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	130
		needle and thread	HECO26	*Hesperostipa comata*	195	520
3	-12"-14"				65	195
		blue grama	BOGR2	*Bouteloua gracilis*	65	195
4	-12-14"				65	130
		streambank wheatgrass	ELLA3	*Elymus lanceolatus*	0	130
		western wheatgrass	PASM	*Pascopyrum smithii*	65	130
5	-12"-14"				65	130
		Grass, perennial	2GP		0	65
		threeawn	ARIST	*Aristida*	0	26
		sideoats grama	BOCU	*Bouteloua curtipendula*	0	65
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	65
		sand dropseed	SPCR	*Sporobolus cryptandrus*	0	65
6	-12"-14"				0	130
		threadleaf sedge	CAFI	*Carex filifolia*	0	130
		sedge	CAREX	*Carex*	0	65

Forb

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
7	-12"-14"				65	195
		Forb, perennial	2FP		0	65
		Cuman ragweed	AMPS	*Ambrosia psilostachya*	0	26
		pussytoes	ANTEN	*Antennaria*	0	26
		cudweed sagewort	ARLU	*Artemisia ludoviciana*	0	26
		milkvetch	ASTRA	*Astragalus*	0	26
		false boneset	BREU	*Brickellia eupatorioides*	0	26
		prairie clover	DALEA	*Dalea*	0	26
		larkspur	DELPH	*Delphinium*	0	26
		sanddune wallflower	ERCA14	*Erysimum capitatum*	0	26
		scarlet beeblossom	GACO5	*Gaura coccinea*	0	26
		hairy false goldenaster	HEVI4	*Heterotheca villosa*	0	26
		bush morningglory	IPLE	*Ipomoea leptophylla*	0	26
		dotted blazing star	LIPU	*Liatris punctata*	0	26
		rush skeletonplant	LYJU	*Lygodesmia juncea*	0	26

		tenpetal blazingstar	MEDE2	*Mentzelia decapetala*	0	26
		evening-primrose	OENOT	*Oenothera*	0	26
		hedgehog cactus	PEDIO	*Pediocactus*	0	26
		beardtongue	PENST	*Penstemon*	0	26
		Parish's popcornflower	PLPA	*Plagiobothrys parishii*	0	26
		lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0	26
		slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	0	26
		prairie coneflower	RACO3	*Ratibida columnifera*	0	26
		veiny dock	RUVE2	*Rumex venosus*	0	26
		ragwort	SENEC	*Senecio*	0	26
		goldenrod	SOLID	*Solidago*	0	26
		scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0	26
		spiderwort	TRADE	*Tradescantia*	0	26
		American vetch	VIAM	*Vicia americana*	0	26

Shrub/Vine

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
8 -12-14"					0	195
		Shrub (>.5m)	2SHRUB		0	65
		silver sagebrush	ARCA13	*Artemisia cana*	0	26
		sand sagebrush	ARFI2	*Artemisia filifolia*	0	26
		fringed sagewort	ARFR4	*Artemisia frigida*	0	26
		fourwing saltbush	ATCA2	*Atriplex canescens*	0	26
		spreading buckwheat	EREF	*Eriogonum effusum*	0	26
		broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0	26
		plains pricklypear	OPPO	*Opuntia polyacantha*	0	26
		western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0	26
		prairie rose	ROAR3	*Rosa arkansana*	0	26
		small soapweed	YUGL	*Yucca glauca*	0	26

Grass/Grasslike

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
9 -15"-17"					225	750
		sand bluestem	ANHA	*Andropogon hallii*	0	225
		prairie sandreed	CALO	*Calamovilfa longifolia*	150	450
		little bluestem	SCSC	*Schizachyrium scoparium*	75	300
10 -15"-17"					225	600
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	150
		needle and thread	HECO26	*Hesperostipa comata*	225	600
11 -15"-17"					75	225
		blue grama	BOGR2	*Bouteloua gracilis*	75	225
12 -15"-17"					75	150
		streambank wheatgrass	ELLA3	*Elymus lanceolatus*	0	150

		western wheatgrass	PASM	*Pascopyrum smithii*	75	150
13	-15"-17"				75	150
		Grass, perennial	2GP		0	75
		threeawn	ARIST	*Aristida*	0	30
		sideoats grama	BOCU	*Bouteloua curtipendula*	0	75
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	75
		sand dropseed	SPCR	*Sporobolus cryptandrus*	0	75
14	-15"-17"				0	150
		threadleaf sedge	CAFI	*Carex filifolia*	0	150
		sedge	CAREX	*Carex*	0	75

Forb

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
15	-15"-17"				75	225
		Forb, perennial	2FP		0	75
		Cuman ragweed	AMPS	*Ambrosia psilostachya*	0	30
		pussytoes	ANTEN	*Antennaria*	0	30
		cudweed sagewort	ARLU	*Artemisia ludoviciana*	0	30
		milkvetch	ASTRA	*Astragalus*	0	30
		false boneset	BREU	*Brickellia eupatorioides*	0	30
		prairie clover	DALEA	*Dalea*	0	30
		larkspur	DELPH	*Delphinium*	0	30
		sanddune wallflower	ERCA14	*Erysimum capitatum*	0	30
		scarlet beeblossom	GACO5	*Gaura coccinea*	0	30
		hairy false goldenaster	HEVI4	*Heterotheca villosa*	0	30
		bush morningglory	IPLE	*Ipomoea leptophylla*	0	30
		dotted blazing star	LIPU	*Liatris punctata*	0	30
		rush skeletonplant	LYJU	*Lygodesmia juncea*	0	30
		tenpetal blazingstar	MEDE2	*Mentzelia decapetala*	0	30
		evening-primrose	OENOT	*Oenothera*	0	30
		Indian breadroot	PEDIO2	*Pediomelum*	0	30
		beardtongue	PENST	*Penstemon*	0	30
		lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0	30
		slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	0	30
		prairie coneflower	RACO3	*Ratibida columnifera*	0	30
		veiny dock	RUVE2	*Rumex venosus*	0	30
		ragwort	SENEC	*Senecio*	0	30
		goldenrod	SOLID	*Solidago*	0	30
		scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0	30
		white heath aster	SYERE	*Symphyotrichum ericoides var. ericoides*	0	30
		spiderwort	TRADE	*Tradescantia*	0	30
		American vetch	VIAM	*Vicia americana*	0	30

Shrub/Vine

Annual Production (pounds per acre)

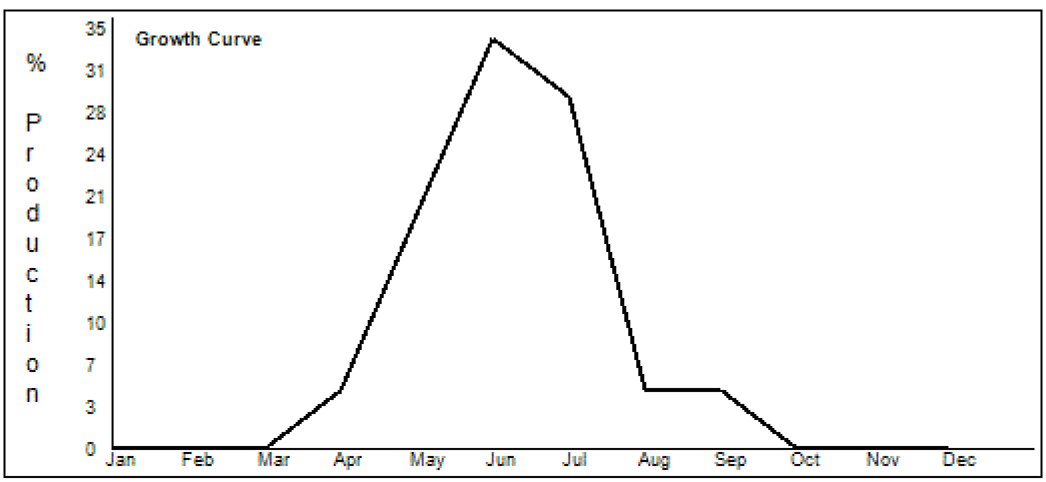
Group	Group name	Common name	Symbol	Scientific name	Low	High
16	-15"-17"				0	225
		Shrub (>.5m)	2SHRUB		0	75
		silver sagebrush	ARCA13	*Artemisia cana*	0	30
		sand sagebrush	ARFI2	*Artemisia filifolia*	0	30
		fringed sagewort	ARFR4	*Artemisia frigida*	0	30
		fourwing saltbush	ATCA2	*Atriplex canescens*	0	30
		spreading buckwheat	EREF	*Eriogonum effusum*	0	30
		broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0	30
		plains pricklypear	OPPO	*Opuntia polyacantha*	0	30
		western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0	30
		prairie rose	ROAR3	*Rosa arkansana*	0	30
		small soapweed	YUGL	*Yucca glauca*	0	30

Plant Growth Curve

Growth curve number:	WY1104
Growth curve name:	12-14SP upland sites w/ warm
Growth curve description:	12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0



At-Risk Plant Community

This plant community developed with frequent and severe defoliation without adequate recovery opportunity during the growing season. The plant community has a reduced component of mid-grasses with an understory of short sod-forming grasses. Dominant grasses include needleandthread, blue grama, and prairie sandreed. A cool-season/warm-season shift may occur depending on the pre-dominant season of use. Recurrent continuous grazing in the spring, over time, will eventually reduce the cool-season grasses such as needle and thread and the rhizomatous wheatgrasses. Likewise, recurrent continuous grazing in the summer will reduce the warm-season bunchgrasses such as little bluestem and sand bluestem. Prairie sandreed is present and distributed across the site is somewhat reduced amounts. The significant forbs include dotted gayfeather, cudweed sagewort, spiderworts, and upright prairie coneflower. Shrubs in this community include Arkansas rose, fringed sagewort, and broom snakeweed. Compared to the Reference Plant Community, blue grama and threadleaf sedge have increased. All of the mid-grass species are present but in lesser amounts, especially the bunchgrasses. Plant diversity is moderate.

In the 12 to 14“ PZ, the total annual production (air-dry weight) is about 900 pounds per acre during an average year, but it can range from about 600 pounds per acre in unfavorable years to about 1,200 pounds per acre in above average years.

In the 15 to 17“ PZ, the total annual production (air-dry weight) is about 1,100 pounds per acre during an average year, but it can range from about 750 pounds per acre in unfavorable years to about 1,450 pounds per acre in above average years.

Total aboveground biomass has been reduced. Reduction of rhizomatous wheatgrasses, nitrogen-fixing forbs, and increased warm-season shortgrasses have begun to alter the biotic integrity of this community. Water and nutrient cycles may be impaired.

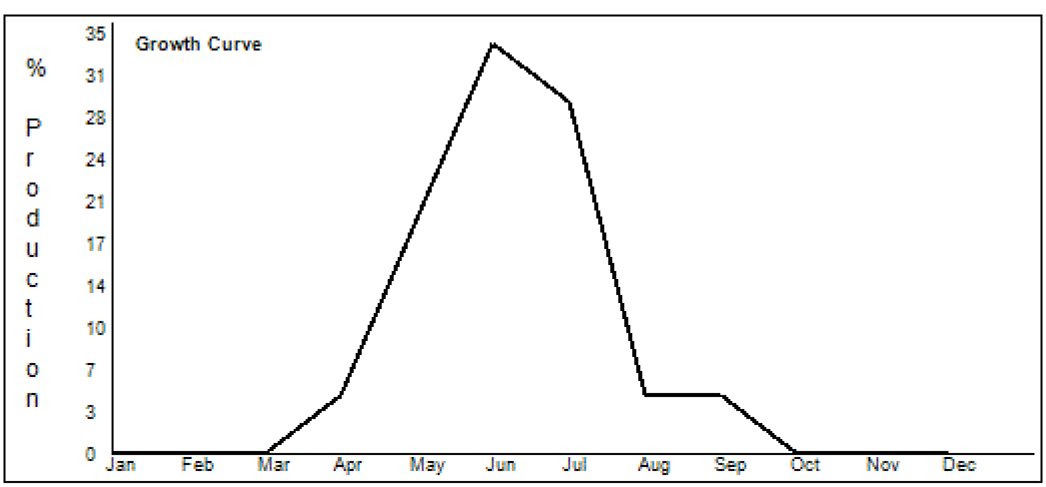
Nearly all plant species typically found in the Reference Plant Community are present and will respond to changes in grazing management.

Plant Growth Curve

Growth curve number:	WY1104
Growth curve name:	12-14SP upland sites w/ warm
Growth curve description:	12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0



Seeded Community

This plant community can vary considerably depending upon how eroded the soil was, the species seeded, the stand that was established, how long ago the stand was established, and the management of the stand since establishment. The Sandy 12-17” PZ Ecological Site has been converted to cropland in some areas.

Low Plant Density Community

This plant community developed under many years of non-use (rest) and lack of fire. Plant species resemble the Reference Plant Community however, frequency and production will be reduced. Eventually, litter levels can become high enough to cause decadence and/or mortality of the stand. Bunchgrasses typically develop dead centers and rhizomatous grasses can form small decadent communities due to a lack of impact by grazing animals. Much of the available nutrients are tied up in standing dead plant material and increased amounts of litter. The semiarid environment and the absence of animal traffic to break down litter will slow nutrient recycling.

Cool- season grasses, and pricklypear have typically increased. Blue grama is reduced. Dominant grasses include prairie sandreed, needleandthread, and western wheatgrass. Other species include sand dropseed and threadleaf sedge. Dominant forbs include annual sunflower and tenpetal blazingstar (also known as mentzelia). Dominant shrubs include pricklypear and fringed sagewort. Invasive grasses such as cheatgrass tend to encroach under these conditions. Water flow patterns and pedestalling can become apparent. Infiltration is reduced and runoff is increased. In advanced stages of non-use (rest) or lack of fire, bare areas will increase causing an erosion concern.

In the 12 to 14“ PZ, the total annual production (air-dry weight) is about 1,000 pounds per acre during an average year, but it can range from about 650 pounds per acre in unfavorable years to about 1,350 pounds per acre in above average years.

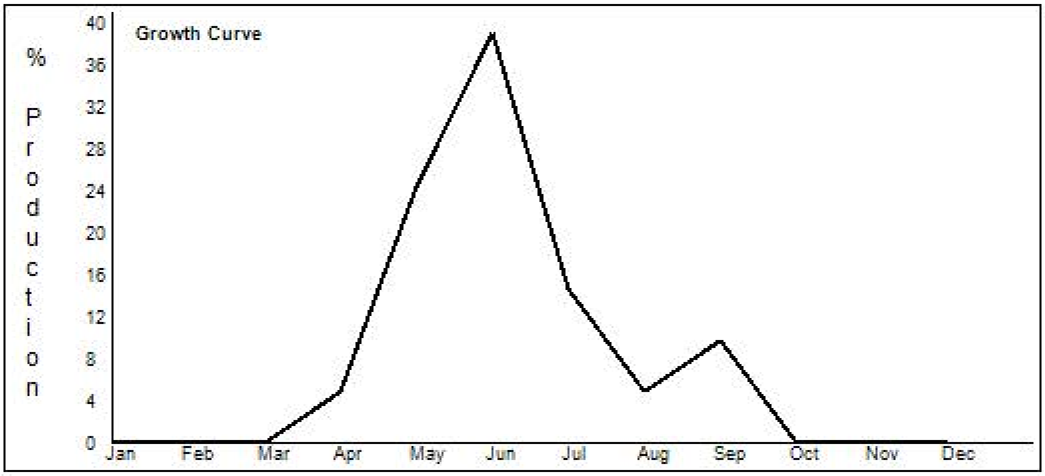
In the 15 to 17” PZ, the total annual production (air-dry weight) is about 1,000 pounds per acre during an average year, but it can range from about 650 pounds per acre in unfavorable years to about 1,350 pounds per acre in above average years.

Plant Growth Curve

Growth curve number:	WY1101
Growth curve name:	12-14SP Upland sites w/o warm seasons
Growth curve description:	12-14" Precipitation Zone, Southern Plains (SP) without warm season (grass) species

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	15	5	10	0	0	0



Growth Curve
% Production
0
4
8
12
16
20
24
28
32
36
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

United States Department of Agriculture Natural Resources Conservation Service Ecological Site Description

Section I: Ecological Site Characteristics

Ecological Site Identification and Concept

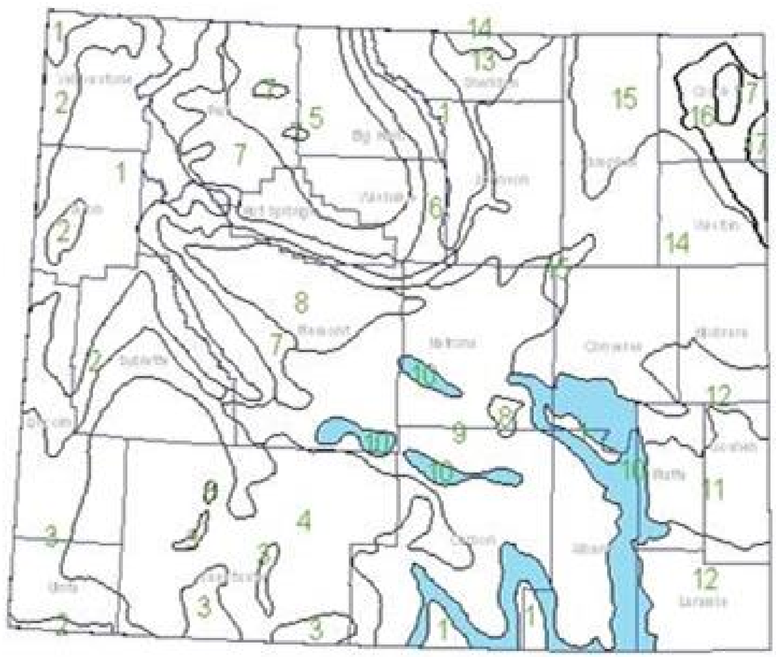
Site stage: Provisional

Provisional: an ESD at the provisional status represents the lowest tier of documentation that is releasable to the public. It contains a grouping of soil units that respond similarly to ecological processes. The ESD contains 1) enough information to distinguish it from similar and associated ecological sites and 2) a draft state and transition model capturing the ecological processes and vegetative states and community phases as they are currently conceptualized. The provisional ESD has undergone both quality control and quality assurance protocols. It is expected that the provisional ESD will continue refinement towards an approved status.

Site name: Shallow Igneous (SwIg) 15-19” Foothills & Mountains Southeast Precipitation Zone

Site type: Rangeland
Site ID: R049XA160WY
Major land resource area (MLRA): 049-Southern Rocky Mountain Foothills

Precipitation Zones for Rangeland Ecological Site Descriptions



Plant Communities

Ecological Dynamics of the Site

As this site deteriorates because of a combination of frequent and severe grazing, species such as Sandberg bluegrass, threadleaf sedge, prairie junegrass unpalatable forbs, and threetip sagebrush will increase. Grasses such as bluebunch wheatgrass, Montana wheatgrass, and Parry’s oatgrass will decrease in frequency and production.

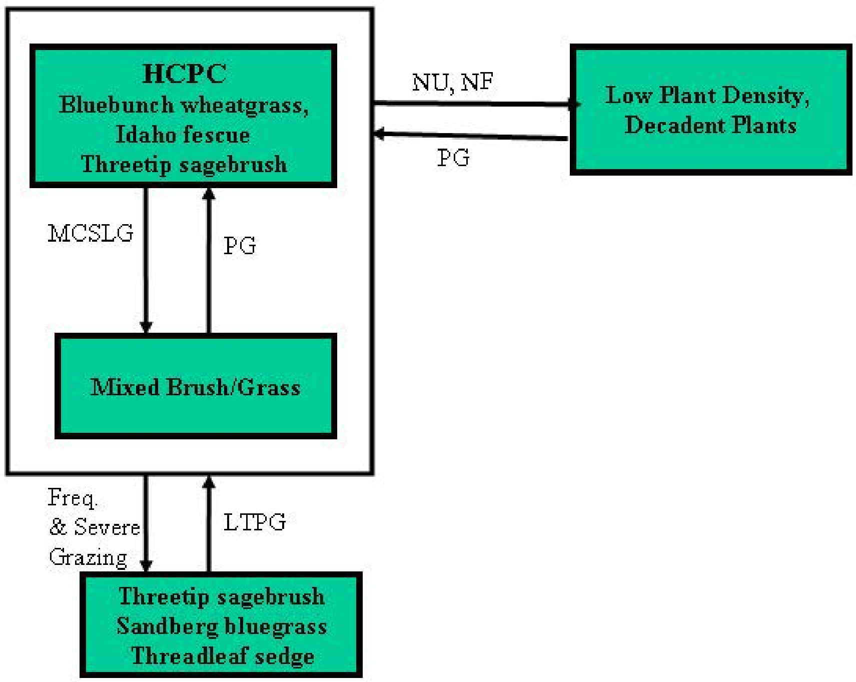
The Historic Climax Plant Community (description follows the plant community diagram) has been determined by study of rangeland relic areas, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical 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.

State-and-Transition Diagram

Site Type: Rangeland
MLRA: 49XA - Southern Rocky Mountain Foothills - northern part

Shallow Igneous 15-19" P.Z.
R049XA160WY



Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)

Bluebunch wheatgrass, Idaho fescue, Threetip sagebrush Plant Community

This plant community is the interpretive plant community for this site and is considered to be the Historic Climax Plant Community (HCPC). This plant community evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. This plant community can be found on areas that are properly managed with grazing, and sometimes on areas receiving occasional short periods of rest. The potential vegetation is about 65% grasses or grass-like plants, 15% forbs, and 25% woody plants.

The major grasses include bluebunch wheatgrass, and Idaho fescue. Other grasses occurring on the state include slimstem muhly, threadleaf sedge, Sandberg bluegrass, Canby bluegrass and Parry's oatgrass. A variety of forbs also occur. Threetip sagebrush can be a conspicuous element of this state. Plant diversity is high.

The total annual production (air-dry weight) of this state is about 900 lbs./acre, but it can range from about 600 lbs./acre in unfavorable years to about 1,200 lbs./acre in above average years.

The following is the growth curve of this plant community expected during a normal year:
Growth curve number:
Growth curve name:
Growth curve description:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0 0 0 5 20 45 20 5 5 0 0 0
(Monthly percentages of total annual growth)

This plant community is extremely stable and well adapted to the 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:

• No use and no fire for 20 years or more will convert this plant community to the Low Plant Density, Decadent Plants Community.

• Moderate, continuous season-long grazing will convert the plant community to the Mixed Brush/Grass Plant Community.

Bluebunch wheatgrass, Idaho fescue, Threetip sagebrush Plant Community Plant Species Composition

Grass/Grasslike

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
1					135	585
		Idaho fescue	FEID	*Festuca idahoensis*	90	225
		slimstem muhly	MUFI	*Muhlenbergia filiculmis*	45	135
		bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	90	225
2					225	405
		Grass, perennial	2GP		0	45
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	45
		threadleaf sedge	CAFI	*Carex filifolia*	0	45
		Parry danthonia	DAPA2	*Danthonia parryi*	0	45
		onespike danthonia	DAUN	*Danthonia unispicata*	0	45
		Montana wheatgrass	ELAL7	*Elymus albicans*	0	45
		needle and thread	HECO26	*Hesperostipa comata*	0	45
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	45

		Common name	Symbol	Scientific name	Low	High
		mountain muhly	MUMO	Muhlenbergia montana	0	45
		mat muhly	MURI	Muhlenbergia richardsonis	0	45
		western wheatgrass	PASM	Pascopyrum smithii	0	45
			POCA	Poa canbyi	0	45
		alkali bluegrass	POSE	Poa secunda	0	45

Forb

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
3					45	135
		Forb, perennial	2FP		0	45
		yarrow	ACHIL	Achillea	0	45
		rose pussytoes	ANRO2	Antennaria rosea	0	45
		fringed sagewort	ARFR4	Artemisia frigida	0	45
		cudweed sagewort	ARLU	Artemisia ludoviciana	0	45
		milkvetch	ASTRA	Astragalus	0	45
		buckwheat	ERIOG	Eriogonum	0	45
		hairy false goldenaster	HEVI4	Heterotheca villosa	0	45
		beardtongue	PENST	Penstemon	0	45
		Hood's phlox	PHHO	Phlox hoodii	0	45
		cinquefoil	POTEN	Potentilla	0	45
		stonecrop	SEDUM	Sedum	0	45

Shrub/Vine

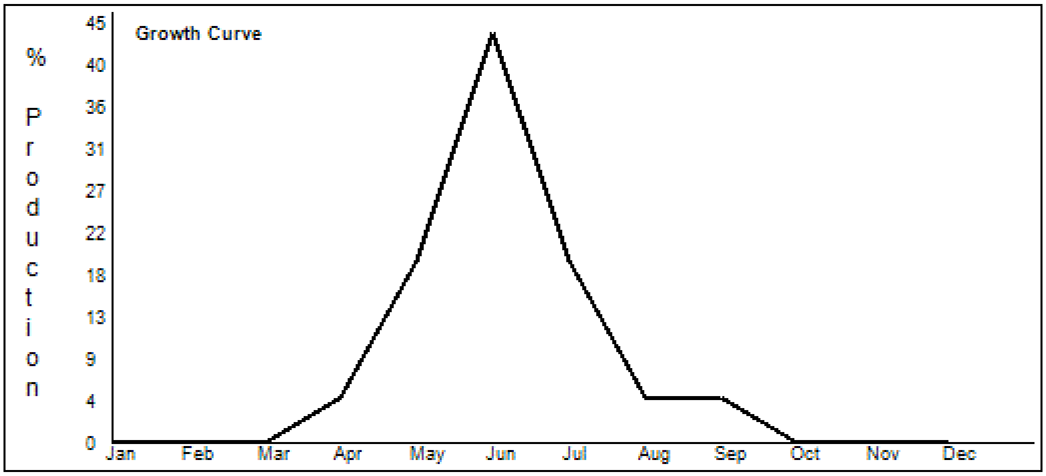
Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
4					45	135
		threetip sagebrush	ARTR4	Artemisia tripartita	45	135
5					0	45
		winterfat	KRLA2	Krascheninnikovia lanata	0	45
6					45	135
		Shrub (>.5m)	2SHRUB		0	45
		black sagebrush	ARNO4	Artemisia nova	0	45
		big sagebrush	ARTR2	Artemisia tridentata	0	45
		Douglas rabbitbrush	CHVI8	Chrysothamnus viscidiflorus	0	45
		rubber rabbitbrush	ERNA10	Ericameria nauseosa	0	45
		antelope bitterbrush	PUTR2	Purshia tridentata	0	45

Plant Growth Curve

Growth curve number:	WY1001
Growth curve name:	15-19SE 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	20	45	20	5	5	0	0	0



Mixed Brush/Grass Plant Community

Historically, this plant community evolved under grazing and a low fire frequency. Currently, it is found under moderate, season-long grazing by livestock. Cool-season grasses make up the majority of the understory with the balance made up of annual cool-season grasses, and miscellaneous forbs.

Dominants include threadleaf sedge, western wheatgrass, and Sandberg bluegrass. Forbs commonly found in this plant community include Hoods phlox and western yarrow.

When compared to the Historic Climax Plant Community, threetip sagebrush has increased but does not produce the thick canopy cover found on sites with moderately deep to deep soils. Production of cool-season grasses has been reduced. The mixture of sagebrush, grass and forbs provide a diverse plant community that will support domestic livestock and wildlife such as mule deer and antelope.

The total annual production (air-dry weight) of this state is about 650 pounds per acre, but it can range from about 450 lbs./acre in unfavorable years to about 850 lbs./acre in above average years.

The following is the growth curve of this plant community expected during a normal year:
Growth curve number:
Growth curve name:
Growth curve description:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0 0 0 5 20 45 20 5 5 0 0 0
(Monthly percentages of total annual growth)

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. If the herbaceous component is intact, it tends to be resilient if the disturbance is not long-term.

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

• Prescribed grazing, will convert this plant community to the Bluebunch wheatgrass, Idaho fescue, Threetip sagebrush Plant Community. The probability of this occurring is high.

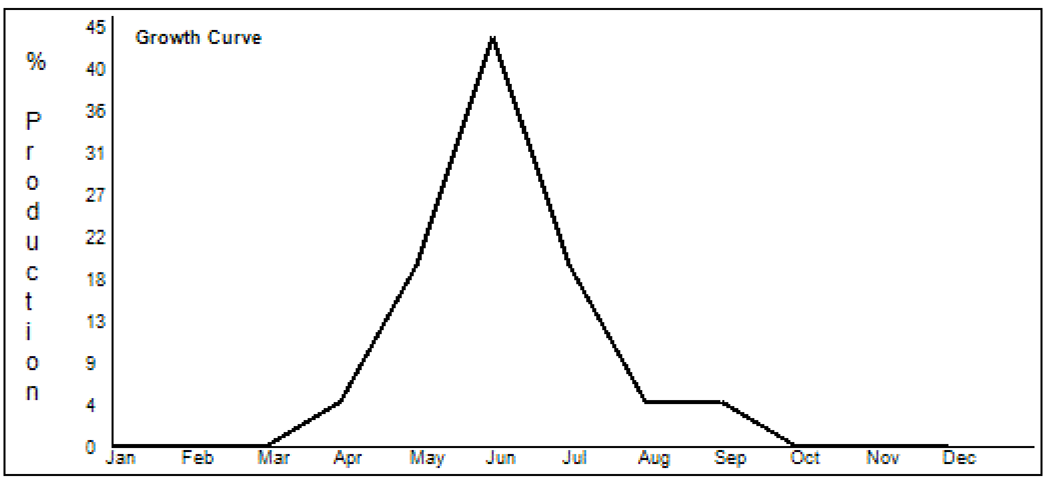
• Frequent and severe grazing, will convert the plant community to the Threetip sagebrush, Sandberg bluegrass, Threadleaf sedge Plant Community. The probability of this occurring is high. If bare areas exist, along with no recovery periods from grazing, annuals can invade and plants not as resistant to grazing will be reduced.

Plant Growth Curve

Growth curve number:	WY1001
Growth curve name:	15-19SE 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	20	45	20	5	5	0	0	0



Low Plant Density, Decadent Plants Community

This plant community is the result of long-term protection from grazing and fire. At first, excessive litter builds up shading out some of the grasses and forbs. Other plants become decadent with low vigor. Bunch grasses often develop dead centers. Eventually, the interspaces between plants increase in size leaving more soil surface exposed. Organic matter oxidizes in the air rather than being incorporated into the soil.

The dominant plants tend to be somewhat similar to those found in the Historic Climax Plant Community. Weedy species and sedges have increased. Noxious weeds may invade the state if a seed source is present. Plant diversity is moderate to high.

The total annual production (air-dry weight) of this state is about 750 pounds per acre, but it can range from about 600 lbs./acre in unfavorable years to about 900 lbs./acre in above average years.

The following is the growth curve of the plant community expected during a normal year:

Growth curve number:
Growth curve name:
Growth curve description:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0 0 0 5 20 45 20 5 5 0 0 0
(Monthly percentages of total annual growth)

This plant community is not resistant to change and is more vulnerable to severe disturbance than the HCPC. The introduction of grazing quickly changes the plant community.

Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestaling are obvious. Infiltration is reduced and runoff is increased.

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

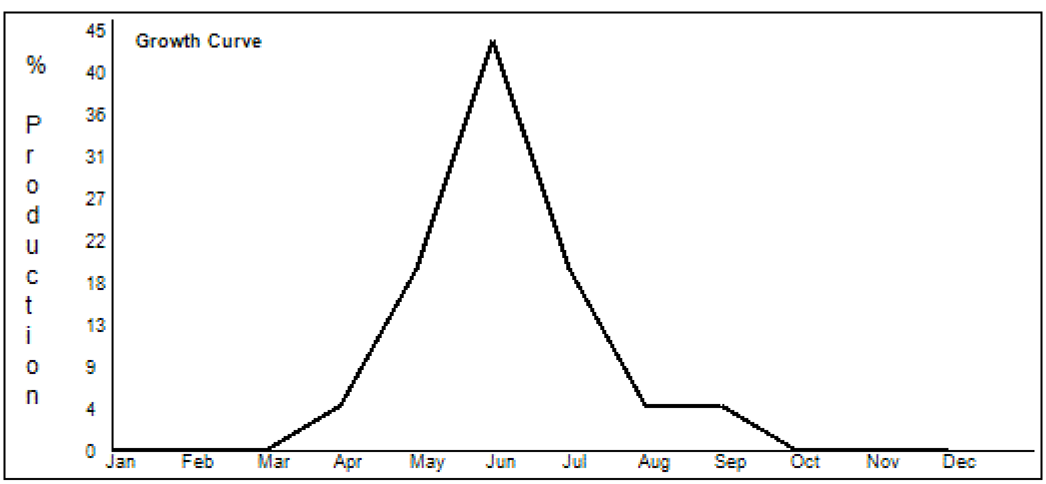
• Prescribed grazing, will return this plant community to at or near the Bluebunch wheatgrass, Idaho fescue, Threetip sagebrush Plant Community.

Plant Growth Curve

Growth curve number:	WY1001
Growth curve name:	15-19SE 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	20	45	20	5	5	0	0	0



Threetip sagebrush, Sandberg bluegrass, Threadleaf sedge Plant Community

This plant community is created when the Mixed Brush/Grass Plant Community is subjected to frequent and severe grazing. Threetip sagebrush, Sandberg bluegrass, cudweed sagewort, hairy goldenaster, and threadleaf sedge will dominate the state.

Compared to the HCPC, threetip sagebrush has increased. Virtually all cool-season mid-grasses are severely decreased. Plant diversity is low.

The total annual production (air-dry weight) of this state is about 350 pounds per acre, but it can range from about 200 lbs./acre in unfavorable years to about 450 lbs./acre in above average years.

The following is the growth curve of the plant community expected during a normal year:
Growth curve number:
Growth curve name:
Growth curve description:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0 0 0 5 20 45 20 5 5 0 0 0
(Monthly percentages of total annual growth)

This plant community is relatively stable and somewhat resistant to overgrazing. The low growing grasses, sedges and threetip sagebrush effectively compete against the establishment of perennial cool-season grasses.

The watershed is usually functioning. The biotic integrity is reduced by the lack of diversity in the plant community.

Transitions or pathways leading to other plant communities are as follows:
• Prescribed grazing will eventually return this plant community to the Mixed Brush/Grass Plant Community.

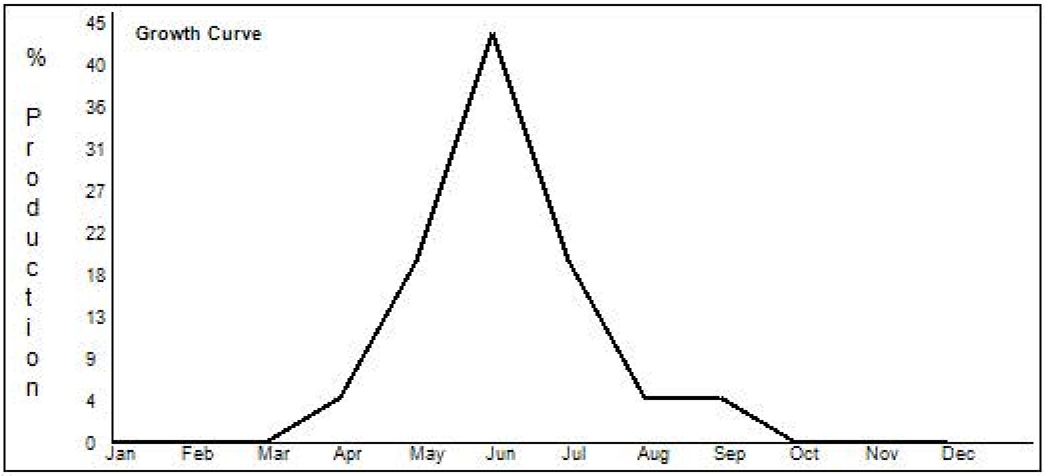
• Long-term, prescribed grazing will eventually return this plant community to at or near the Bluebunch wheatgrass, Idaho fescue, Threetip sagebrush Plant Community.

Plant Growth Curve

Growth curve number:	WY1001
Growth curve name:	15-19SE 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	20	45	20	5	5	0	0	0


Growth Curve
% Production
45
40
36
31
27
22
18
13
9
4
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

United States Department of Agriculture Natural Resources Conservation Service Ecological Site Description

Section I: Ecological Site Characteristics

Ecological Site Identification and Concept

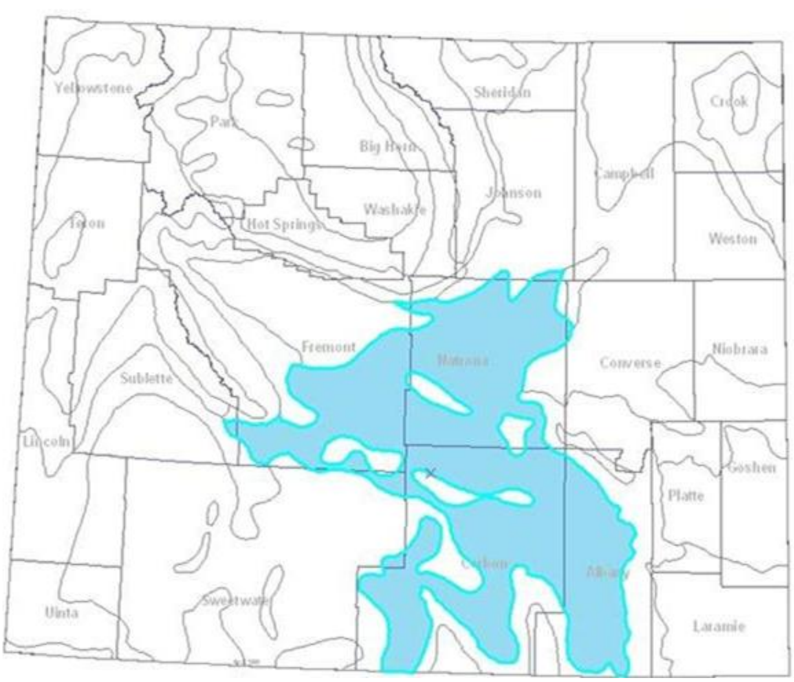
Site stage: Provisional

Provisional: an ESD at the provisional status represents the lowest tier of documentation that is releasable to the public. It contains a grouping of soil units that respond similarly to ecological processes. The ESD contains 1) enough information to distinguish it from similar and associated ecological sites and 2) a draft state and transition model capturing the ecological processes and vegetative states and community phases as they are currently conceptualized. The provisional ESD has undergone both quality control and quality assurance protocols. It is expected that the provisional ESD will continue refinement towards an approved status.

Site name: Loamy (Ly) 10-14" P.Z., High Plains Southeast

Site type: Rangeland
Site ID: R034AY322WY
Major land resource area (MLRA): 034A-Cool Central Desertic Basins and Plateaus

Precipitation Zones for Rangeland Ecological Site Descriptions



Plant Communities

Ecological Dynamics of the Site

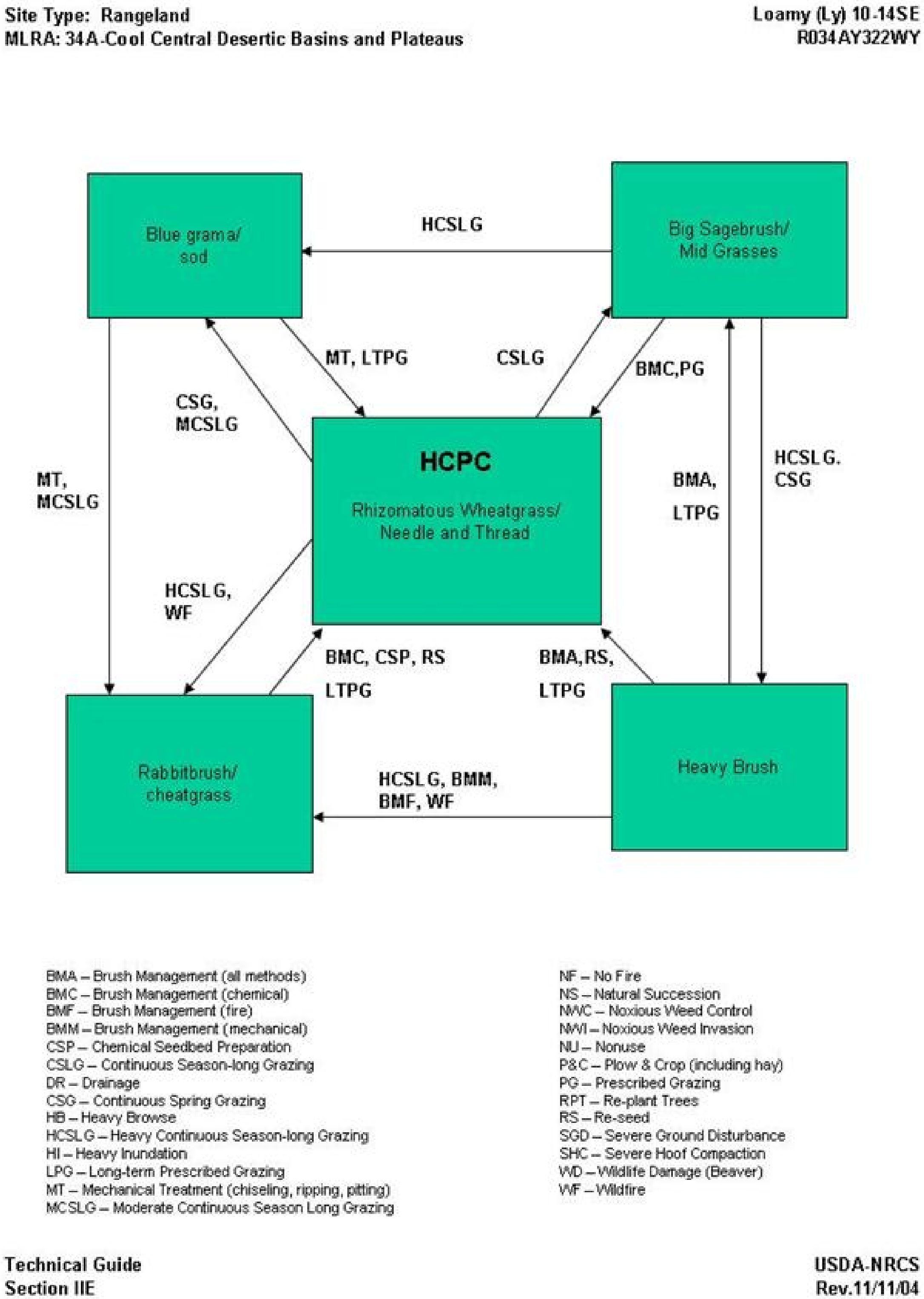
As this site deteriorates from improper grazing management, woody species such as big sagebrush and rubber rabbitbrush will increase. Bunchgrasses such as needle and thread, bluebunch wheatgrass, and green needlegrass will decrease in frequency and production. These are usually replaced by prairie junegrass, Sandberg bluegrass, blue grama, and several undesirable forbs.

Big sagebrush will become dominant on some areas with an absence of fire. Wildfires are often actively controlled so chemical control using herbicides has replaced the historic role of fire on this site. Recently, prescribed burning has regained some popularity.

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.

State-and-Transition Diagram



Rhizomatous Wheatgrass/Needle and Thread Plant Community (HCPC)

The interpretive plant community for this site is the Historic Climax Plant Community. Potential vegetation is estimated at 80% grasses or grass-like plants, 10% forbs and 10% woody plants. The major grasses include rhizomatous wheatgrass, needle and thread, bluebunch wheatgrass, and green needlegrass. Big sagebrush and rubber rabbitbrush are the major woody plants.
A typical plant composition for this state consists of rhizomatous wheatgrass 30-40%, needle and

thread 10-20%, bluebunch wheatgrass 5-15%, green needlegrass 5-10%, muttongrass 5-10%, perennial forbs 5-10%,and big sagebrush 5-15%. Ground cover, by ocular estimate, varies from 30-40%.

The total annual production (air-dry weight) of this state is about 1100 pounds per acre, but it can range from about 600lbs./acre in unfavorable years to about 1400 lbs./acre in above average years.

This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climate. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

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

• Continuous Season-long Grazing will convert the plant community to the Big Sagebrush/Mid Grass Plant Community if big sagebrush is present at 5-10%.

• Moderate Continuous Season-long Grazing or Continuous Spring Grazing will convert the plant community to the Blue Grama Sod Plant Community

• Heavy Continuous Season Long Grazing with Wild Fire will convert this plant community to the Rabbitbrush/Cheatgrass plant community.

Rhizomatous Wheatgrass/Needle and Thread Plant Community (HCPC) Plant Species Composition

Grass/Grasslike

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
1					330	440
		western wheatgrass	PASM	*Pascopyrum smithii*	330	440
2					110	220
		needle and thread	HECO26	*Hesperostipa comata*	110	220
3					55	165
		bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	55	165
4					55	110
		green needlegrass	NAVI4	*Nassella viridula*	55	110
5					55	110
		mutton bluegrass	POFE	*Poa fendleriana*	55	110
6					55	220
		Grass, perennial	2GP		0	55
		Bloomer's ricegrass	ACBL	*Achnatherum ×bloomeri [hymenoides × occidentale]*	0	55
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	55
		blue grama	BOGR2	*Bouteloua gracilis*	0	55

		needleleaf sedge	CADU6	*Carex duriuscula*	0	55
		threadleaf sedge	CAFI	*Carex filifolia*	0	55
		plains reedgrass	CAMO	*Calamagrostis montanensis*	0	55
		bottlebrush squirreltail	ELEL5	*Elymus elymoides*	0	55
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	55
		mountain muhly	MUMO	*Muhlenbergia montana*	0	55
			POCA	*Poa canbyi*	0	55
		alkali bluegrass	POSE	*Poa secunda*	0	55

Forb

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
7					55	165
		Forb, perennial	2FP		0	55
		yarrow	ACHIL	*Achillea*	0	55
		fringed sagewort	ARFR4	*Artemisia frigida*	0	55
		larkspur	DELPH	*Delphinium*	0	55
		beardtongue	PENST	*Penstemon*	0	55
		Hood's phlox	PHHO	*Phlox hoodii*	0	55
		scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0	55

Shrub/Vine

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
8					55	165
		big sagebrush	ARTR2	*Artemisia tridentata*	55	165
9					0	55
		Douglas rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0	55
10					0	55
		Shrub (>.5m)	2SHRUB		0	55

Plant Growth Curve

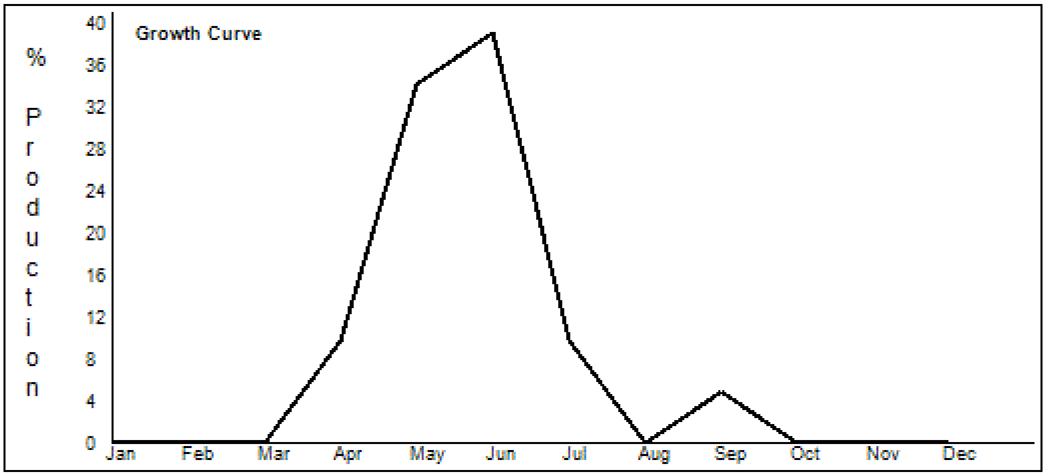
Growth curve number: WY0901

Growth curve name: 34AI, Upland Sites

Growth curve description: All Upland Sites

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	10	35	40	10	0	5	0	0	0



Big Sagebrush/Mid Grass Plant Community

This plant community is the result of continuous season long grazing of the HCPC. Big sagebrush dominates the site with an understory of rhizomatous Wheatgrass and needle and thread. Prairie junegrass, threadleaf sedge, blue grama, and other short grass and grasslike plants begin to increase in frequency and production. When compared to the HCPC, big sagebrush has increased to 25-35%

The total annual production (air-dry weight) of this state is about 1000 pounds per acre, but it can range from about 500 lbs./acre in unfavorable years to about 1300 lbs./acre in above average years.

The soil is protected and erosion may increase if management is not changed. The biotic integrity may be reduced due to loss of mid grasses and change in structure. The watershed is functioning but some disturbances could put it at risk

Transitional pathways leading to other plant communities are as follows:

• Brush Management and Prescribed Grazing will return this state to near Historic Climax Plant Community (Rhizomatous Wheatgrass/Needle and Thread Plant Community).

• Brush Management with Heavy Continuous Season-long Grazing will convert the plant community to the Heavy Brush Plant Community.

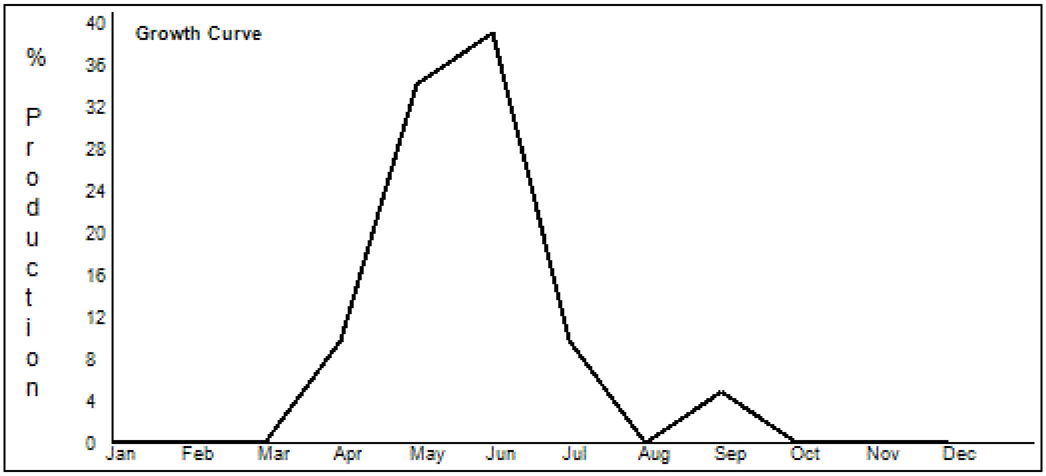
• Heavy Continuous Season-long Grazing will convert the plant community to the Blue Grama Sod Plant Community.

Plant Growth Curve

Growth curve number:	WY0901
Growth curve name:	34AI, Upland Sites
Growth curve description:	All Upland Sites

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	10	35	40	10	0	5	0	0	0



Blue Grama Sod Plant Community

This plant community is a result of moderate to heavy continuous season-long grazing or continuous spring grazing in the absence of big Sagebrush. Needle and thread and bluebunch wheatgrass give dominance to shorter stature grasses such as blue grama, prairie junegrass, Sandberg bluegrass, and threadleaf sedge. Rhizomatous wheatgrasses have also decreased. Forbs such as hoods phlox, yarrow, and fringed sagewort are common.

The total annual production (air-dry weight) of this state is about 700 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 state is somewhat stable but vulnerable to excessive erosion. The biotic integrity of this plant community is at risk or non-functioning. The watershed is usually at risk or non-functioning as bare ground increases.

Transitional pathways leading to other plant communities are as follows:

• Mechanical Treatment (Chiseling, etc.) followed by Prescribed Grazing or Long-term Prescribed Grazing may eventually return this state to near Historic Climax Plant Community (Rhizomatous Wheatgrass/Needle and Thread Plant Community).
• Mechanical Treatment followed by Moderate Continuous Season Long Grazing will lead this community to the Rabbitbrush/Cheatgrass Plant Community.

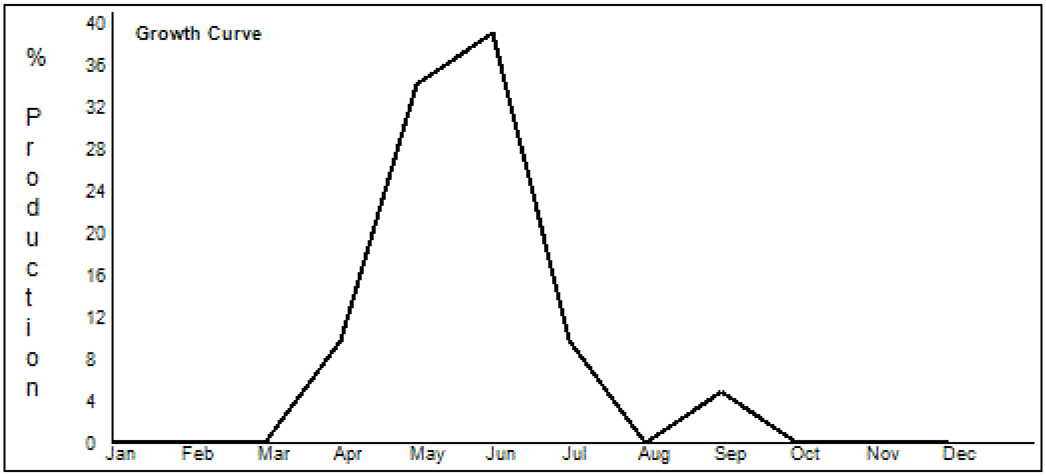
Plant Growth Curve

Growth curve number:	WY0901
Growth curve name:	34AI, Upland Sites
Growth curve description:	All Upland Sites

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

0	0	0	10	35	40	10	0	5	0	0	0



Rabbitbrush/Cheatgrass Plant Community

This plant community is a result of moderate to heavy continuous season-long grazing following fire or other practices designed to remove big sagebrush. Most desirable species have been removed allowing establishment of rabbitbrush (prolific sprouter) cheatgrass and other annuals. Prickly pear cactus is a large component of this community and provides refuge and seed source for blue grama, needle and thread, and other species.

The total annual production (air-dry weight) of this state is about 400 pounds per acre, but it can range from about 50 lbs./acre in unfavorable years to about 600 lbs./acre in above average years.

This state is unstable and vulnerable to excessive erosion. The biotic integrity of this plant community is at risk or non-functioning. The watershed is usually at risk or non-functioning as bare ground increases.

Transitional pathways leading to other plant communities are as follows:

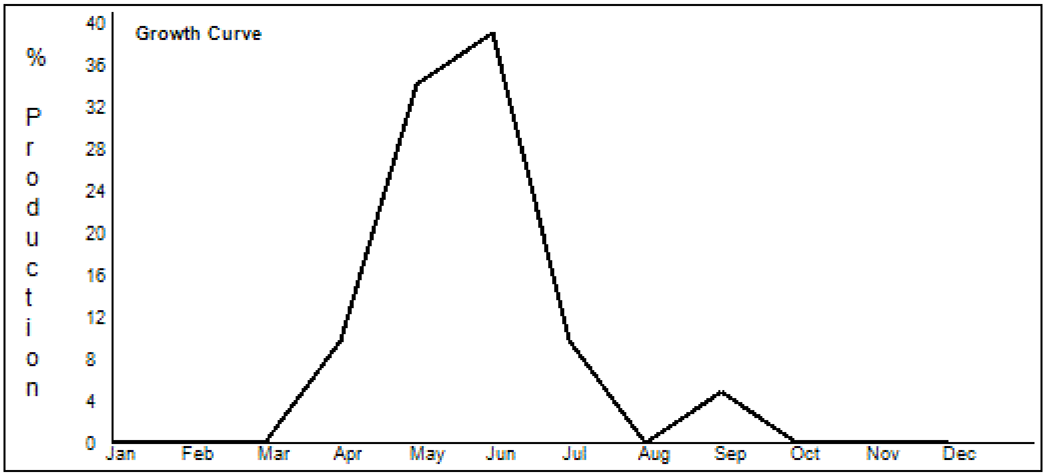
Brush Management (chemical), Chemical Seedbed Preparation and Reseeding followed by Prescribed Grazing or Long-term Prescribed Grazing may eventually return this state to near Historic Climax Plant Community (Rhizomatous Wheatgrass/Needle and Thread Plant Community).

Plant Growth Curve

Growth curve number:	WY0901
Growth curve name:	34AI, Upland Sites
Growth curve description:	All Upland Sites

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	10	35	40	10	0	5	0	0	0



Heavy Brush Plant Community

This plant community is the result of heavy continuous season long grazing or continuous spring grazing. Big sagebrush dominates the site with a sparse understory of rhizomatous Wheatgrass and needle and thread. Prairie junegrass, threadleaf sedge, blue grama, and other short grass and grasslike plants are present but provide insignificant amount to total production. When compared to the HCPC, big sagebrush has increased to 40-50%. This community is susceptible to invasion by cheatgrass and other noxious weeds.

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 800 lbs./acre in above average years.

This state is unstable and vulnerable to excessive erosion. The biotic integrity is reduced due to loss production. The watershed is functioning at risk

Transitional pathways leading to other plant communities are as follows:

• Brush Management, Reseeding and Long Term Prescribed Grazing will return this state to near Historic Climax Plant Community (Rhizomatous Wheatgrass/Needle and Thread Plant Community).

• Brush Management with Long Term Prescribed Grazing will convert the plant community similar to the Big Sagebrush/Mid Grass Plant Community.

• Heavy Continuous Season-long Grazing following Brush Management (mechanical or fire) or Wild Fire will convert the plant community to the Rabbitbrush/Cheatgrass Plant Community.

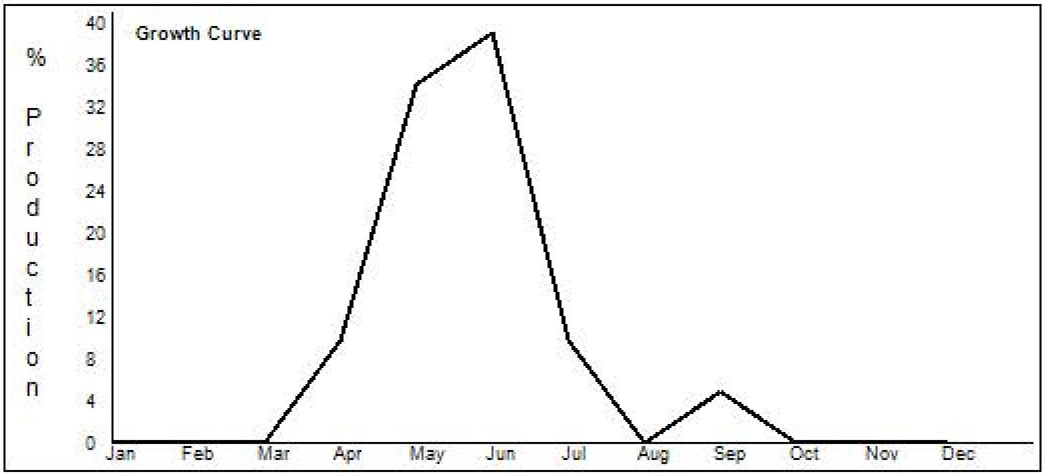
Plant Growth Curve

Growth curve number:	WY0901
Growth curve name:	34AI, Upland Sites
Growth curve description:	All Upland Sites

Percent Production by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

0	0	0	10	35	40	10	0	5	0	0	0



APPENDIX 5A

MEAN ANNUAL RUNOFF PER HUC 12 – LOWHAM METHOD

Mean Annual Runoff - Lowham Method

Plains and High Desert Region

$$\boxed{Q = 0.0021 \cdot [A^{0.88}] \cdot [P^{1.19}]}$$

Where A is drainage area (sq mi), P is mean annual precipitation (in), Q is mean annual discharge (cfs)

HUC 12	Lowham Hydrologic Region	Precipitation Gage (for Wet/Dry Estimation)	Area (sq mi)	Mean Annual Precipitation (in)			Annual Runoff (cfs)			Acre-Ft/year/sq mile			
				Normal (PRISM)	Dry	Wet	Normal (PRISM)	Dry	Wet	Normal (PRISM)	Dry	Wet	
1 - Bear Creek-North Laramie River	Mountainous Region	Double Four Ranch	44.26	21.324	10.52	19.47	2.25	0.97	2.02	37.099	16.004	33.294	*
2 - Brush Creek-Sybille Creek	Plains Region	Chugwater	40.95	16.041	11.06	20.91	1.50	0.96	2.05	26.686	17.145	36.584	
3 - Cherry Creek	Mountainous Region	Double Four Ranch	21.62	15.997	10.52	19.47	0.85	0.52	1.07	28.719	17.440	36.283	
4 - Chug Spring	Plains Region	Wheatland 4 N	27.18	15.459	9.47	18.40	1.00	0.56	1.23	26.827	14.973	33.004	
5 - Chugwater Creek-Antelope Road	Plains Region	Wheatland 4 N	32.54	14.362	9.47	18.40	1.07	0.65	1.44	24.052	14.652	32.298	
6 - Chugwater Creek-Chugwater	Plains Region	Chugwater	56.85	16.185	11.06	20.91	2.02	1.28	2.74	25.931	16.483	35.172	
7 - Chugwater Creek-Dry Creek	Plains Region	Wheatland 4 N	55.16	15.472	9.47	18.40	1.86	1.04	2.29	24.667	13.753	30.316	
8 - Chugwater Creek-Dry Creek-Laramie River	Plains Region	Chugwater	59.77	16.575	11.06	20.91	2.17	1.34	2.86	26.516	16.385	34.961	
9 - Chugwater Creek-North Chugwater Creek	Plains Region	Chugwater	55.80	16.127	11.06	20.91	1.98	1.26	2.69	25.879	16.520	35.250	
10 - Chugwater Creek-Threemile Creek	Plains Region	Sybille Research Unit	54.03	16.136	12.03	20.00	1.92	1.36	2.48	25.996	18.329	33.562	
11 - Deadhead Creek	Plains Region	Sybille Research Unit	40.73	15.875	12.03	20.00	1.47	1.06	1.94	26.375	18.961	34.720	
12 - Deer Creek-Laramie River	Plains Region	Wheatland 4 N	36.59	14.626	9.47	18.40	1.21	0.72	1.60	24.235	14.448	31.848	
13 - Dry Laramie River	Plains Region	Double Four Ranch	54.29	14.882	10.52	19.47	1.75	1.16	2.42	23.596	15.616	32.488	
14 - Dwery Cemetary	Plains Region	Wheatland 4 N	31.55	14.071	9.47	18.40	1.02	0.64	1.40	23.559	14.707	32.419	
15 - Eagles Nest Canyon	Plains Region	Wheatland 4 N	23.53	15.069	9.47	18.40	0.85	0.49	1.08	26.476	15.233	33.580	
16 - Fish Creek-North Laramie River	Plains Region	Wheatland 4 N	61.04	14.764	9.47	18.40	1.93	1.14	2.50	23.047	13.587	29.950	
17 - Hunton Creek	Plains Region	Chugwater	26.25	16.250	11.06	20.91	1.03	0.65	1.39	28.587	18.085	38.590	
18 - Laramie River-Dodge Creek	High Desert Region	Sybille Research Unit	45.57	14.129	12.03	20.00	1.41	1.17	2.14	22.653	18.708	34.255	
19 - Laramie River-Grayrocks Reservoir	Plains Region	Wheatland 4 N	65.69	14.055	9.47	18.40	1.94	1.21	2.67	21.546	13.468	29.688	
20 - Laramie River-Laramie River Ditch	Plains Region	Wheatland 4 N	49.18	13.796	9.47	18.40	1.47	0.94	2.07	21.820	13.944	30.737	
21 - Laramie River-Luman Creek	Plains Region	Double Four Ranch	40.92	15.162	10.52	19.47	1.40	0.91	1.88	24.959	16.155	33.609	
22 - Laramie River-Marble Query Spring	Plains Region	Wheatland 4 N	41.45	14.315	9.47	18.40	1.32	0.81	1.78	23.272	14.233	31.374	
23 - Laramie River-Preemption Creek	Mountainous Region	Sybille Research Unit	31.82	15.299	12.03	20.00	1.13	0.85	1.56	26.000	19.531	35.764	
24 - Laramie River-Sixmile Creek	Plains Region	Wheatland 4 N	54.47	13.885	9.47	18.40	1.62	1.03	2.27	21.718	13.774	30.362	
25 - Laramie River-Slate Creek	Mountainous Region	Double Four Ranch	40.87	15.090	10.52	19.47	1.39	0.90	1.88	24.821	16.158	33.614	
26 - Lower Bluegrass Creek	Mountainous Region	Sybille Research Unit	44.96	15.697	12.03	20.00	1.58	1.15	2.11	25.718	18.738	34.311	
27 - Lower Duck Creek-Dry Laramie River	Mountainous Region	Double Four Ranch	37.97	16.398	10.52	19.47	1.44	0.85	1.76	27.644	16.301	33.913	
28 - Lower Middle Chugwater Creek	Plains Region	Sybille Research Unit	43.52	16.316	12.03	20.00	1.61	1.12	2.05	27.034	18.811	34.445	
29 - Lower North Sybille Creek	Plains Region	Sybille Research Unit	31.25	15.658	12.03	20.00	1.15	0.84	1.53	26.785	19.574	35.841	
30 - Lower Richeau Creek	Plains Region	Chugwater	49.38	16.284	11.06	20.91	1.80	1.13	2.42	26.566	16.764	35.771	
31 - Lower South Chugwater Creek	Plains Region	Sybille Research Unit	35.34	17.028	12.03	20.00	1.41	0.93	1.71	29.163	19.287	35.317	
32 - Lower South Fork Sybille Creek	Plains Region	Sybille Research Unit	43.72	15.984	12.03	20.00	1.58	1.13	2.06	26.366	18.801	34.426	
33 - Lower Sybille Creek	Plains Region	Wheatland 4 N	22.78	14.724	9.47	18.40	0.81	0.48	1.05	25.858	15.293	33.711	
34 - Middle Bluegrass Creek	High Desert Region	Sybille Research Unit	53.34	15.807	12.03	20.00	1.86	1.34	2.46	25.406	18.358	33.614	
35 - Middle North Sybille Creek	High Desert Region	Sybille Research Unit	32.05	16.575	12.03	20.00	1.25	0.86	1.57	28.575	19.514	35.732	
36 - Middle Sybille Creek	High Desert Region	Sybille Research Unit	30.92	17.530	12.03	20.00	1.30	0.83	1.52	30.676	19.598	35.887	

Mean Annual Runoff - Lowham Method

Plains and High Desert Region

$$Q = 0.0021 \cdot [A^{0.88}] \cdot [P^{1.19}]$$

Where A is drainage area (sq mi), P is mean annual precipitation (in), Q is mean annual discharge (cfs)

HUC 12	Lowham Hydrologic Region	Precipitation Gage (for Wet/Dry Estimation)	Area (sq mi)	Mean Annual Precipitation (in)			Annual Runoff (cfs)			Acre-Ft/year/sq mile			
				Normal (PRISM)	Dry	Wet	Normal (PRISM)	Dry	Wet	Normal (PRISM)	Dry	Wet	
37 - Mule Creek-Sybille Creek	Plains Region	Sybille Research Unit	24.40	15.801	12.03	20.00	0.93	0.67	1.23	27.892	20.164	36.922	
38 - North Laramie River-Antelope Creek	High Desert Region	Double Four Ranch	31.58	16.122	10.52	19.47	1.20	0.72	1.50	27.698	16.665	34.670	
39 - North Laramie River-Bar M Creek	Mountainous Region	Double Four Ranch	42.12	20.939	10.52	19.47	2.11	0.93	1.93	36.521	16.099	33.493	*
40 - North Laramie River-Big Draw	Plains Region	Wheatland 4 N	50.77	14.193	9.47	18.40	1.56	0.97	2.13	22.482	13.891	30.620	
41 - North Laramie River-Cow Creek	High Desert Region	Double Four Ranch	52.46	17.692	10.52	19.47	2.09	1.13	2.34	29.108	15.681	32.622	
42 - North Laramie River-Coyote Creek	Mountainous Region	Double Four Ranch	45.31	16.841	10.52	19.47	1.73	0.99	2.06	27.936	15.959	33.201	
43 - North Laramie River-Owen Creek	Mountainous Region	Double Four Ranch	58.77	15.462	10.52	19.47	1.97	1.25	2.59	24.460	15.468	32.181	
44 - Pinto Creek	High Desert Region	Double Four Ranch	26.44	15.709	10.52	19.47	0.99	0.62	1.28	27.433	17.024	35.417	
45 - Sturgeon Creek	Mountainous Region	Double Four Ranch	30.06	17.333	10.52	19.47	1.25	0.69	1.44	30.370	16.764	34.877	
46 - Twentytwo Mile Draw	High Desert Region	Double Four Ranch	57.71	13.102	10.52	19.47	1.59	1.23	2.55	20.128	15.502	32.251	
47 - Upper Bluegrass Creek	High Desert Region	Sybille Research Unit	41.24	14.429	12.03	20.00	1.33	1.07	1.96	23.507	18.933	34.668	
48 - Upper Duck Creek-Lower Duck Creek	High Desert Region	Double Four Ranch	42.55	16.648	10.52	19.47	1.62	0.94	1.95	27.765	16.080	33.452	
49 - Upper Middle Chugwater Creek	High Desert Region	Sybille Research Unit	50.35	18.150	12.03	20.00	2.08	1.27	2.33	30.155	18.485	33.848	
50 - Upper North Sybille Creek	High Desert Region	Sybille Research Unit	34.02	16.699	12.03	20.00	1.33	0.90	1.65	28.625	19.375	35.478	
51 - Upper Richeau Creek	Plains Region	Chugwater	53.18	16.437	11.06	20.91	1.94	1.21	2.58	26.625	16.616	35.455	
52 - Upper South Chugwater Creek	High Desert Region	Sybille Research Unit	39.85	18.639	12.03	20.00	1.75	1.04	1.90	32.010	19.011	34.811	
53 - Upper South Fork Sybille Creek	Plains Region	Sybille Research Unit	29.55	17.664	12.03	20.00	1.26	0.80	1.46	31.125	19.706	36.083	
54 - Upper Sybille Creek	Plains Region	Sybille Research Unit	49.07	15.304	12.03	20.00	1.66	1.25	2.28	24.691	18.542	33.952	
55 - Wheatland Creek	Plains Region	Wheatland 4 N	56.02	14.701	9.47	18.40	1.78	1.05	2.32	23.168	13.728	30.261	

*Estimated "wet" year precipitation is less than the normal (PRISM) value for the watershed. There are no gages in the Laramie mountains with >40 years of data, so computed dry/wet year precipitation based on the Double Four Ranch Station is likely underestimated for these mountainous watersheds

APPENDIX 5B

PEAK FLOW PER HUC 12 – MILLER (USGS) METHOD

Appendix 5B - Peak Flow - Miller (USGS) Method

Peak Flow Characteristics : Published Regression Coefficients (Miller 2003)

Recurrence Interval	Region 1: Rocky Mountain Region				Region 3: Eastern Basins and Eastern Plains Region		
	A	B	C	D	A	B	C
1.5 yr	0.126	0.885	2.56	0.032	1.12	0.401	3.01
2 yr	0.313	0.866	2.32	-0.069	2.28	0.402	2.9
2.33 yr	0.458	0.858	2.22	-0.110	3.1	0.403	2.84
5 yr	1.89	0.829	1.85	-0.262	10.1	0.407	2.6
10 yr	4.71	0.810	1.60	-0.357	21.9	0.410	2.44
25 yr	12.1	0.790	1.34	-0.451	48.8	0.416	2.27
50 yr	22.3	0.776	1.16	-0.510	80.9	0.423	2.16
100 yr	38.6	0.764	1.00	-0.562	127	0.432	2.05
200 yr	64.3	0.752	0.857	-0.611	193	0.441	1.94
500 yr	120	0.738	0.674	-0.670	323	0.454	1.80

Equation for Region 1: Rocky Mountain Region (Miller, 2003)

$$Q = A \cdot [AREA^B] \cdot [\frac{ELEV - 3000}{1000}]^C \cdot [LNG - 100]^D$$

Q = peak discharge (cfs), AREA = total drainage area (sq mi), ELEV = mean basin elevation (ft), LNG = longitude of basin outlet (absolute value)
A, B, C, and D are coefficients that vary with recurrance interval (see table)

Equation for Region 3: Eastern Basins and Eastern Plains Region (Miller, 2003)

$$Q = A \cdot [AREA^B] \cdot [SOIL^C]$$

Q = peak discharge (cfs), AREA = total drainage area (sq mi), SOIL = mean basin soil hydrologic index
A, B, and C are coefficients that vary with recurrance interval (see table)

HUC12 Basin Name	Region	Area (sq mi)	Mean Basin Elev (ft)	Longitude	Soil Index	Peak flows in cfs for various return periods									
						1.5 yr	2 yr	2.33 yr	5 yr	10 yr	25 yr	50 yr	100 yr	200 yr	500 yr
1 - Bear Creek-North Laramie River	1	44.26	7733	-105.45	3.34	203.71	273.23	309.73	497.92	666.38	903.31	1079.83	1275.22	1495.69	1802.12
2 - Brush Creek-Sybille Creek	3	40.95	5583		2.45	73.98	136.94	177.09	472.10	896.65	1753.90	2703.57	3975.78	5659.85	8766.65
3 - Cherry Creek	1	21.62	6847	-105.31	3.20	63.50	90.96	105.99	188.53	270.01	392.77	493.00	607.82	741.60	938.81
4 - Chug Spring	3	27.18	5057		2.59	73.91	135.95	175.16	460.16	865.35	1672.99	2556.15	3722.83	5248.79	8025.49
5 - Chugwater Creek-Antelope Road	3	32.54	4742		2.28	54.42	101.51	131.80	357.12	685.59	1355.55	2102.62	3109.98	4453.01	6945.85
6 - Chugwater Creek-Chugwater	3	56.85	5316		2.57	97.19	179.05	230.96	609.63	1150.31	2236.56	3437.70	5044.19	7164.94	11072.29
7 - Chugwater Creek-Dry Creek	3	55.16	5045		2.19	59.43	111.42	145.11	397.90	770.12	1538.20	2405.60	3591.23	5189.94	8198.02
8 - Chugwater Creek-Dry Creek-Laramie River	3	59.77	5692		2.38	78.65	146.14	189.39	509.32	973.11	1917.52	2973.43	4402.04	6308.83	9861.38
9 - Chugwater Creek-North Chugwater Creek	1	55.80	6231	-104.98	2.47	93.87	138.62	163.54	304.85	450.67	677.15	868.78	1092.60	1355.52	1754.91
10 - Chugwater Creek-Threemile Creek	1	54.03	6529	-105.09	2.74	114.35	165.07	192.92	347.24	501.41	735.30	927.77	1149.59	1407.41	1791.45
11 - Deadhead Creek	1	40.73	6039	-105.13	2.72	60.78	91.37	108.61	208.09	313.39	480.17	624.59	795.06	997.43	1309.42
12 - Deer Creek-Laramie River	3	36.59	4740		2.50	74.46	137.57	177.69	471.55	892.84	1740.17	2675.24	3922.72	5568.14	8591.30
13 - Dry Laramie River	1	54.29	5566	-105.08	2.61	50.78	79.14	95.49	193.43	302.52	482.01	644.13	839.95	1076.34	1452.43
14 - Dwery Cemetary	3	31.55	4798		2.50	70.64	130.46	168.46	446.56	844.85	1644.54	2524.98	3696.54	5238.81	8065.08
15 - Eagles Nest Canyon	3	23.53	4916		2.69	78.36	143.51	184.44	479.80	896.34	1720.07	2614.30	3786.48	5309.03	8058.72
16 - Fish Creek-North Laramie River	3	61.04	5323		2.58	100.51	185.15	238.82	630.29	1189.24	2312.59	3555.69	5219.70	7417.64	11470.75
17 - Hunton Creek	3	26.25	5526		2.38	56.14	104.26	135.02	362.12	690.43	1354.34	2088.62	3070.10	4368.63	6758.24
18 - Laramie River-Dodge Creek	1	45.57	7102	-105.53	2.93	144.97	200.81	230.72	389.82	539.63	757.68	928.16	1120.21	1339.57	1654.67
19 - Laramie River-Grayrocks Reservoir	3	65.69	4669		2.47	91.51	169.35	218.99	583.84	1109.08	2172.72	3357.42	4954.15	7076.70	11016.87
20 - Laramie River-Laramie River Ditch	3	49.18	4663		1.96	40.52	76.90	100.80	283.82	559.06	1137.31	1799.24	2716.50	3970.35	6361.14
21 - Laramie River-Luman Creek	3	40.92	5584		2.45	74.00	136.98	177.13	472.20	896.81	1754.13	2703.87	3976.12	5660.19	8766.88
22 - Laramie River-Marble Query Spring	3	41.45	4920		2.15	49.80	93.55	121.94	335.66	651.26	1303.14	2038.55	3042.38	4395.44	6937.34
23 - Laramie River-Preemption Creek	1	31.82	6695	-105.31	3.20	80.65	115.80	135.05	241.11	346.26	505.05	635.10	784.41	958.11	1215.26
24 - Laramie River-Sixmile Creek	3	54.47	4468		2.35	72.98	135.77	176.08	474.76	908.64	1793.30	2782.81	4122.06	5910.76	9244.17
25 - Laramie River-Slate Creek	1	40.87	5686	-105.20	2.82	44.46	68.74	82.68	165.47	256.68	405.58	538.97	699.25	892.24	1197.11
26 - Lower Bluegrass Creek	1	44.96	6256	-105.21	3.05	79.14	116.60	137.45	255.37	376.74	565.03	724.23	909.95	1128.16	1459.10
27 - Lower Duck Creek-Dry Laramie River	1	37.97	7091	-105.33	3.20	122.40	170.87	196.95	336.71	469.63	664.51	818.23	991.97	1191.37	1479.23
28 - Lower Middle Chugwater Creek	1	43.52	6722	-105.21	3.08	108.29	154.62	179.89	318.38	454.54	658.85	824.77	1014.74	1234.73	1559.04
29 - Lower North Sybille Creek	1	31.25	6088	-105.21	2.86	50.12	75.30	89.50	171.35	257.92	395.04	513.78	653.86	820.36	1076.78
30 - Lower Richeau Creek	3	49.38	5524		2.32	67.63	125.97	163.47	441.90	847.15	1674.43	2600.07	3853.17	5527.75	8648.95
31 - Lower South Chugwater Creek	1	35.34	7068	-105.24	3.46	113.13	158.65	183.21	315.38	441.87	628.13	775.83	943.12	1135.60	1414.38
32 - Lower South Fork Sybille Creek	1	43.72	6219	-105.23	3.23	75.03	110.86	130.84	244.13	361.23	543.45	698.08	878.78	1091.41	1414.69
33 - Lower Sybille Creek	3	22.78	4862		2.11	37.10	69.80	91.02	251.04	487.61	975.16	1522.12	2263.92	3259.66	5117.75
34 - Middle Bluegrass Creek	1	53.34	7004	-105.40	3.04	156.55	218.00	251.01	427.53	595.00	839.96	1032.62	1250.32	1499.27	1858.70
35 - Middle North Sybille Creek	1	32.05	6813	-105.33	3.51	88.00	125.35	145.71	256.99	366.04	529.36	661.74	813.05	988.43	1246.21

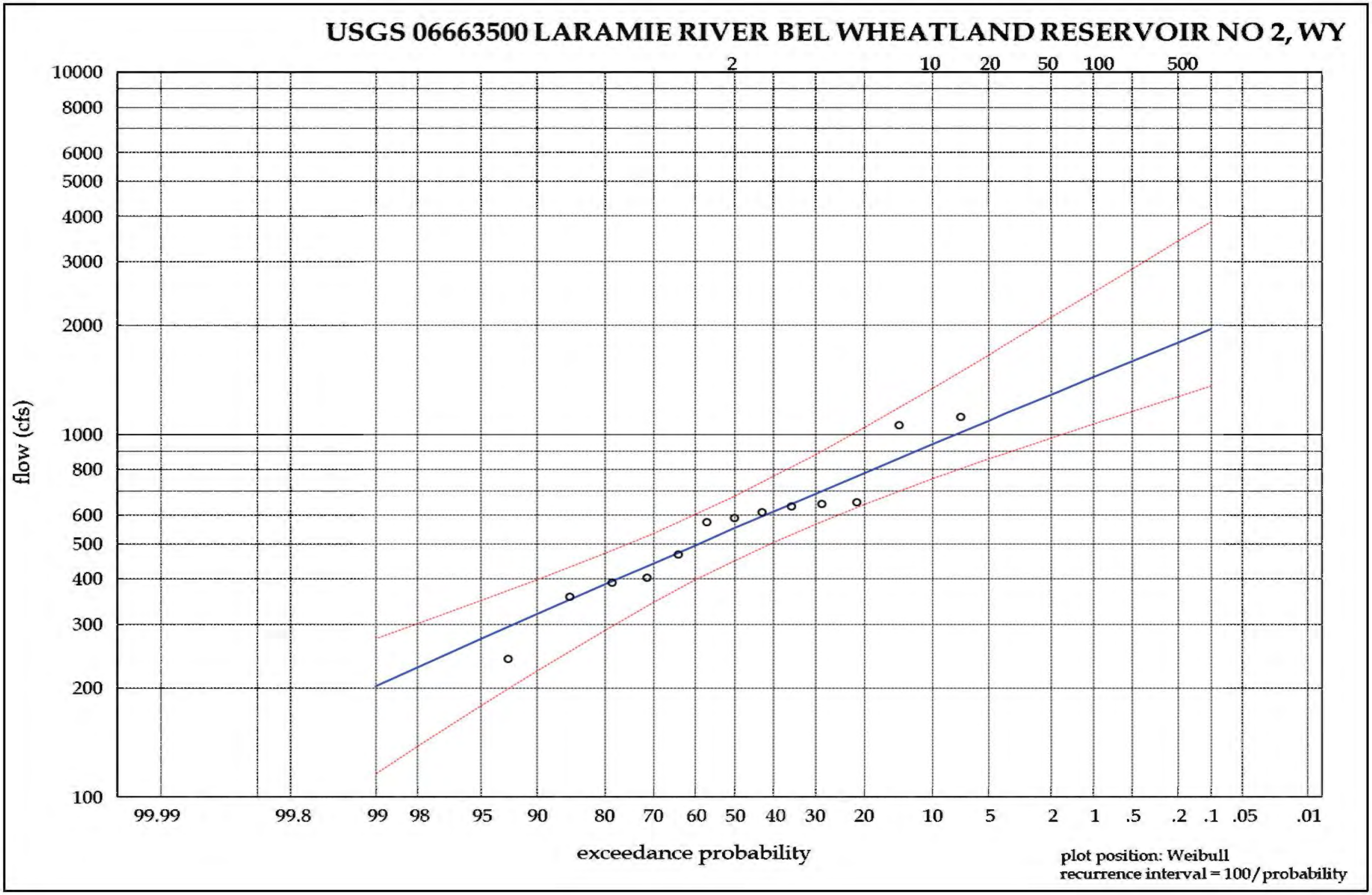
HUC12 Basin Name	Region	Area (sq mi)	Mean Basin Elev (ft)	Longitude	Soil Index	Peak flows in cfs for various return periods									
						1.5 yr	2 yr	2.33 yr	5 yr	10 yr	25 yr	50 yr	100 yr	200 yr	500 yr
36 - Middle Sybille Creek	1	30.92	7096	-105.33	3.80	102.37	143.44	165.60	284.74	398.65	566.31	699.23	849.71	1022.94	1273.60
37 - Mule Creek-Sybille Creek	1	24.40	6352	-105.22	3.01	49.67	73.50	86.81	162.37	240.54	362.39	465.98	587.00	730.01	947.11
38 - North Laramie River-Antelope Creek	1	31.58	7400	-105.68	2.82	125.52	171.70	196.26	325.24	444.39	615.66	747.38	894.66	1062.46	1300.28
39 - North Laramie River-Bar M Creek	1	42.12	7869	-105.72	3.11	209.97	278.62	314.45	497.27	658.41	882.80	1047.68	1229.28	1433.43	1714.47
40 - North Laramie River-Big Draw	3	50.77	4808		2.06	47.73	90.08	117.74	327.57	640.15	1291.47	2032.33	3052.40	4438.01	7063.56
41 - North Laramie River-Cow Creek	1	52.46	7364	-105.57	3.17	192.44	261.77	298.48	490.38	666.20	917.29	1108.61	1322.10	1563.90	1905.50
42 - North Laramie River-Coyote Creek	1	45.31	7029	-105.40	3.16	137.68	192.02	221.24	377.72	526.46	744.38	916.16	1110.33	1332.80	1654.15
43 - North Laramie River-Owen Creek	1	58.77	5984	-105.16	2.97	80.23	120.21	142.70	272.07	408.51	623.92	809.76	1028.90	1288.08	1687.32
44 - Pinto Creek	1	26.44	7252	-105.65	2.70	98.26	136.04	156.28	263.82	364.94	512.13	627.26	756.77	905.24	1117.88
45 - Sturgeon Creek	1	30.06	7030	-105.40	3.17	95.80	134.65	155.65	268.89	377.70	538.42	666.46	811.68	979.09	1222.11
46 - Twentytwo Mile Draw	1	57.71	7143	-105.68	2.48	183.40	251.64	287.98	479.56	657.61	914.36	1112.67	1335.15	1587.78	1948.24
47 - Upper Bluegrass Creek	1	41.24	7191	-105.56	2.38	140.20	193.49	221.98	372.92	514.25	719.18	878.61	1057.81	1262.33	1554.94
48 - Upper Duck Creek-Lower Duck Creek	1	42.55	7286	-105.49	3.01	152.68	209.70	240.07	400.29	549.14	763.80	929.55	1115.33	1326.91	1628.12
49 - Upper Middle Chugwater Creek	1	50.35	7631	-105.32	3.79	215.76	290.89	330.45	535.45	720.39	981.72	1177.69	1395.21	1640.90	1984.18
50 - Upper North Sybille Creek	1	34.02	7291	-105.45	3.27	125.61	173.32	198.82	333.88	460.17	643.17	785.36	945.03	1127.53	1388.11
51 - Upper Richeau Creek	1	53.18	6080	-104.95	2.63	79.52	118.98	141.15	268.50	402.36	613.17	794.39	1007.72	1260.00	1647.45
52 - Upper South Chugwater Creek	1	39.85	7754	-105.30	3.77	187.58	252.53	286.70	463.46	622.43	846.70	1014.47	1200.40	1410.70	1703.58
53 - Upper South Fork Sybille Creek	1	29.55	7160	-105.30	3.68	102.27	142.98	164.91	282.54	394.60	559.11	689.09	836.01	1005.05	1249.01
54 - Upper Sybille Creek	3	49.07	5469		2.39	73.27	136.07	176.28	473.38	903.50	1777.45	2751.60	4065.20	5814.03	9061.26
55 - Wheatland Creek	3	56.02	4923		2.01	46.19	87.42	114.43	320.33	628.59	1274.09	2011.67	3032.04	4423.97	7073.96

APPENDIX 5C

PEAK FLOW AT GAGED SITES – LOG PEARSON III METHOD

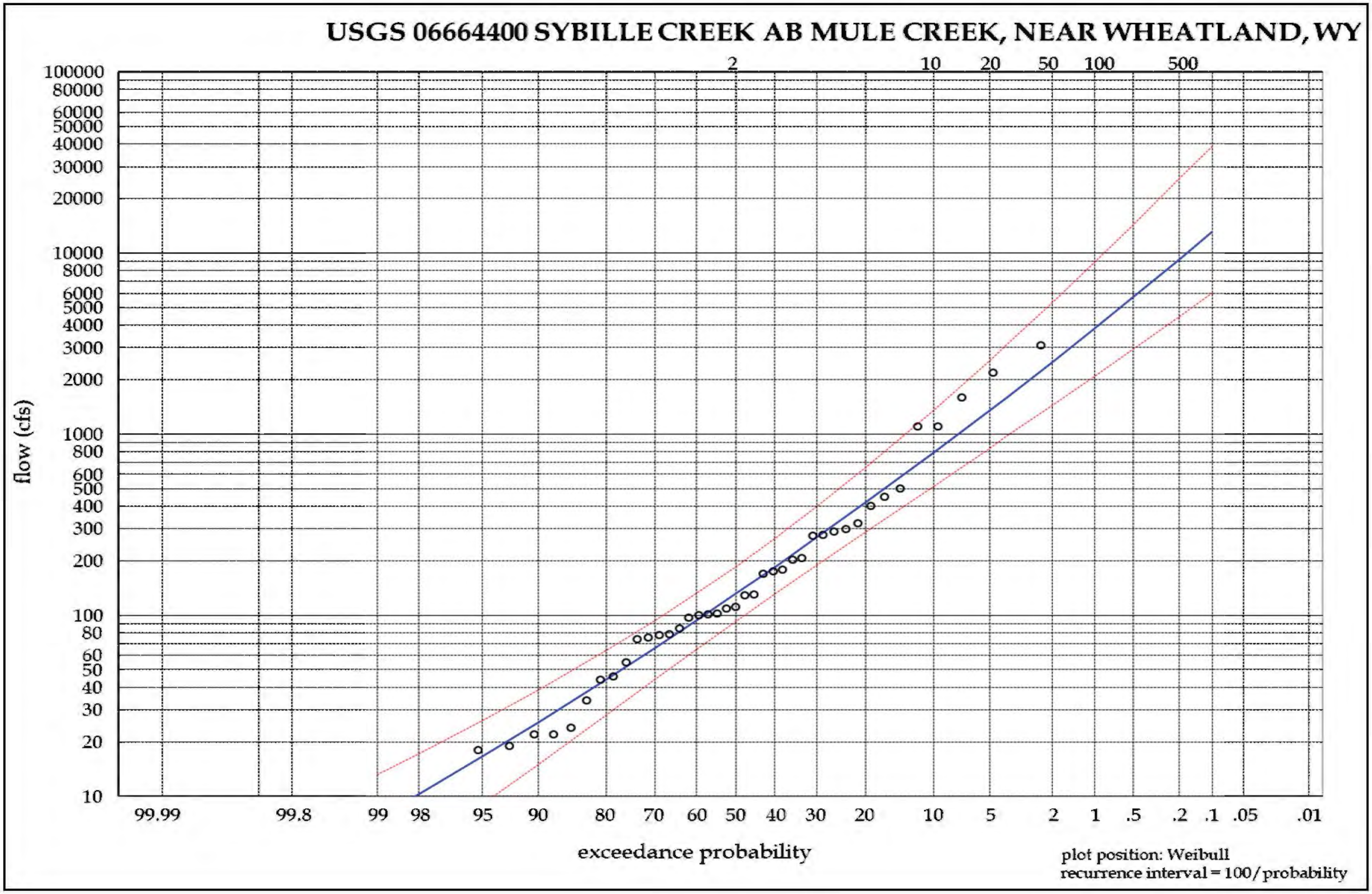
USGS 06663500 LARAMIE RIVER BEL WHEATLAND RESERVOIR NO 2, WY

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	1,954	3,869	1,362
500	1,796	3,416	1,275
200	1,591	2,860	1,160
100	1,439	2,470	1,071
50	1,289	2,105	980
25	1,140	1,763	887
20	1,091	1,657	856
10	940	1,343	755
5	784	1,048	642
3.333	687	882	567
2.5	613	766	505
2	551	677	450
1.667	495	602	397
1.429	441	535	344
1.250	385	471	289
1.111	319	398	223
1.053	273	348	178
1.020	228	301	138
1.010	202	274	116


USGS 06663500 LARAMIE RIVER BEL WHEATLAND RESERVOIR NO 2, WY
2
10
20
50
100
500
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
flow (cfs)
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

USGS 06664400 SYBILLE CREEK AB MULE CREEK, NEAR WHEATLAND, WY

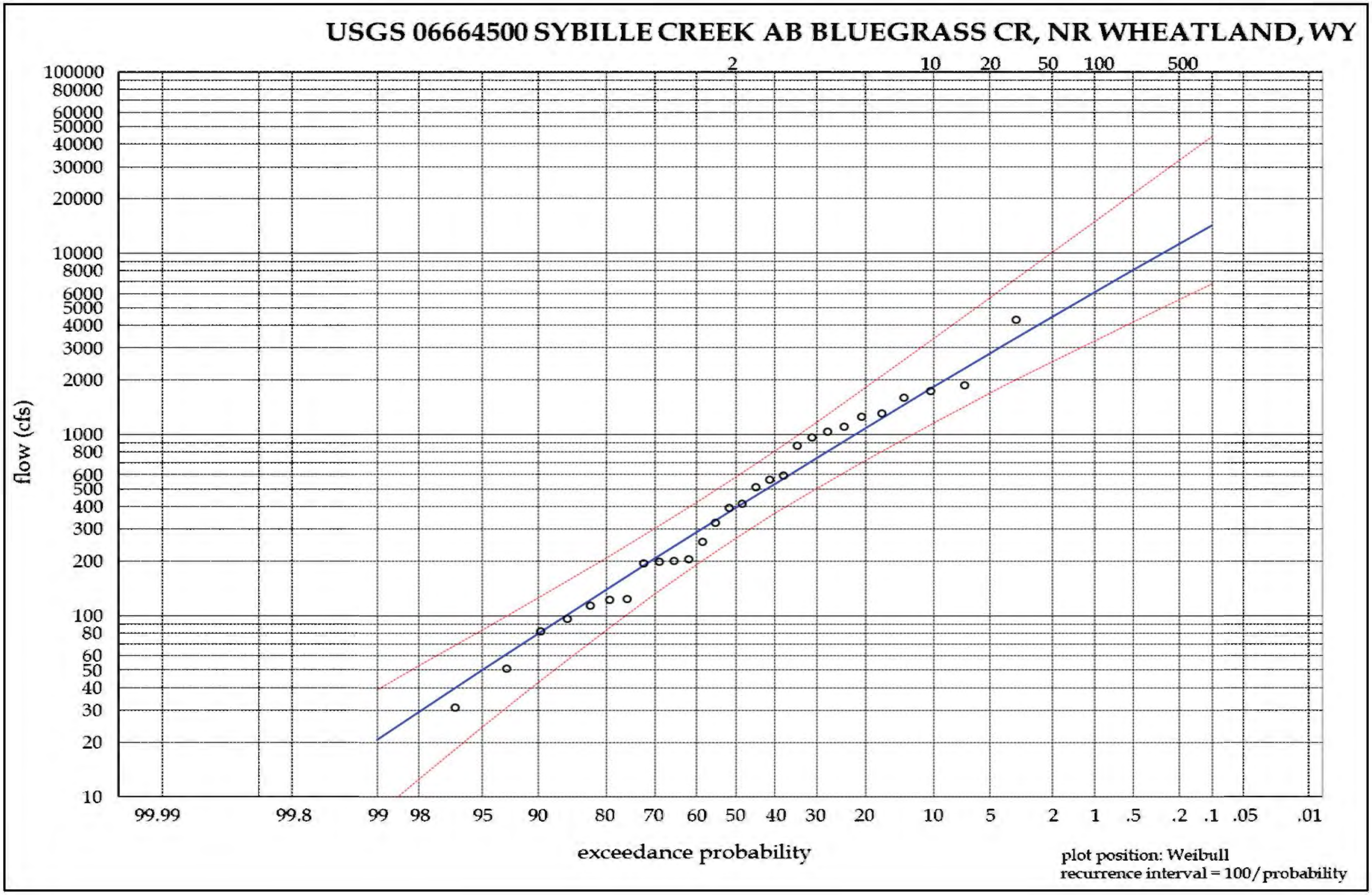
recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	13,072	39,039	6,021
500	9,242	25,658	4,469
200	5,683	14,263	2,938
100	3,832	8,875	2,088
50	2,509	5,342	1,444
25	1,581	3,081	963
20	1,348	2,551	836
10	788	1,356	517
5	418	654	289
3.333	268	398	189
2.5	185	266	131
2	131	186	92
1.667	94	132	65
1.429	66	94	44
1.250	44	64	28
1.111	26	39	15
1.053	17	26	9
1.020	10	17	5
1.010	8	13	4



USGS 06664400 SYBILLE CREEK AB MULE CREEK, NEAR WHEATLAND, WY
2
10
20
50
100
500
flow (cfs)
100000
80000
60000
50000
40000
30000
20000
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

USGS 06664500 SYBILLE CREEK AB BLUEGRASS CR, NR WHEATLAND, WY

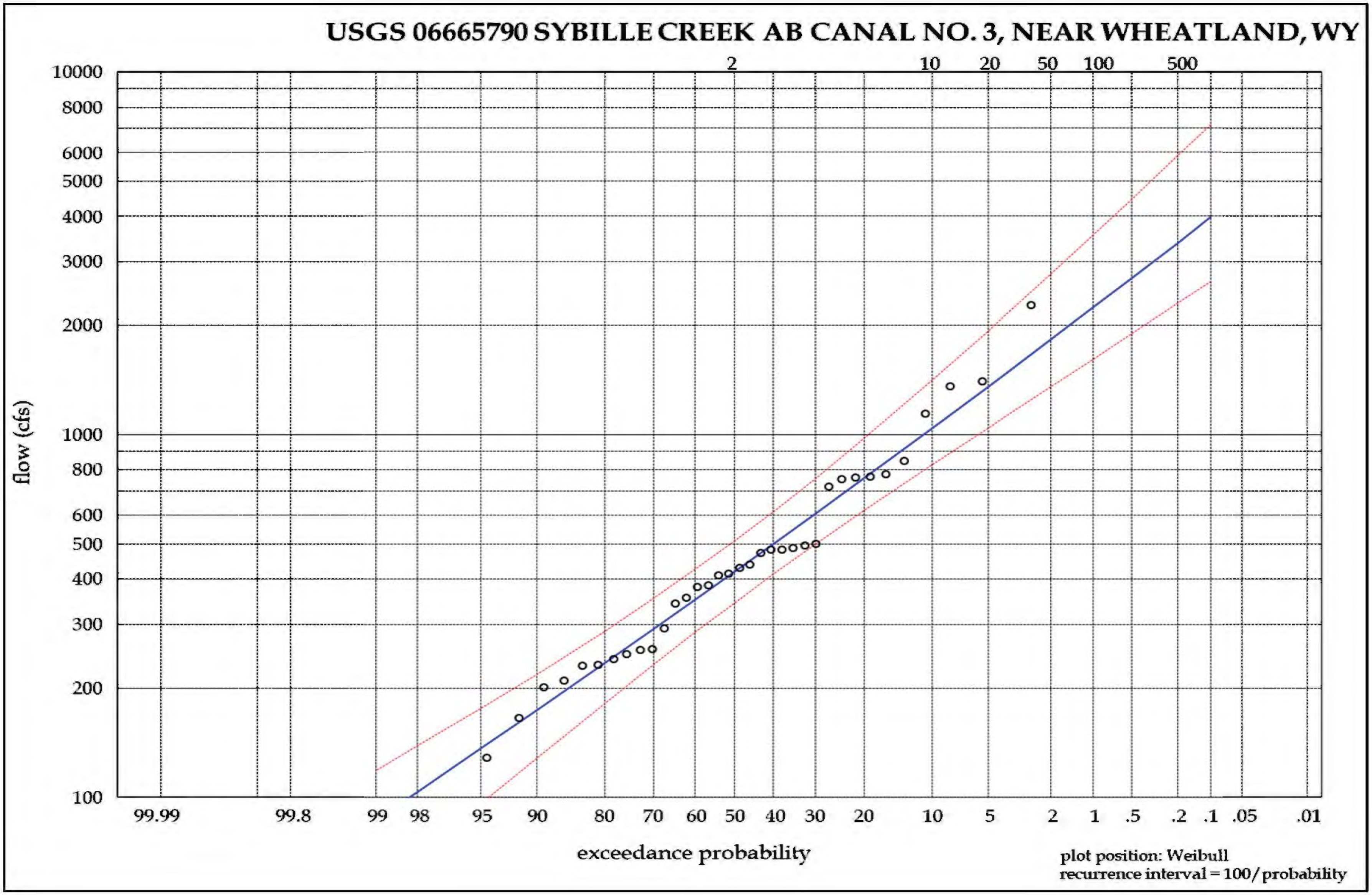
recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	14,241	43,879	6,762
500	11,262	32,603	5,553
200	8,037	21,295	4,177
100	6,068	14,956	3,291
50	4,451	10,149	2,526
25	3,144	6,587	1,872
20	2,782	5,664	1,683
10	1,823	3,375	1,160
5	1,085	1,813	724
3.333	743	1,169	506
2.5	536	811	367
2	394	582	267
1.667	289	422	191
1.429	207	303	132
1.250	139	208	83
1.111	80	126	43
1.053	50	84	24
1.020	30	53	13
1.010	21	39	8



USGS 06664500 SYBILLE CREEK AB BLUEGRASS CR, NR WHEATLAND, WY
2
10
20
50
100
500
100000
80000
60000
50000
40000
30000
20000
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
flow (cfs)
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

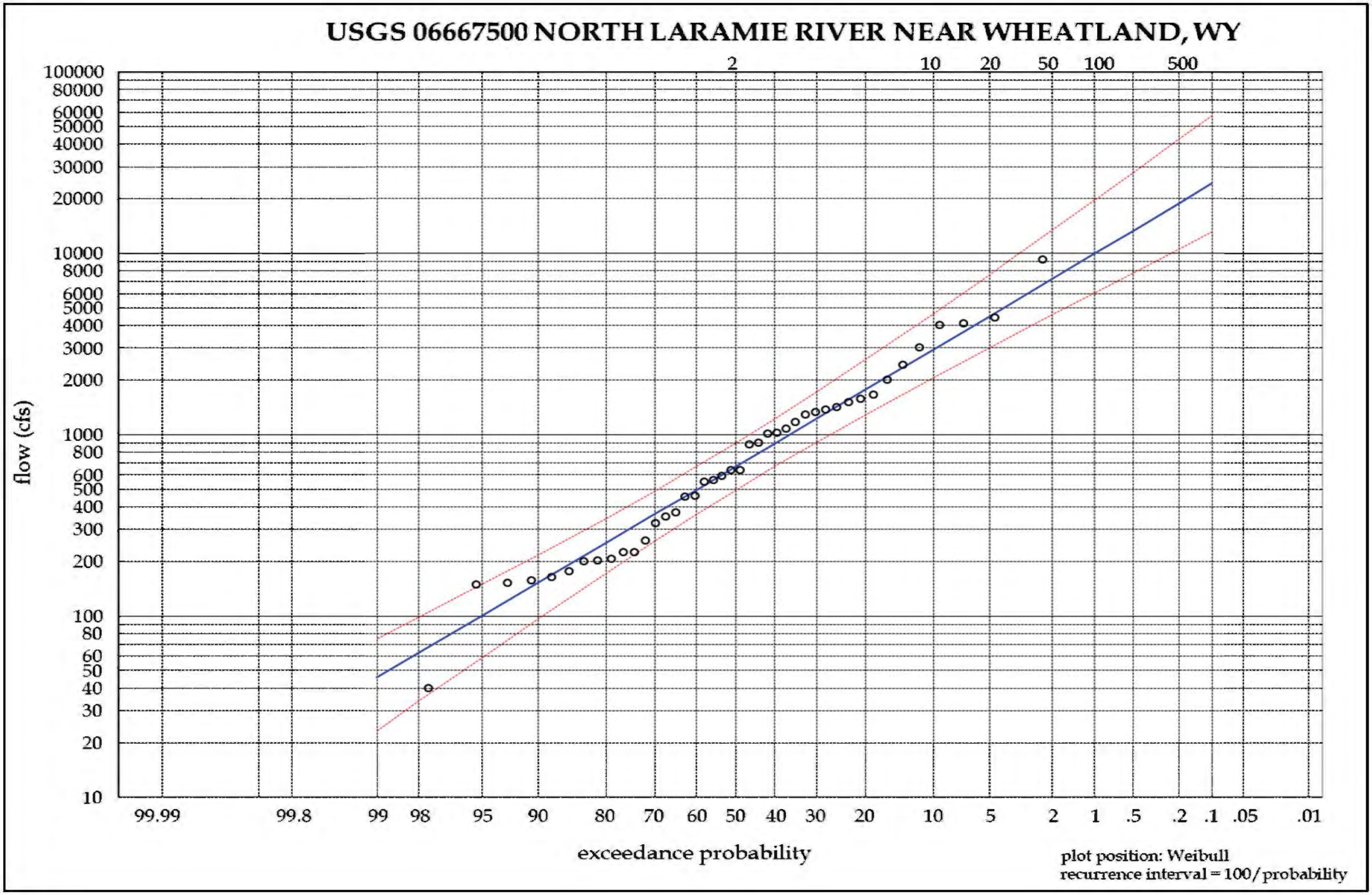
USGS 06665790 SYBILLE CREEK AB CANAL NO. 3, NEAR WHEATLAND, WY

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	3,972	7,152	2,641
500	3,383	5,875	2,303
200	2,696	4,450	1,896
100	2,239	3,546	1,616
50	1,829	2,775	1,357
25	1,464	2,121	1,117
20	1,355	1,933	1,043
10	1,041	1,412	825
5	759	977	618
3.333	605	757	498
2.5	500	614	413
2	419	509	344
1.667	351	425	285
1.429	291	353	232
1.250	234	288	182
1.111	174	219	128
1.053	136	176	96
1.020	104	139	69
1.010	87	119	56


USGS 06665790 SYBILLE CREEK AB CANAL NO. 3, NEAR WHEATLAND, WY
flow (cfs)
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
2
10
20
50
100
500
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

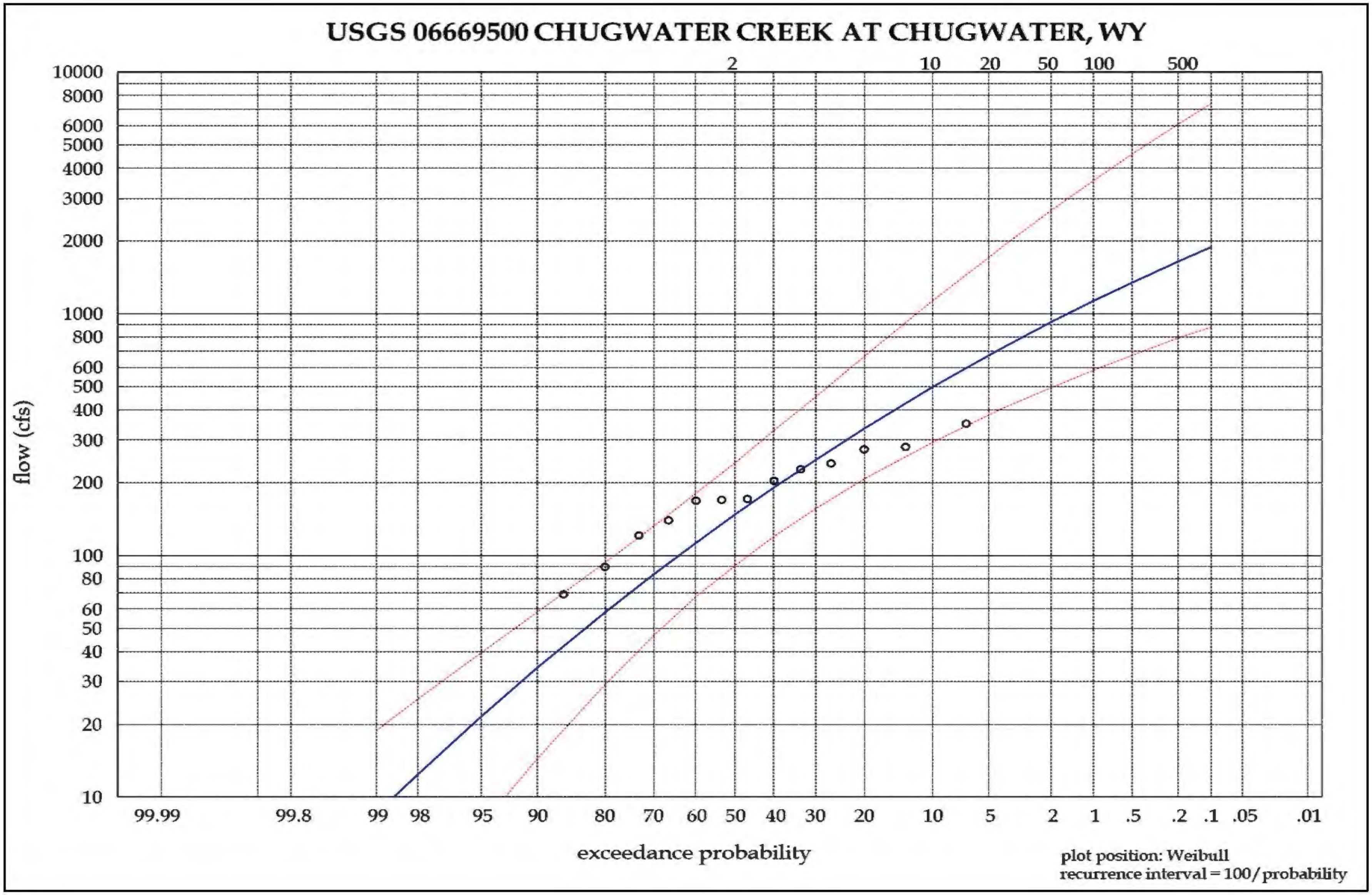
USGS 06667500 NORTH LARAMIE RIVER NEAR WHEATLAND, WY

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	24,244	57,308	13,105
500	18,914	42,492	10,577
200	13,282	27,782	7,787
100	9,925	19,595	6,043
50	7,221	13,407	4,575
25	5,073	8,819	3,351
20	4,485	7,626	3,004
10	2,940	4,650	2,056
5	1,764	2,587	1,286
3.333	1,222	1,716	906
2.5	893	1,221	666
2	666	897	494
1.667	497	666	363
1.429	364	490	259
1.250	252	346	172
1.111	152	217	96
1.053	100	150	59
1.020	63	99	34
1.010	46	75	23


USGS 06667500 NORTH LARAMIE RIVER NEAR WHEATLAND, WY
2
10
20
50
100
500
100000
80000
60000
50000
40000
30000
20000
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
flow (cfs)
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

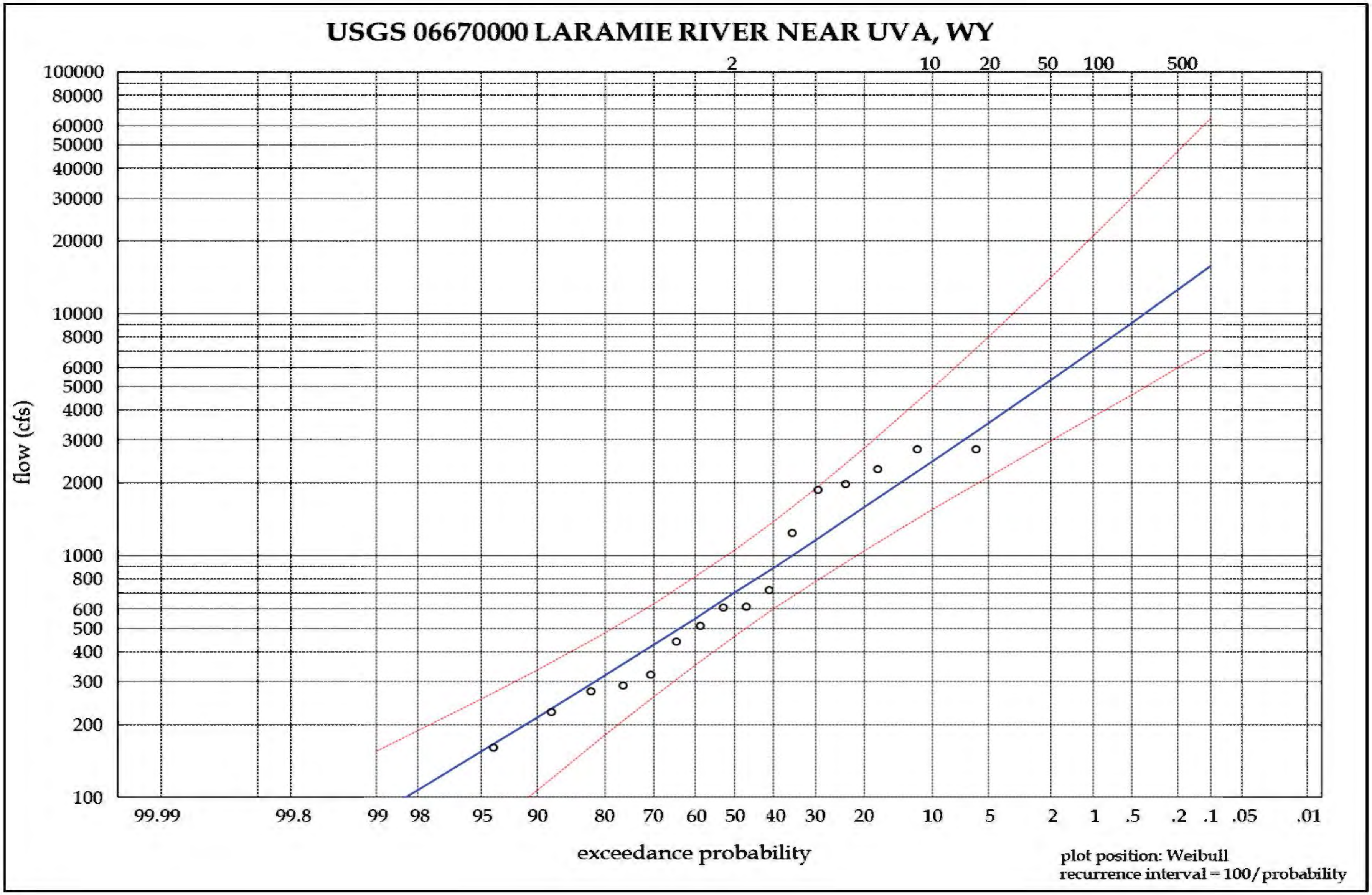
USGS 06669500 CHUGWATER CREEK AT CHUGWATER, WY

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	1,885	7,410	882
500	1,647	6,105	792
200	1,346	4,574	674
100	1,129	3,564	584
50	924	2,683	496
25	731	1,931	408
20	671	1,716	380
10	496	1,131	294
5	336	669	207
3.333	249	455	156
2.5	191	328	120
2	147	242	91
1.667	112	180	67
1.429	83	132	47
1.250	58	94	29
1.111	34	58	14
1.053	22	40	8
1.020	12	25	4
1.010	9	19	2


USGS 06669500 CHUGWATER CREEK AT CHUGWATER, WY
2
10
20
50
100
500
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
flow (cfs)
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

USGS 06670000 LARAMIE RIVER NEAR UVA, WY

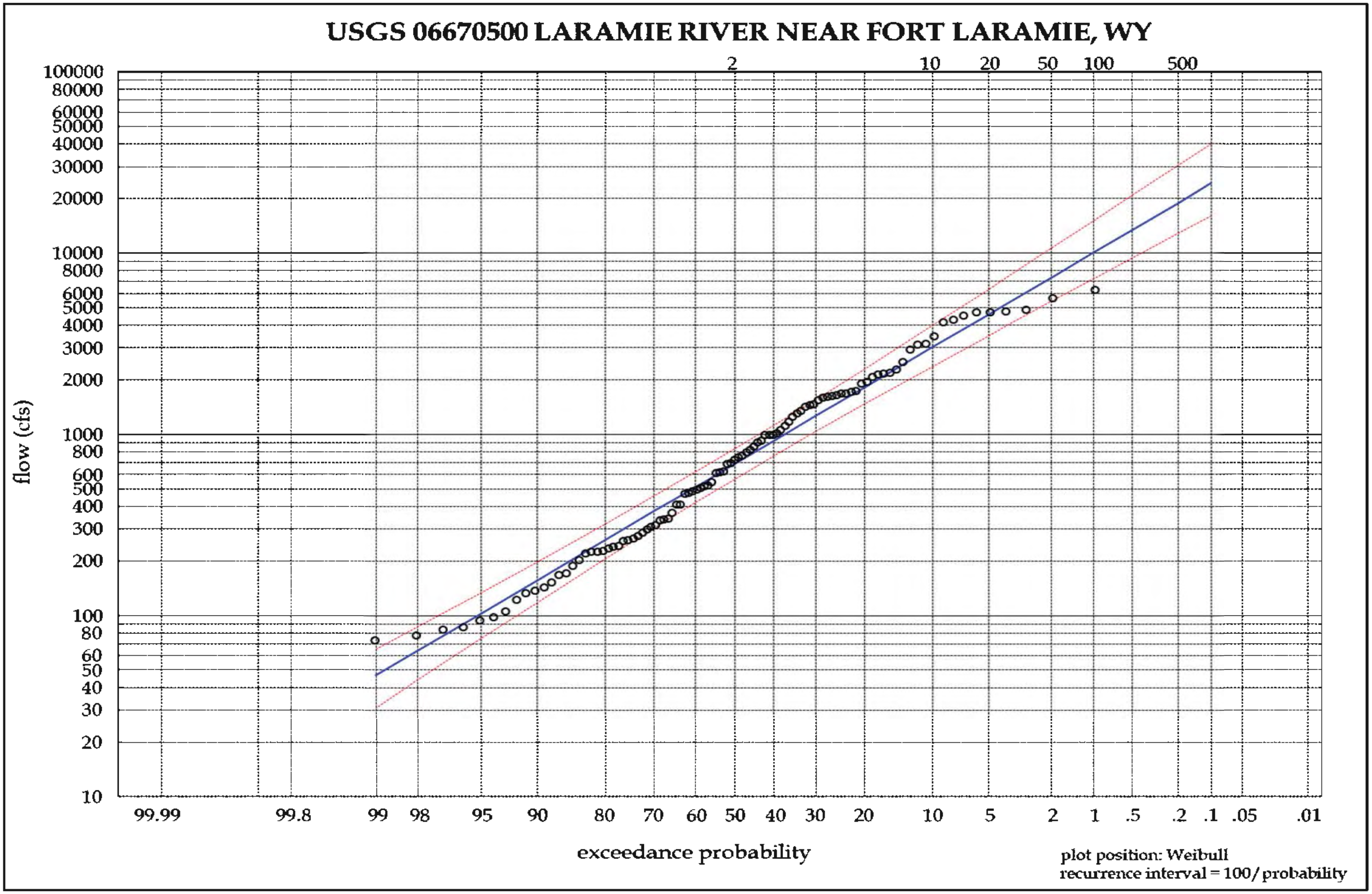
recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	15,775	64,500	7,129
500	12,590	46,994	5,960
200	9,156	30,095	4,620
100	7,058	20,947	3,747
50	5,326	14,184	2,980
25	3,908	9,271	2,308
20	3,511	8,010	2,110
10	2,437	4,899	1,546
5	1,577	2,774	1,049
3.333	1,157	1,885	782
2.5	891	1,381	601
2	700	1,052	464
1.667	551	816	353
1.429	427	633	261
1.250	319	480	181
1.111	214	336	107
1.053	154	254	69
1.020	108	188	42
1.010	85	155	30



USGS 06670000 LARAMIE RIVER NEAR UVA, WY
flow (cfs)
100000
80000
60000
50000
40000
30000
20000
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
2
10
20
50
100
500
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
exceedance probability
plot position: Weibull
recurrence interval = 100/probability

USGS 06670500 LARAMIE RIVER NEAR FORT LARAMIE, WY

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	24,203	40,301	16,027
500	18,962	30,660	12,845
200	13,389	20,774	9,362
100	10,047	15,076	7,206
50	7,340	10,630	5,408
25	5,177	7,218	3,924
20	4,582	6,309	3,506
10	3,015	3,982	2,377
5	1,815	2,297	1,473
3.333	1,259	1,555	1,036
2.5	921	1,122	762
2	687	831	568
1.667	513	620	421
1.429	375	456	304
1.250	260	320	205
1.111	156	198	118
1.053	103	134	75
1.020	64	87	44
1.010	47	65	31



USGS 06670500 LARAMIE RIVER NEAR FORT LARAMIE, WY
flow (cfs)
exceedance probability
2
10
20
50
100
500
100000
80000
60000
50000
40000
30000
20000
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
99.99
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
.5
.2
.1
.05
.01
plot position: Weibull
recurrence interval = 100/probability

APPENDIX 6A

PROJECT DESCRIPTIONS AND COST ESTIMATES

Lower Laramie River Watershed Study
Appendix 6A

IRR-001: Christinick Pipeline Conversion Project (Christinick-001)

This project would entail the conversion of an existing open ditch within the Wheatland Irrigation District to a buried pipeline. The existing ditch experiences significant losses due to seepage and evapotranspiration from vegetation within it. Completion of the project would result in water savings by reducing these losses. Operation and maintenance costs would also be reduced.

Project components would include:

- Installing a 1,750 LF buried 18-inch diameter irrigation pipe
- Installing pipe inlet structure at existing earthen ditch with an 18-inch waterman slide gate

Project Location:
Section 21, Township 23 North, Range 68 West.

Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: Wheatland Irrigation District

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

IRR-001 Christinick 001 Pipeline Conversion Conceptual Design

Watershed Plan Component: **IRR-001**
Project Name: **Christinic Pipeline Conversion Project**
Project Sponsor/Number: **Christinic-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 4,300
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000	2	$ 8,000
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20	1750	$ 35,000
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 47,300
	Contingencies (15% of subtotal)				$ 7,095
	Engineering and technical assistance (10% of subtotal)				$ 4,730
	Estimated project cost				$ 59,125

IRR-002: Cohorn Pipeline Conversion Project (Cohorn-001)

This project would entail the conversion of an existing open ditch within the Wheatland Irrigation District to a buried pipeline. The existing ditch experiences significant losses due to seepage and evapotranspiration from vegetation within it. Completion of the project would result in water savings by reducing these losses. Operation and maintenance costs would also be reduced.

Project components would include:

- Installing 2,925 LF of 18-inch HDPE irrigation pipe
- Installing concrete pipe inlet at existing turnout from WID lateral
- Installing two farm turnouts
- Tying pipeline to existing 18-inch culvert at county road

Project Location:
Section 19, Township 24 North, Range 68 West.

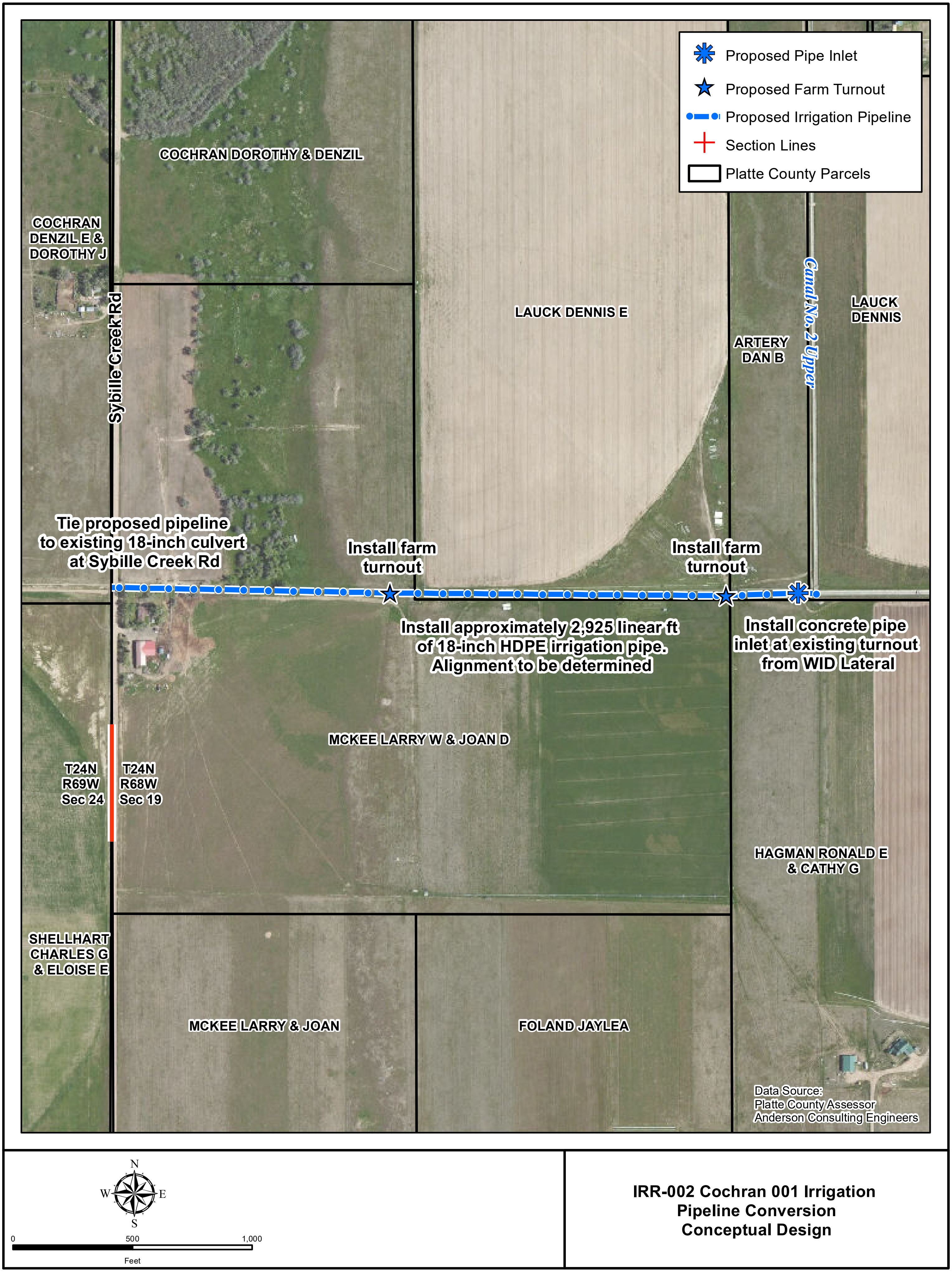
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: Wheatland Irrigation District

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



IRR-002 Cochran 001 Irrigation Pipeline Conversion Conceptual Design

Watershed Plan Component: **IRR-002**
Project Name: **Cochorn Pipeline Conversion Project**
Project Sponsor/Number: **Cochorn-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 8,250
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000	6	$ 24,000
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20	2925	$ 58,500
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 90,750
	Contingencies (15% of subtotal)				$ 13,613
	Engineering and technical assistance (10% of subtotal)				$ 9,075
	Estimated project cost				$ 113,438

IRR-003: Faris Pipeline Project (Faris-001)

This project would complete an existing ditch modification project.

Previously, the point of diversion of the Wilson No. 2 ditch, which experienced seepage and maintenance issues, was moved to a location requiring pumping from the North Laramie River. This effort allows the ditch owner to bypass several miles of problematic ditch.

Completion of this proposed pipeline project would facilitate pumping of water between the remaining Wilson No. 2 ditch and the Mitchell No. 5 / Charles Wilson Ditch.

Project components would include:

- Installing 635 LF of buried 10-inch diameter PVC pipeline

Project Location:
Section 6, Township 25 North, Range 69 West.

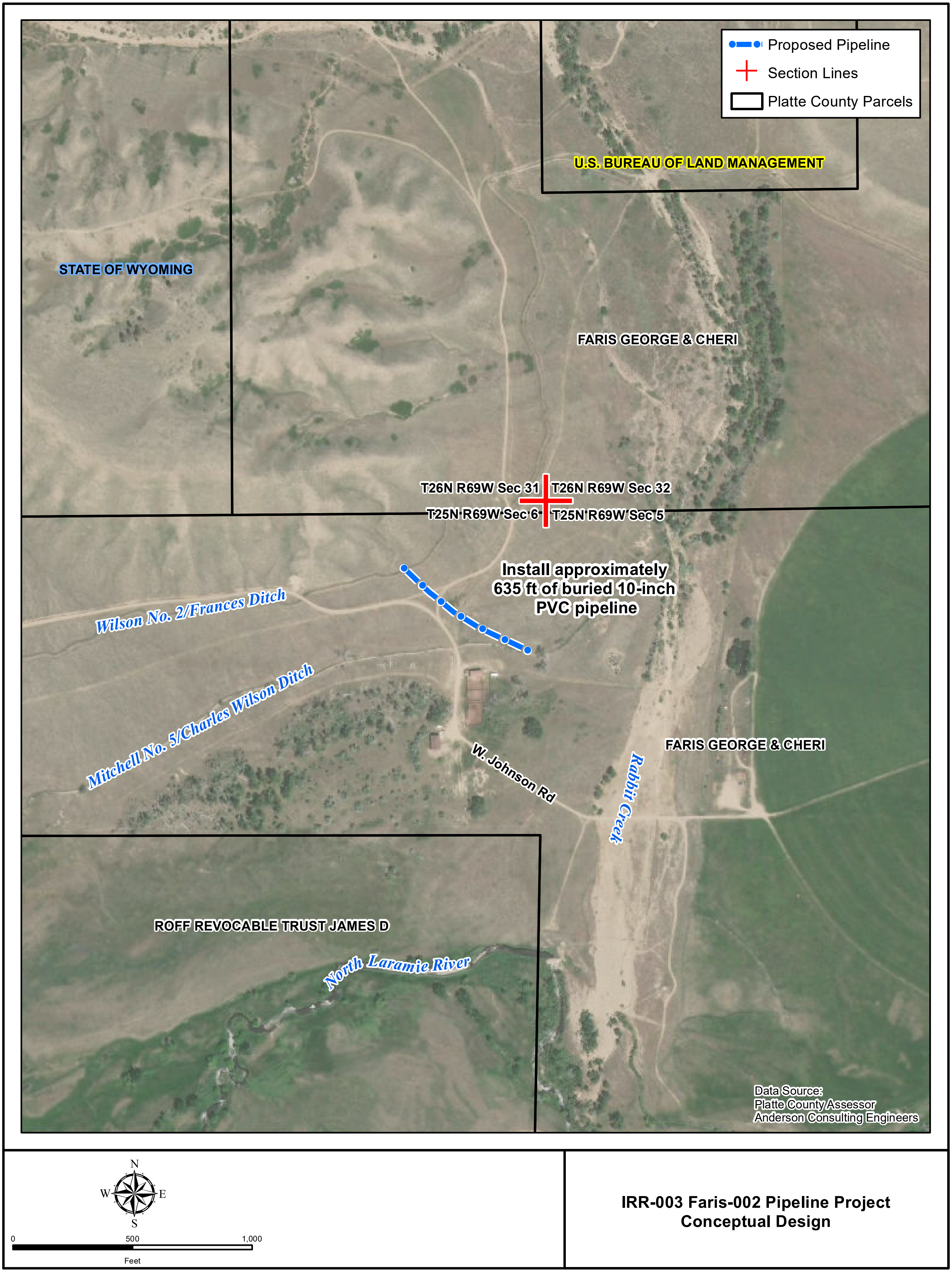
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: North Laramie River

Grazing Allotment: Rabbit Creek 2 (BLM)

Sage Grouse Core Area: Not Applicable



IRR-003 Faris-002 Pipeline Project
Conceptual Design

Watershed Plan Component: **IRR-003**
Project Name: **Faris Pipeline Project**
Project Sponsor/Number: **Faris-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,070
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000	2	$ 8,000
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20	635	$ 12,700
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 22,770
	Contingencies (15% of subtotal)				$ 3,416
	Engineering and technical assistance (10% of subtotal)				$ 2,277
	Estimated project cost				$ 28,463

IRR-004: Iron Mountain Ditch No. 2 Headgate Replacement Project (Farthing-001)

This irrigation project will consist of converting a non-stable and highly erodible check dam structure into a more stable and less erosive stone-constructed structure. Currently this facility is quite temporary, washing out almost every year.

Project components would include:

- Removal of the existing temporary structure
- Construction of a rock diversion dam within Middle Chugwater Creek
- Construction of a diversion headgate (Waterman-type) within a concrete headwall.
- Incorporation of an 18-inch Parshall flume for diversion measurement.

Project Location:
Section 4, Township 18 North, Range 70 West.

Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: Middle Chugwater Creek

Grazing Allotment: Iron Mountain (BLM)

Sage Grouse Core Area: Not Applicable

IRR-004 Farthing 001 Diversion Construction/Replacement Conceptual Design

Watershed Plan Component: **IRR-004**
Project Name: **Iron Mountain Ditch No. 2 Headgate Replacement Project**
Project Sponsor/Number: **Farthing-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			
1A	Lump sum based on other information	LS			$ 47,000
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 47,000
	Contingencies (15% of subtotal)				$ 7,050
	Engineering and technical assistance (10% of subtotal)				$ 4,700
	Estimated project cost				$ 58,750

IRR-005: Davidson Ditch Headgate Replacement Project (Farthing-002)

This irrigation project will consist of converting a non-stable and highly erodible check dam structure into a more stable and less erosive stone-constructed structure. Currently this facility is quite temporary, washing out almost every year.

Project components would include:

- Removal of the existing temporary structure
- Construction of a rock diversion dam within Middle Chugwater Creek
- Construction of a diversion headgate (Waterman-type) within a concrete headwall.
- Incorporation of an 18-inch Parshall flume for diversion measurement.

Project Location:
Section 34, Township 19 North, Range 70 West.

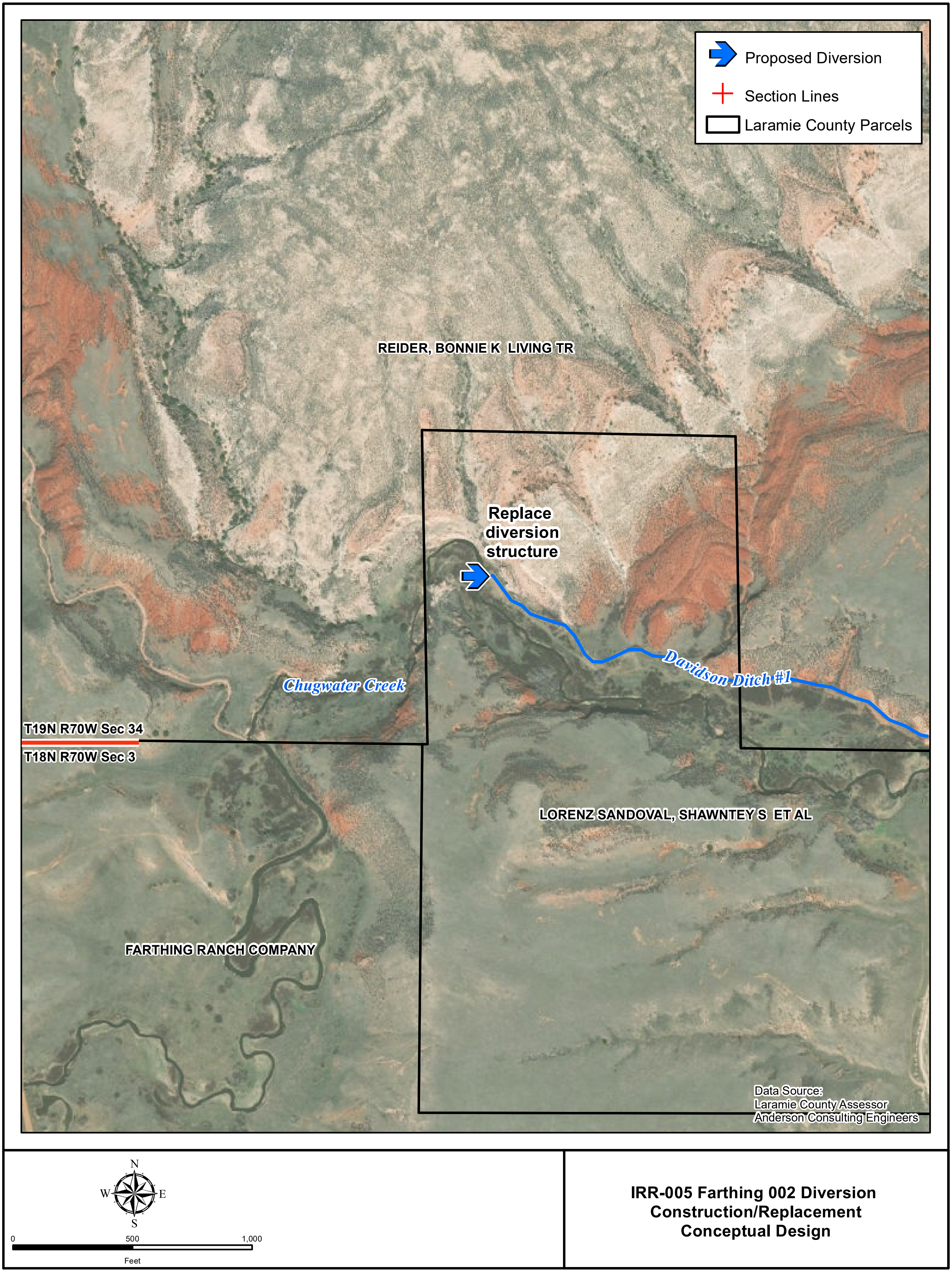
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: Middle Chugwater Creek

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



IRR-005 Farthing 002 Diversion Construction/Replacement Conceptual Design

Watershed Plan Component: **IRR-005**
Project Name: **Davidson Ditch Headgate Replacement Project**
Project Sponsor/Number: **Farthing-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			
1A	Lump sum based on other information	LS			$ 47,000
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 47,000
	Contingencies (15% of subtotal)				$ 7,050
	Engineering and technical assistance (10% of subtotal)				$ 4,700
	Estimated project cost				$ 58,750

IRR-006: **Kontour Headgate Replacement Project (Kontour-001)**

The proposed project would involve replacement of an existing failing diversion headgate on the North Laramie River. The existing facility is old, leaky and in general pool condition.

Project components would include:

- Replacing existing diversion headgate with 24-inch Waterman gate and concrete headwall
- Replacing failing culvert with 40 LF of 24-inch diameter corrugated metal pipe

Project Location:
Section 2, Township 25 North, Range 69 West.

Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: North Laramie River

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

N
W E
S

0 125 250
Feet

IRR-006 Kontour-001 Headgate Replacement Conceptual Design

Watershed Plan Component: **IRR-006**
Project Name: **Kontour Headgate Replacement Project**
Project Sponsor/Number: **Kontour-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 532
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000	1	$ 4,000
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36	30	$ 1,083
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12	20	$ 240
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
					$ 5,855
	Project Subtotal				$ 5,855
	Contingencies (15% of subtotal)				$ 878
	Engineering and technical assistance (10% of subtotal)				$ 586
	Estimated project cost				$ 7,319

IRR-007: Schockley Headgate Project (Schockley-001)

During a 2017 flood event on the Laramie River, the headgate for the Kittel No. 1 Ditch was abandoned due to streambank erosion. This project would involve stabilization of the eroding streambank, construction of a new headgate structure with slide gate, and reconstruction of a portion of the ditch which was destroyed during the flood event.

Construction of the proposed project would enable the ditch to function again as it currently has no means of diverting water from the Laramie River. Construction would also mitigate existing streambank erosion at the site, allow establishment of riparian vegetation thereby improving habitat, and reduce sedimentation in the Laramie River.

Project components would include:

- Construction of streambank erosion structures to protect the proposed headgate
- Construction of a new headgate / concrete headwall structure
- Construction of a 12-inch Parshall Flume to facilitate measurement of diversions
- Reconstruction of approximately 700 feet of earthen ditch

Project Location:

Section 20, Township 24 North, Range 69 West.

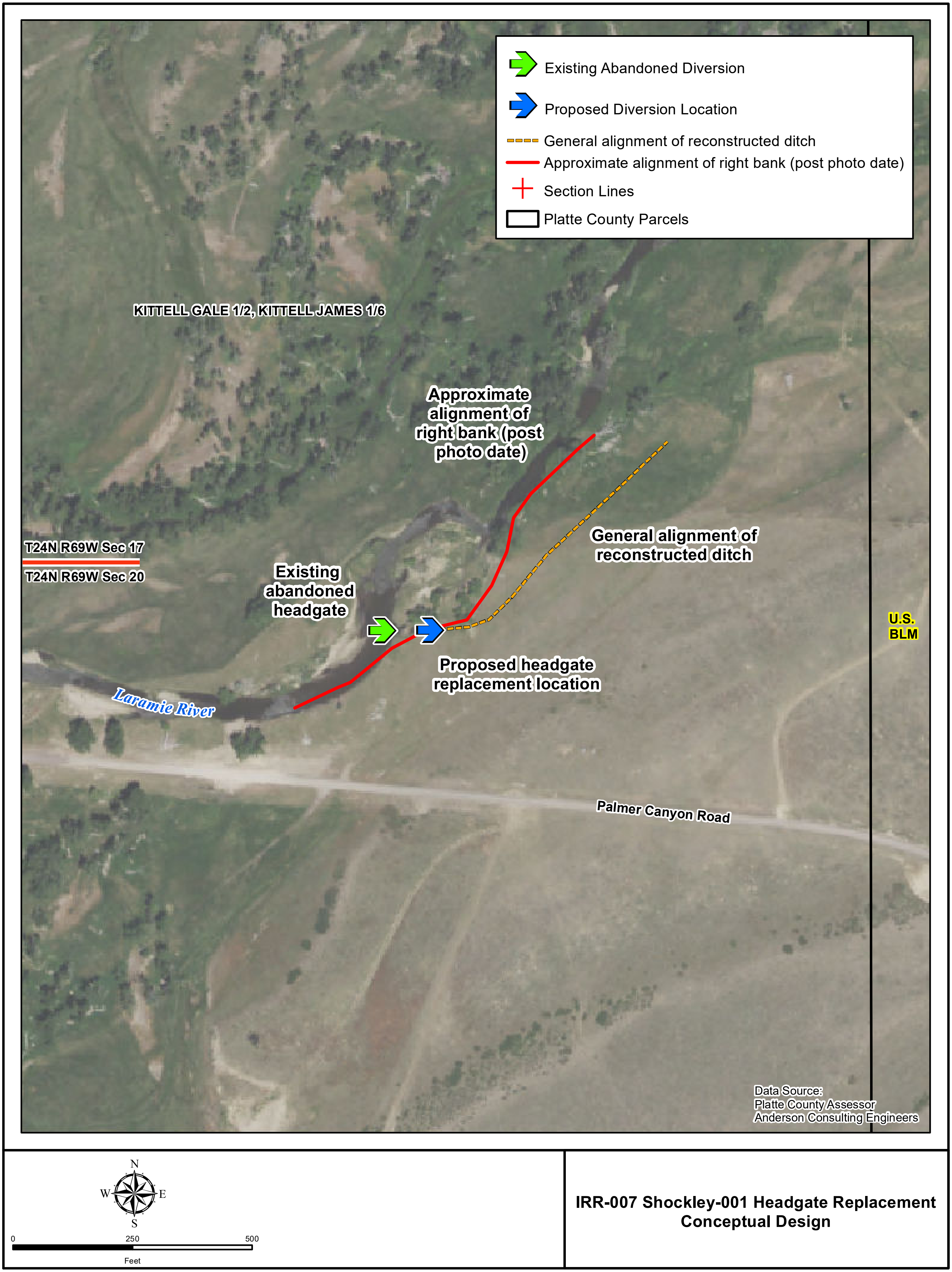
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: Laramie River

Grazing Allotment: Laramie River 4 (BLM)

Sage Grouse Core Area: Not Applicable



IRR-007 Shockley-001 Headgate Replacement Conceptual Design

Watershed Plan Component: **IRR-007**
Project Name: **Schockley Headgate Project**
Project Sponsor/Number: **Schockley-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 6,060
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000	4	$ 36,000
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500	1	$ 4,500
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000	1	$ 18,000
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3	700	$ 2,100
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250	5	$ 6,250
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 72,910
	Contingencies (15% of subtotal)				$ 10,937
	Engineering and technical assistance (10% of subtotal)				$ 7,291
	Estimated project cost				$ 91,138

L/W-001: Brant Stock Reservoir Rehabilitation Project (Brant-001)

This project involves the restoration of storage functionality to an existing stock reservoir which has filled with sediment. The project would involve excavation of sediment within the reservoir, improving the existing embankment and construction of a small levee to enhance water collection capability.

Project components would include:

- Sediment excavation
- Reservoir embankment improvement
- Incorporation of an outlet facility similar to commercially available AgriDrain products

Project Location:
Section 8, Township 23 North, Range 68 West.

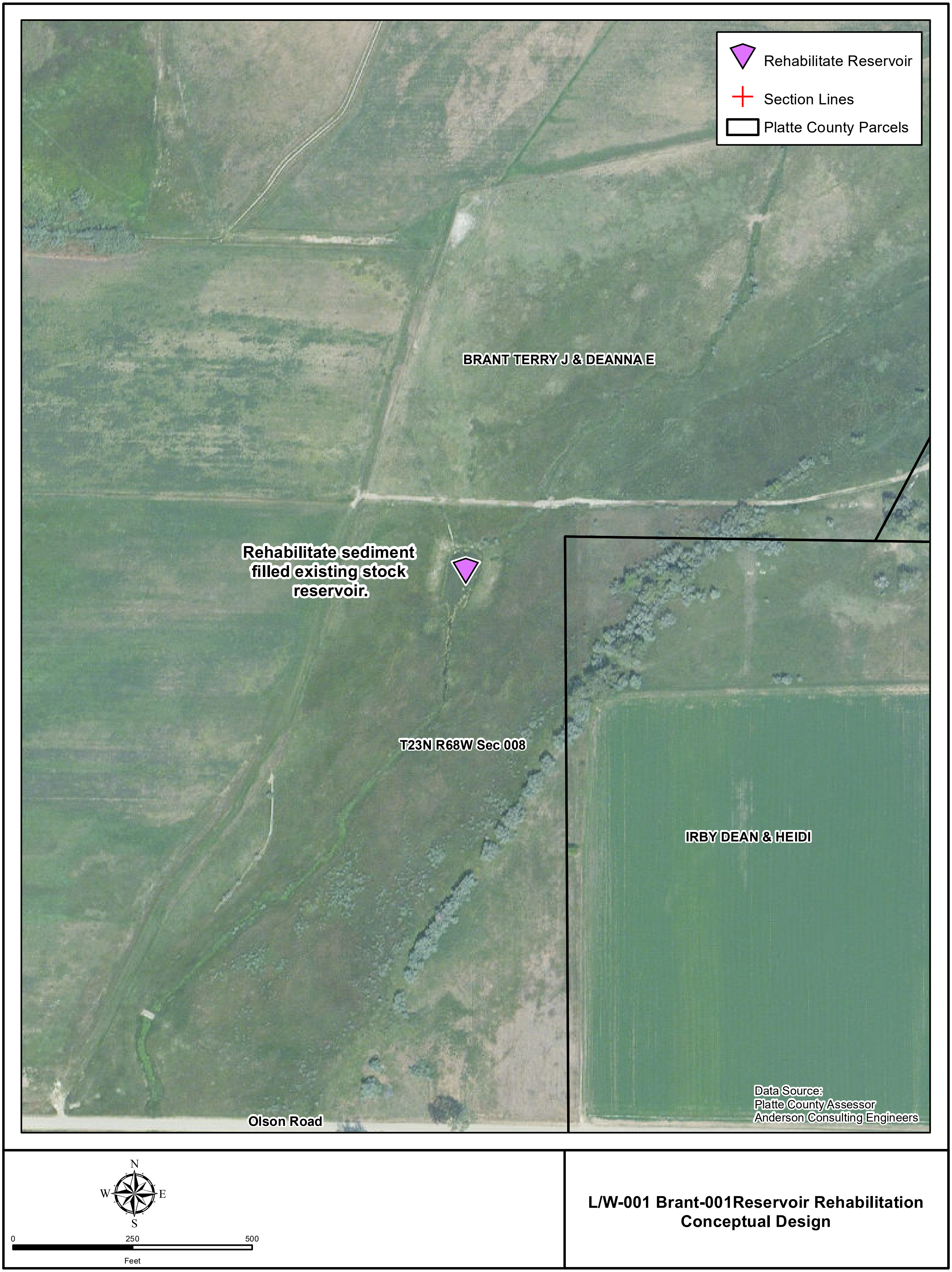
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: unnamed tributary to Rock Creek (Tributary to Laramie River)

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



L/W-001 Brant-001Reservoir Rehabilitation Conceptual Design

Watershed Plan Component: **L/W-001**
Project Name: **Brant Stock Reservoir Rehabilitation Project**
Project Sponsor/Number: **Brant-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,649
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000	1	$ 5,000
17	Unclassified excavation	CY	$ 4	2000	$ 8,000
18	Excavation and Placement of Embankment Fill	CY	$ 7	500	$ 3,250
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12	20	$ 240
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 18,139
	Contingencies (15% of subtotal)				$ 2,721
	Engineering and technical assistance (10% of subtotal)				$ 1,814
	Estimated project cost				$ 22,674

L/W-002: Brown Well and Stock Tank Project (Brown-001)

This project would involve drilling a new well, installing a solar pump, and stock tank. Completion of the project would provide a reliable source of water to livestock and wildlife.

Project components would include:

- Installing two 1,200-gallon rubber tire stock tanks
- Installing approximately 1,075 linear feet of 1.5-in HDPE buried pipeline
- Installing a new well approximately 300 feet deep.
- It is assumed that electrical source is available

Project Location:
Section 27, Township 24 North, Range 68 West.

Land Ownership (Surface):

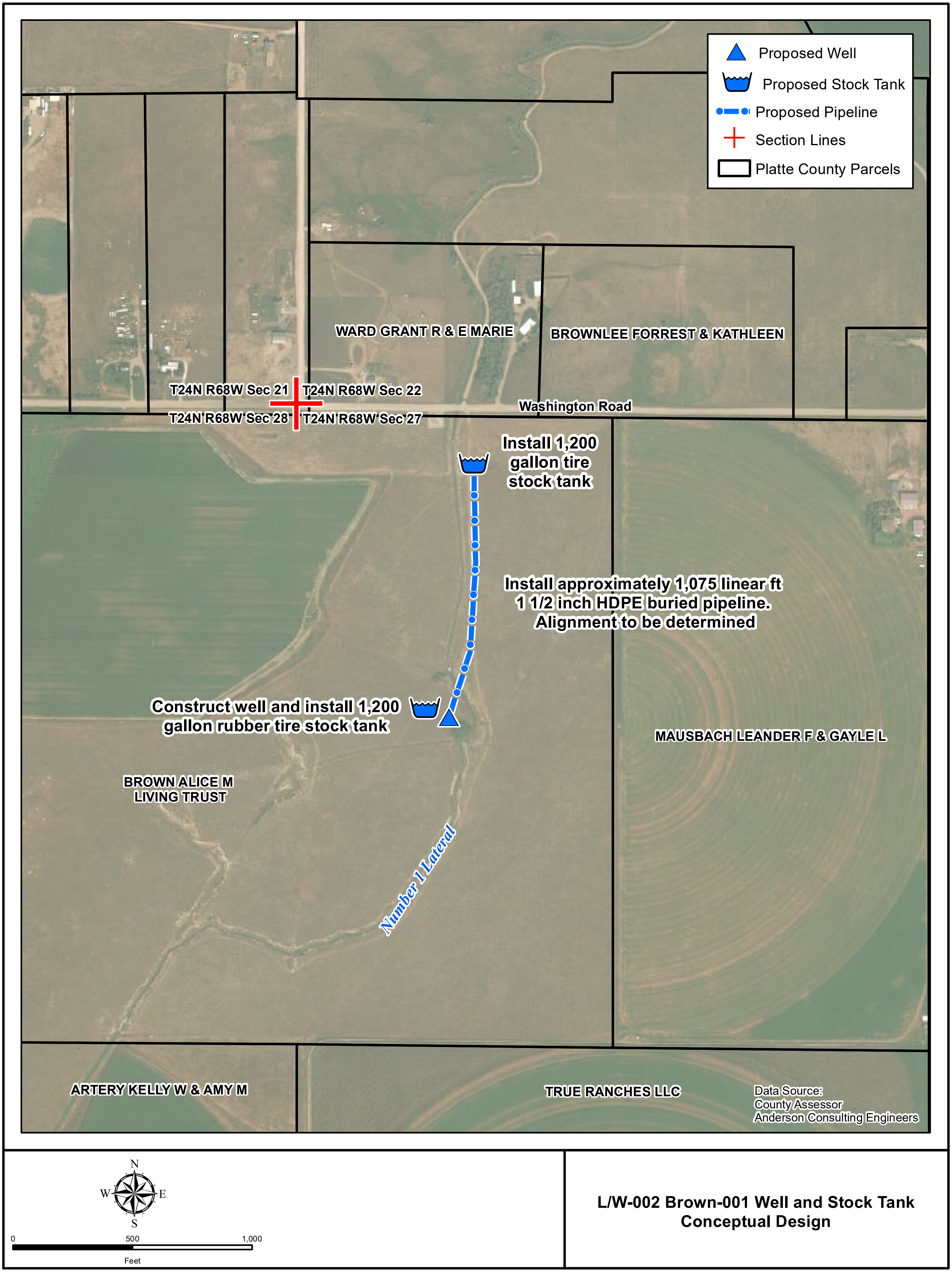
The facility is located on privately-owned lands.

Water Source: groundwater

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

Note: See the included Hydrogeologic Evaluation



L/W-002 Brown-001 Well and Stock Tank Conceptual Design

Hydrogeologic Evaluation

The site is located in T24N, R68W, Sec. 27, about 1 mile southwest of Wheatland, at approximate elevation 4892 feet. There are 6 existing groundwater permits in this area. See the attached figure for locations[1].

Permit	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
192837	Forrest Brownlee	25	100	280
8672	Russell Brown	12.5	10	41
98473	Morris Stille	15	90	300
159623	Leander Mausbach	800	122	490
299	Clearview Dairy, Inc.	850	94	520
37940	True Ranches, LLC	1250	105	580

This site is in the middle of an expanse of center pivots in the Wheatland Irrigation District. The surface is on sand and loess terrace deposits, which overlie the Arikaree Formation. Based on the surrounding wells, the first approximately 50 feet in this area consists predominantly of sand and gravel, with some logs noting thin clay layers. In approximately the 50 - 100 feet depth interval, wells commonly found clay or sandy clay. Below 100 feet are an inconsistent series of sandstone and sandy clay strata, with several wells reporting thin limestone intervals. The high-capacity wells in this group are screened or perforated across long intervals - nearly the entire well in #159623, 260 feet in #299, and 320 feet in #37940 - in order to accumulate production from the many discrete water-bearing strata encountered.

Even in the deepest of these wells, it does not appear the Arikaree Formation was fully penetrated (i.e. into the underlying Brule Formation).

The 8672 well, reporting a depth-to-water of only 10 feet is obviously an anomaly. There is no log available for this shallow, 50-year-old well, but it may have simply tapped a local gravel layer sitting on top of a clay zone, i.e. creating a local "perched" water table. While future wells might find similar conditions, the more secure water table is clearly around 100 feet.

Groundwater recharge to the site is likely abundant, both via seepage from surface-irrigation facilities and deep percolation beneath sprinkler systems (either surface or groundwater sourced). By the same token, however, there is abundant local extraction of groundwater, so any new wells should anticipate significant seasonal fluctuations in water level and be completed with sufficient available drawdown (the difference between the total depth and the depth-to-water) to accommodate.

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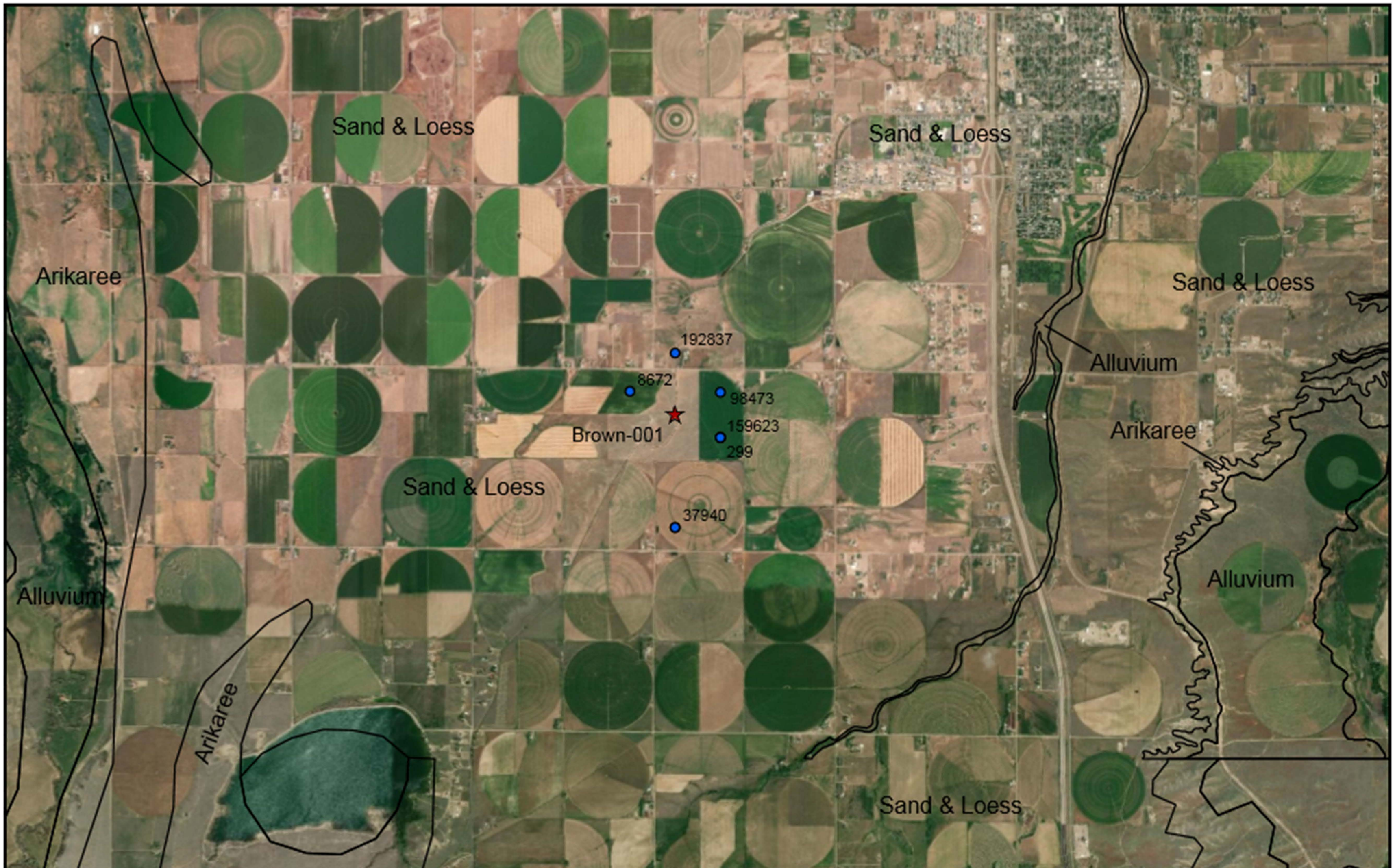
[1]The location of the prospective well is accurate; the locations of the State Engineers Office groundwater permits are only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

The two low-capacity neighboring wells - #98473 and #192837 - were both drilled to approximately 300 feet, suggesting a target depth for similar future wells. These wells were completed with perforations through the 260 - 300 and 220 - 280 feet intervals, and the pumps were set at 200 feet and 165 feet, respectively. Based on the pump test reported at #192837, the specific capacity of these strata is only 0.5 gpm per foot of drawdown, indicating the strata developed by two wells is only modestly productive. Considering the potential for additional drawdown from nearby high-capacity wells, these well design appear cautious, but not unreasonable. (That they were drilled by different drillers in different years suggests this as a prudent design for these strata, rather than simply being one driller's "standard" construction.)

None of these local wells reported a chemical analysis, but all those offering an opinion considered the water to be of "good" quality, which is consistent with what one would expect from the Arikaree aquifer.

Conclusions:

1. There is a high likelihood of developing groundwater supplies on the order of 5 - 10 gpm from the Arikaree Formation in this area.
2. A well depth on the order of 300 feet would be prudent, as production is a function of accumulating water from multiple zones rather than simply drilling to a known production zone at a known depth.
3. A minimum well depth of 200 feet is suggested for even low-production wells, based on an anticipated depth-to-water of approximately 100 feet and the need to accommodate in-well drawdown, interference drawdown from nearby wells, and long-term water level fluctuations.
4. Groundwater quality at this location is likely adequate for stock and domestic use.
5. A groundwater permit from the Wyoming State Engineer's Office will be required, but there should be no special water-rights related issues with a well for stock or domestic use at this location.



● approximate location of Wyoming State Engineer groundwater permit

Brown-001 Groundwater Prospect
Lower Laramie Watershed

Watershed Plan Component: **L/W-002**
Project Name: **Brown Well and Stock Tank Project**
Project Sponsor/Number: **Brown-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,173
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50	300	$ 15,000
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	1075	$ 3,225
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 23,898
	Contingencies (15% of subtotal)				$ 3,585
	Engineering and technical assistance (10% of subtotal)				$ 2,390
	Estimated project cost				$ 29,872

L/W-003: Faris Well Replacement Project (Faris-001)

This project would replace an existing well which is currently unreliable and in need of replacement. The new well would provide a source of water for livestock and wildlife in an area without alternative sources except an ephemeral stream. Construction of the project would relieve grazing pressure on riparian vegetation. An electrical powerline is located approximately ½ mile from the proposed project; construction of a well with solar platform and pump appears to be more cost effective.

Project components would include:

- Construction of a new well approximately 300 feet in depth.
- Installing new solar platform, pump and requisite fittings in the new well.
- Installing a new 1,200 gallon rubber tire stock tank

Project Location:

Section 31, Township 26 North, Range 69 West.

Land Ownership (Surface):

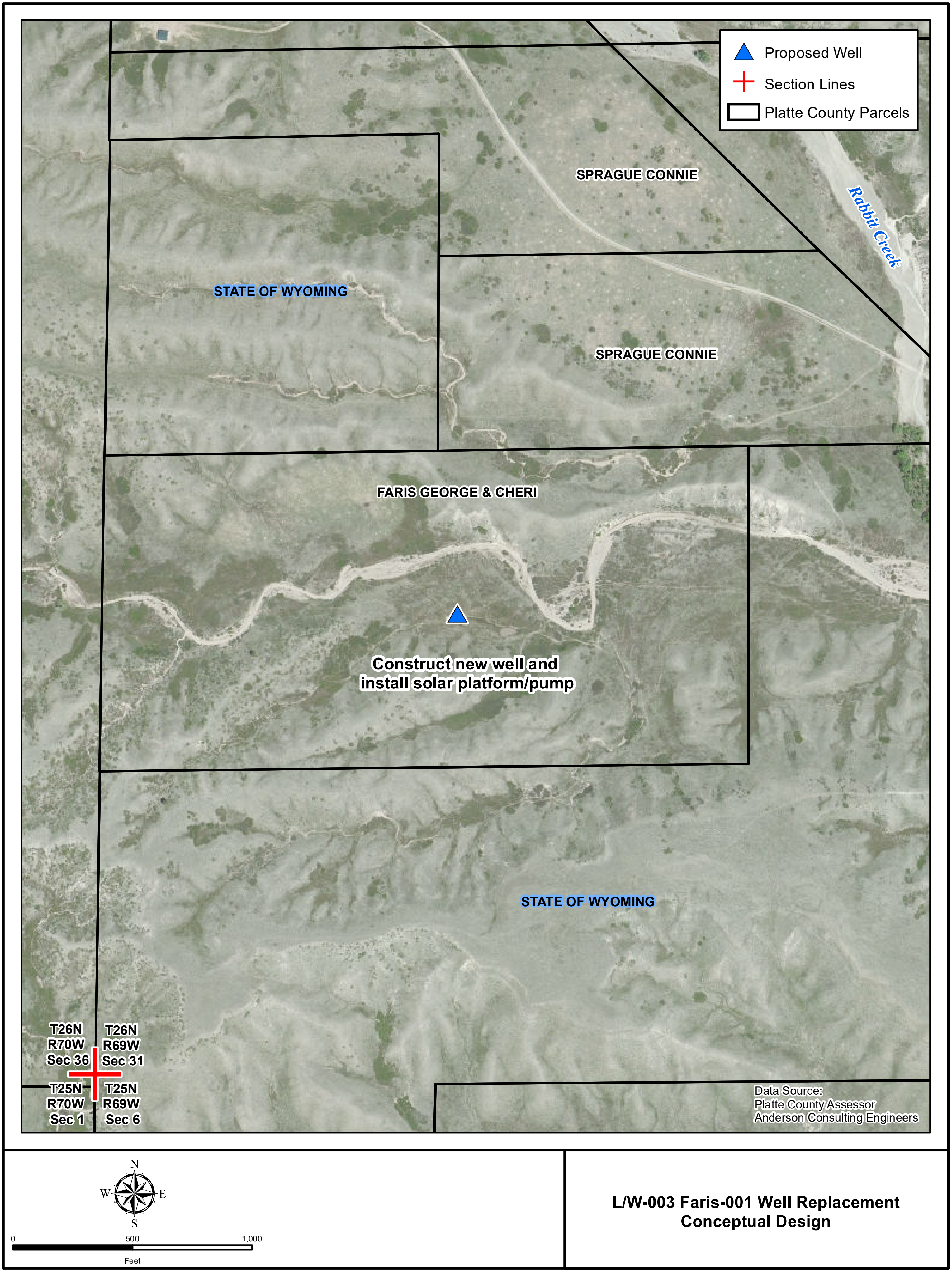
The facility is located on lands owned by:

- Privately-owned property,

Water Source: N/A

Grazing Allotment: Rabbit Creek 2 (BLM)

Sage Grouse Core Area: Not Applicable



L/W-003 Faris-001 Well Replacement Conceptual Design

Watershed Plan Component: **L/W-003**
Project Name: **Faris Well Replacement Project**
Project Sponsor/Number: **Faris-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,680
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50	300	$ 15,000
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500	1	$ 2,500
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	100	$ 300
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 40,480
	Contingencies (15% of subtotal)				$ 6,072
	Engineering and technical assistance (10% of subtotal)				$ 4,048
	Estimated project cost				$ 50,600

L/W-004: Gillaspie Spring Development Project 1 (Gillaspie-001)

The proposed project would involve development of an existing spring in the Chugwater Creek watershed. Stabilization of a small headcut is highly recommended at this location because migration of the headcut upstream could jeopardize the integrity of the project both structurally and hydrologically.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams. It would also reduce sedimentation within the Chugwater Creek watershed by mitigating an active headcut in an un-named tributary.

Project components would include:

- Installing 1,200-gallon rubber tire stock tank
- Stabilizing existing headcut
- Installing approximately 250 LF of 1.5” diameter buried HDPE pipeline
- Replacing existing spring development

Project Location:
Section 29, Township 20 North, Range 67 West.

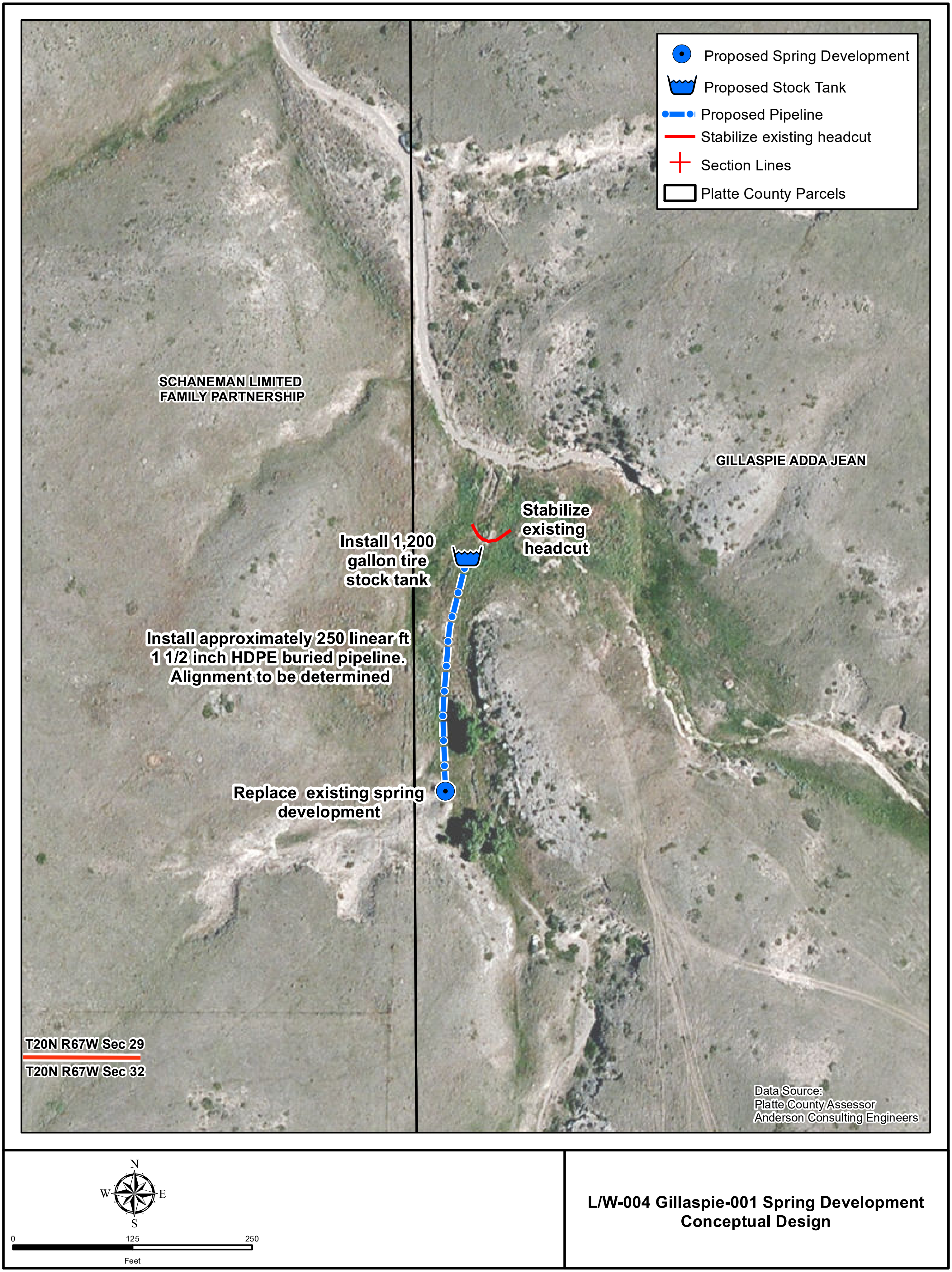
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: spring within the Chugwater Creek watershed.

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



L/W-004 Gillaspie-001 Spring Development Conceptual Design

Watershed Plan Component: **L/W-004**
Project Name: **Gillaspie Spring Development Project 1**
Project Sponsor/Number: **Gillaspie-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,510
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000	1	$ 5,000
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	250	$ 750
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5	400	$ 2,000
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4	20	$ 80
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125	30	$ 3,750
21	Filter fabric under riprap	SY	$ 4	5	$ 20
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250	0.5	$ 625
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 17,235
	Contingencies (15% of subtotal)				$ 2,585
	Engineering and technical assistance (10% of subtotal)				$ 1,724
	Estimated project cost				$ 21,544

L/W-005: Gillaspie Spring Development Project 2 (GIllaspie-002)

The proposed project would involve development of an existing spring in the Chugwater Creek watershed.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Installing 1,200 gallon rubber stock tire stock tank
- Installing approximately 200 LF of buried 1.5" diameter HDPE pipeline
- Replacing existing spring development

Project Location:
Section 29, Township 20 North, Range 67 West.

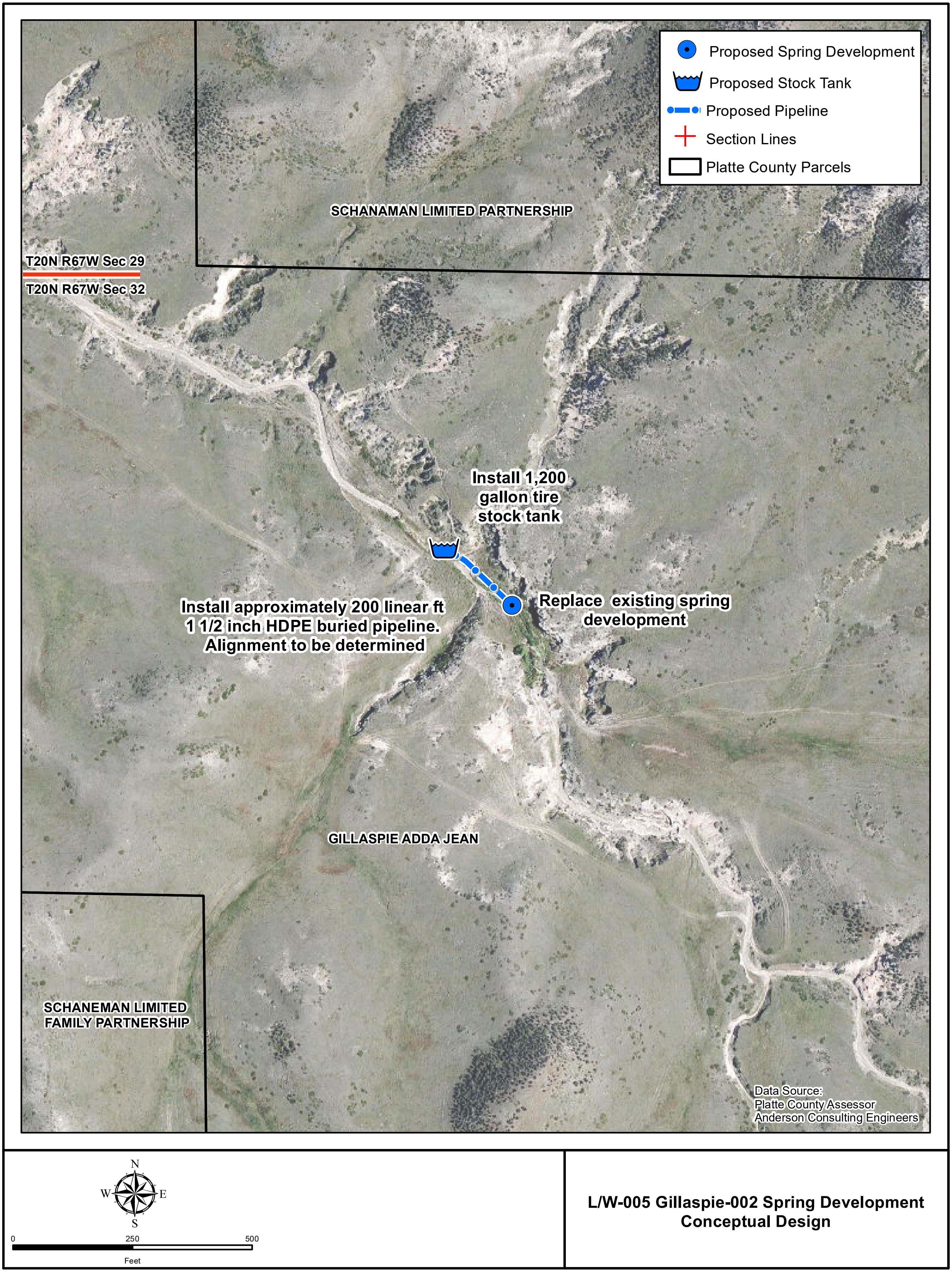
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: spring within the Chugwater Creek watershed.

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



L/W-005 Gillaspie-002 Spring Development Conceptual Design

Watershed Plan Component: **L/W-005**
Project Name: **Gillaspie Spring Development Project 2**
Project Sponsor/Number: **Gillaspie-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,110
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000	1	$ 5,000
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	200	$ 600
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5	400	$ 2,000
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 12,210
	Contingencies (15% of subtotal)				$ 1,832
	Engineering and technical assistance (10% of subtotal)				$ 1,221
	Estimated project cost				$ 15,263

L/W-006: Gillaspie Solar Project 1 (Gillaspie-003)

The proposed project would entail installation of a solar platform/pump in an existing well.

Project components would include:

- Installing solar platform and pump in an existing well.

Project Location:
Section 5, Township 19 North, Range 67 West.

Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: existing well

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

L/W-006 Gillaspie 003 Solar Platform
Conceptual Design

Watershed Plan Component: **L/W-006**
Project Name: **Gillaspie Solar Project 1**
Project Sponsor/Number: **Gillaspie-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,800
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500	1	$ 2,500
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 19,800
	Contingencies (15% of subtotal)				$ 2,970
	Engineering and technical assistance (10% of subtotal)				$ 1,980
	Estimated project cost				$ 24,750

L/W-007: Gillaspie Solar Project 2 (GIllaspie-004)

The proposed project would entail installation of a solar platform/pump in an existing well.

Project components would include:

- Installing solar pump and platform in an existing well.

Project Location:
Section 5, Township 19 North, Range 67 West.

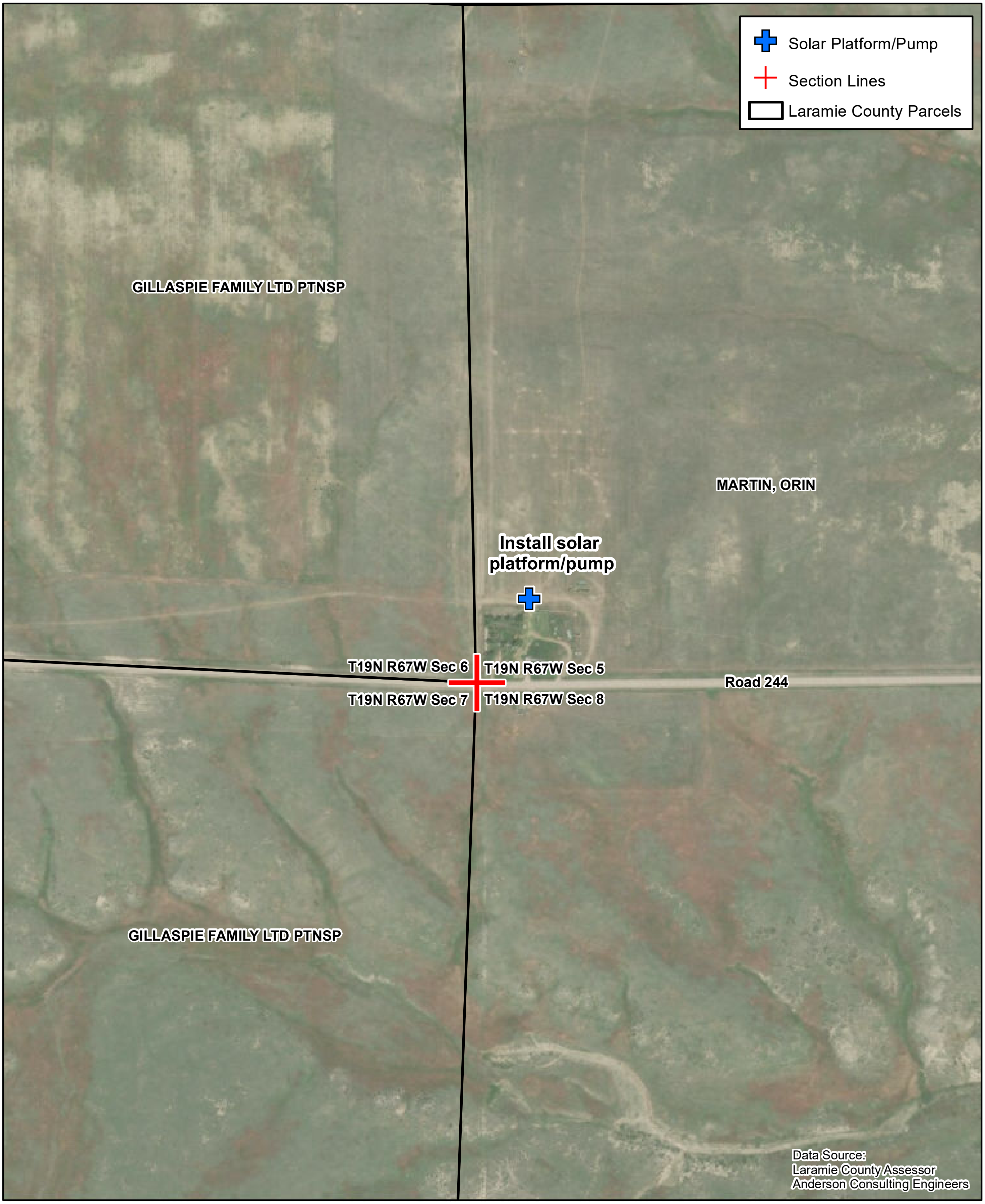
Land Ownership (Surface):

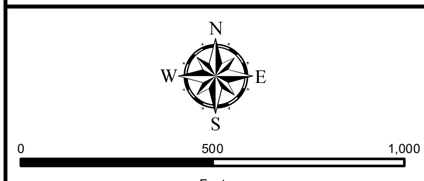
The facility is located on privately-owned lands.

Water Source: existing well

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable





L/W-007 Gillaspie 004 Solar Platform Conceptual Design

Watershed Plan Component: **L/W-007**
Project Name: **Gillaspie Solar Project 2**
Project Sponsor/Number: **Gillaspie-004**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,800
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500	1	$ 2,500
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 19,800
	Contingencies (15% of subtotal)				$ 2,970
	Engineering and technical assistance (10% of subtotal)				$ 1,980
	Estimated project cost				$ 24,750

L/W-008: Irvine Stock Reservoir Rehabilitation (Irvine-001)

The proposed project would involve the rehabilitation of an existing stock reservoir within the George Creek subbasin in the Laramie River watershed. The existing reservoir has filled with sediment and reportedly loses water to seepage.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Excavation of sediment within the existing reservoir
- Placement and integration of a geotextile liner within the excavated reservoir.
- Installation of a reservoir outlet facility such as an AgriDrain type of product.

Project Location:
Section 15, Township 23 North, Range 70 West.

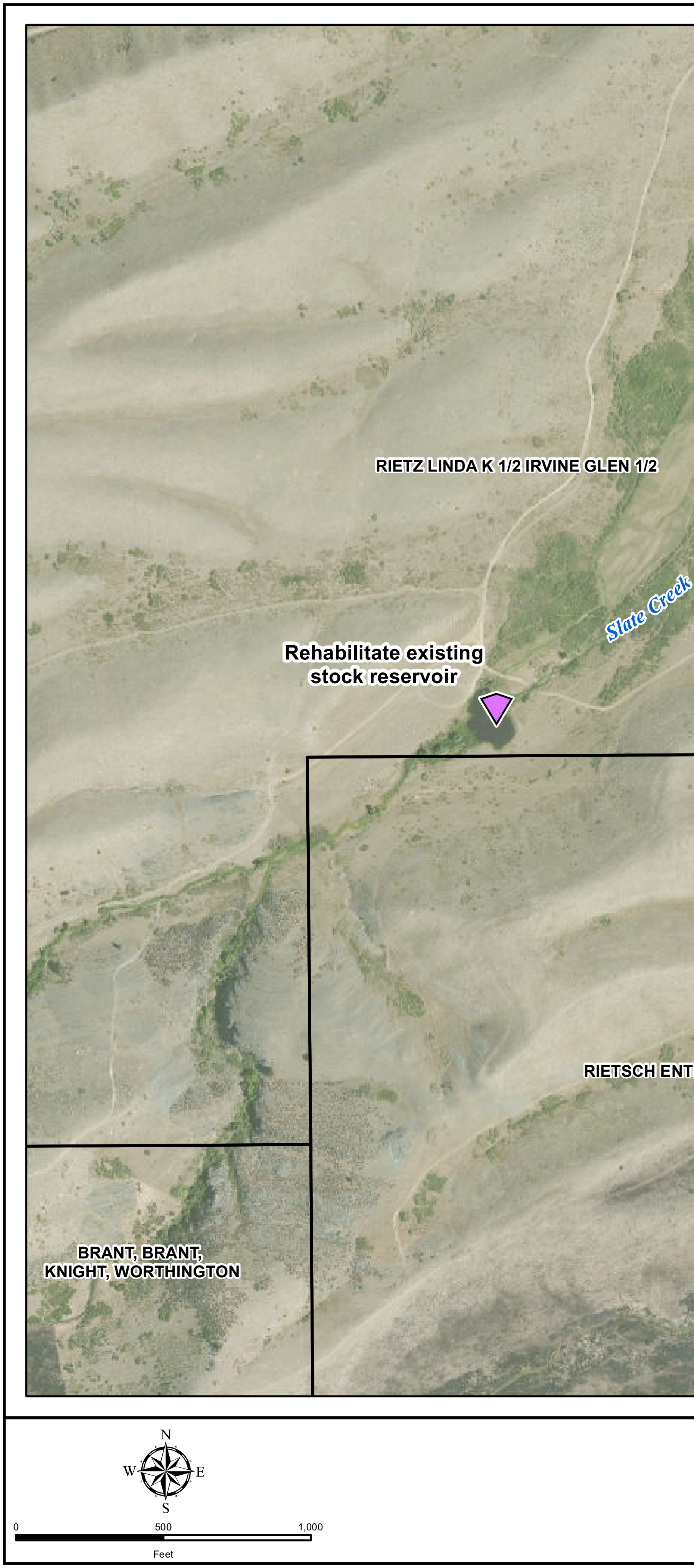
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: George Creek (tributary to Laramie River)

Grazing Allotment: Reed Creek (BLM)

Sage Grouse Core Area: Not Applicable



L/W-008 Irvine 001 Reservoir Rehabilitation Conceptual Design

Watershed Plan Component: **L/W-008**
Project Name: **Irvine Stock Reservoir Rehabilitation**
Project Sponsor/Number: **Irvine-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,700
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000	1	$ 5,000
17	Unclassified excavation	CY	$ 4	3000	$ 12,000
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35	600	$ 21,000
25	Material Haul > 1 mile	CY	$ 13	600	$ 7,800
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 47,500
	Contingencies (15% of subtotal)				$ 7,125
	Engineering and technical assistance (10% of subtotal)				$ 4,750
	Estimated project cost				$ 59,375

L/W-009: Langseth Well Construction Project 1 (Langseth-001)

This proposed project would involve construction of a new well, installation of a with solar platform/pump, and placement of a 1,200 gallon stock tank. The proposed project would provide a reliable source of water in an area without other sources.

Project components would include:

- Installing well at approximately 300-feet deep
- Installing solar platform and submersible pump
- Installing 1,200-gallon rubber tire stock tank

Project Location:
Section 15, Township 21 North, Range 67 West.

Land Ownership (Surface):

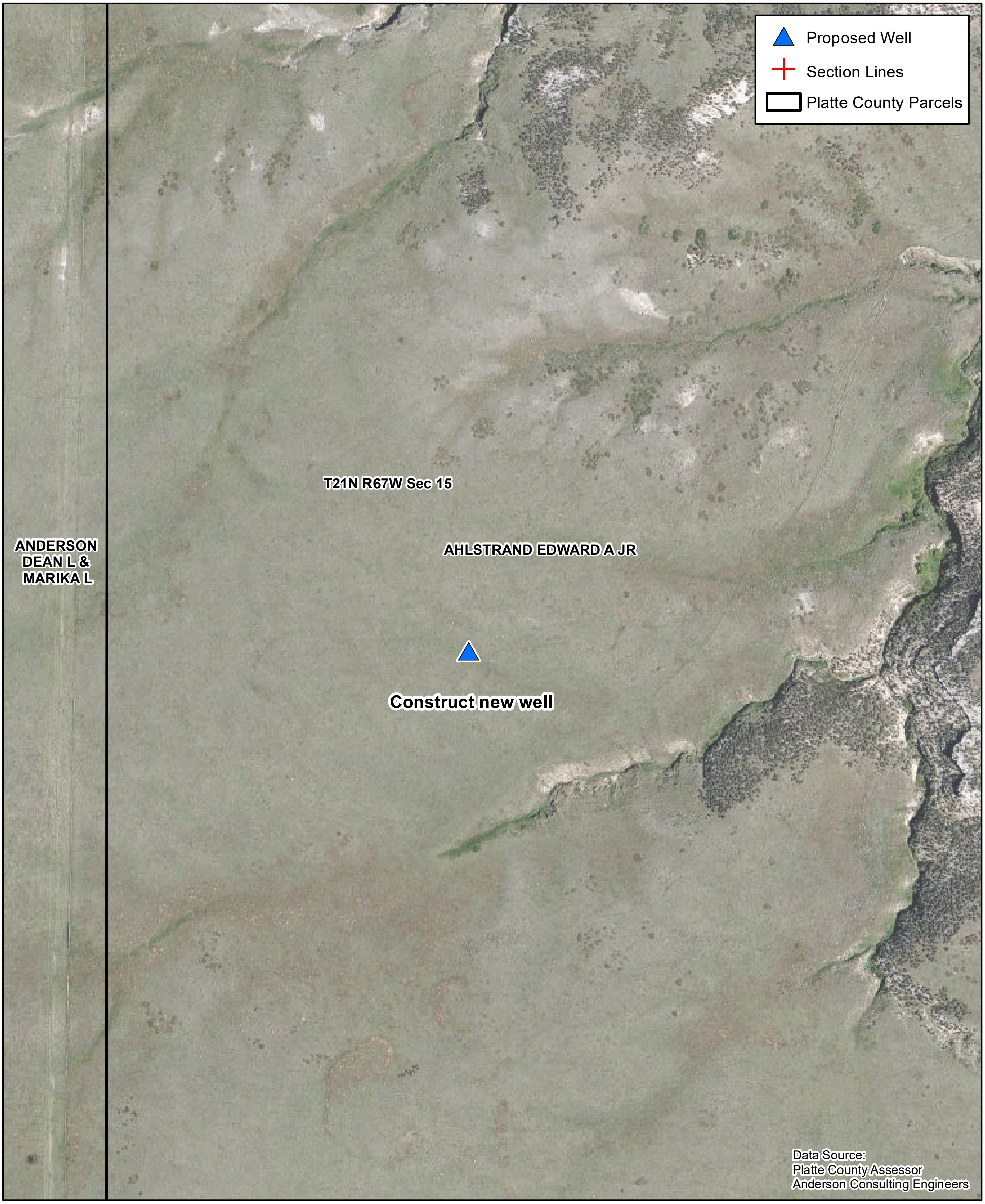
The facility is located on privately-owned lands.

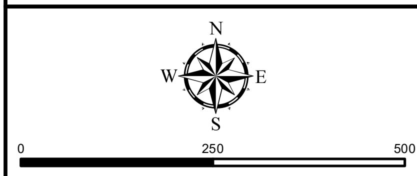
Water Source: new source

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

Note: See the included Hydrogeologic Evaluation





L/W-009 Langseth-001 Well Construction Conceptual Design

Hydrogeologic Evaluation

The “Langseth-001 and -002” sites are located in T21N, R67W, Sec. 15 and T21N, R67W, Sec. 11, respectively. They are about 2.5-3 miles northwest of Chugwater, at approximate elevations 5625 and 5575 feet[1], respectively. There are 14 existing groundwater permits in this area. See the attached figure for locations[2].

Permit	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
11521	M.L. Parrish/St. of Wyo.	12.5	60	200(?)
13490	W.J. Brown Jr.	10	Unknown	Unknown
13489	W.J. Brown Jr.	15	Unknown	Unknown
13492	W.J. Brown Jr.	10	Unknown	Unknown
13484	W.J. Brown Jr.	10	48	90
7099	James Collins	160	30	63
7100	James Collins	175	40	79
7098	James Collins	150	23	55
6825	Louis Voight	2.5	65	118
39622	Louis Voight	3	0	5
24980	Harding & Kirkbride Livestock	150	37	220
60652	5W Ranch	20	55	165
190169	Tom West	10	20	100
173183	Don Guidice	25	80	200

At the surface at the prospective well sites (and across the adjacent hilltops) are remnants of the Arikaree Formation, sitting on top of outcrops of the underlying Brule Formation, which forms the Chugwater and Richeau Creek valleys. Right along the creeks are limited alluvial deposits. #39622 is basically a spring, i.e. a shallow, dug well, at the Arikaree / Brule contact. This system captures the benefit of the somewhat more permeable Arikaree receiving local recharge across the hilltop to the

[1]This discussion is based on a specific location and elevation. Some adjustment of projected depths may be appropriate if the precise site is at a different elevation.

[2]The location of the prospective well is accurate; the locations of the State Engineers Office groundwater permits are only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

south, with groundwater flow impeded from continuing downward by the lower permeability of the Brule.

At the prospective wells, there is likely a similar situation, i.e. a small amount of local recharge may "pile up" on top of the underlying Brule. However, that #6825 was drilled on through the Arikaree and found a depth-to-water of 65 feet in the Brule indicates that any "perched" groundwater present was deemed insufficient to usefully develop. Future wells should not rely on shallow water at the Arikaree / Brule interface.

The 2.5, 10, and 10-15 gpm production reported for 6825, 13484, and 11521 are credible for the Brule. Of this set, only 11521 provides a log, identifying the water-bearing zone as a "sand" with a "good flow of water", at 85 - 90 ft., overlain by clay and "cement rock".

The group of wells to the northeast of the prospective site - 13490, 13489, 13492 - are all old wells (drilled prior to 1930) for which no data are available. Yields were apparently sufficient for local stock use, and the wells were reported in 1972 to produce between 10 and 15 gpm.

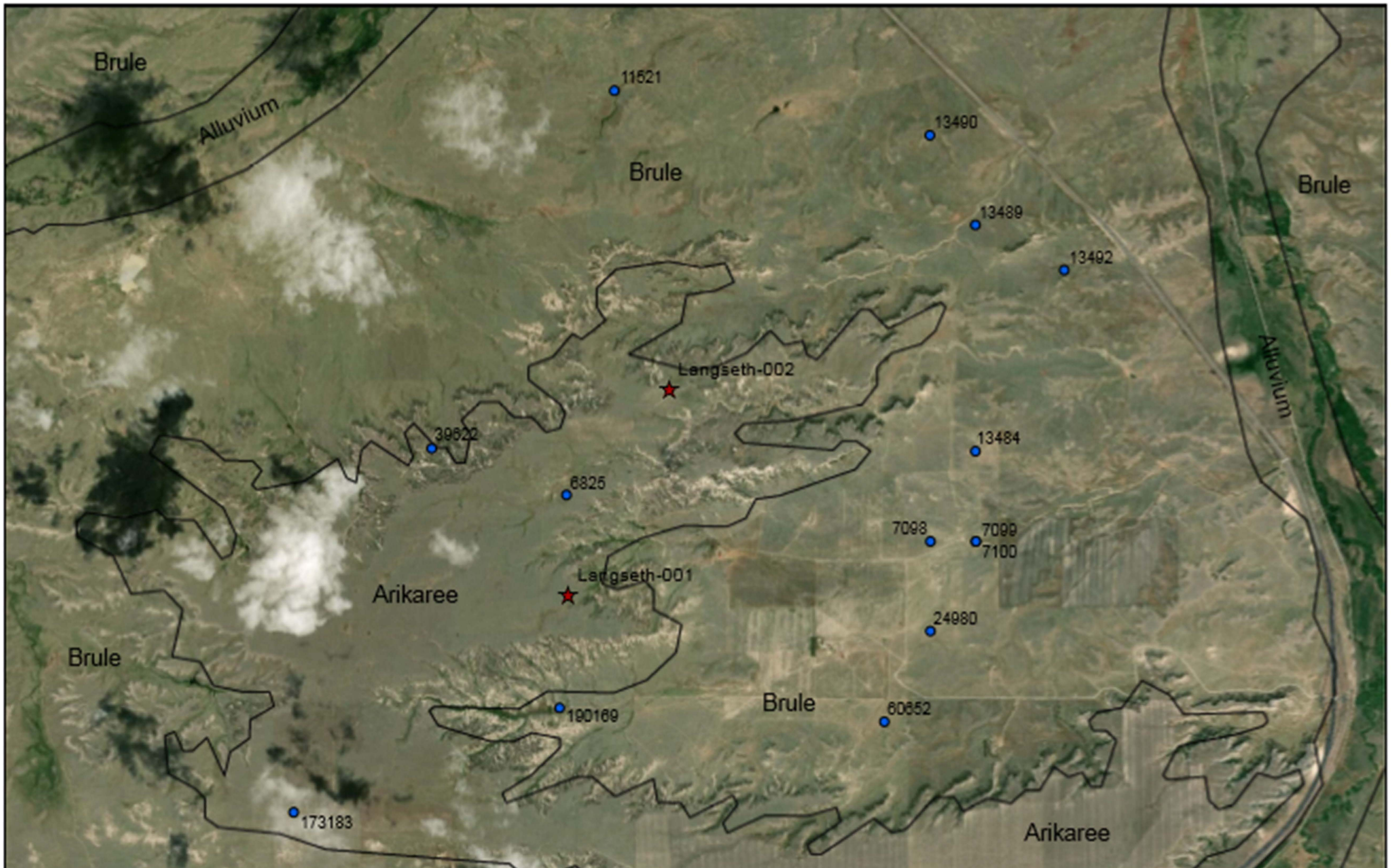
The group of wells to the east - 7098, 7099, and 7100 - report hitting a remarkably productive zone in the Brule, with tested yields from 120 to 175 gpm. The water-bearing zone in this case was a sand and gravel unit at approximately 50 feet depth, within the typical clay section. Reported drawdown for these well tests were 50 - 65 ft. Well 2490 reports a test at approximately 120 gpm, but no such gravel unit. This well was perforated from the water level (40 feet) to 220 feet, indicating the accumulation of groundwater from many small zones.

Subtraction of reported depths-to-water from apparent surface elevations provides a first approximation of the water level elevation. Due to the relatively low permeability of the Brule, groundwater gradients are steep, i.e. the groundwater elevation changes significantly from point to point. The suggested groundwater elevation at #6825, between the two Langseth prospects, is 5500 feet, but is only 5370 feet at #190169, to the south. Wells east of Langseth-001 indicate groundwater elevations around 5200 feet. Thus, at Langseth-001 (5625 feet surface elevation) a depth-to-water around 200 feet is suggested. For Langseth-002 (5575 feet surface elevation) a depth-to-water around 220 feet is suggested.

All of these wells reported "good" groundwater quality, i.e. for the intended use of watering stock.

Conclusions:

1. There is a good likelihood of developing groundwater supplies on the order of 5 - 10 gpm from the Brule Formation in this area.
2. Given the relatively high elevation of the prospective site, it may be necessary to drill somewhat deeper than the wells listed above, and a greater depth to water may be anticipated. If the depths-to-water estimated above are approximately correct, it would be prudent to anticipate drilling to approximately 300 feet to provide available drawdown, to increase the chances of accumulating adequate water from many low-yield zones, and to guard against future fluctuations in water level.
3. Groundwater quality at this location is likely adequate for stock use.
4. A groundwater permit from the Wyoming State Engineer's Office will be required, but there should be no special water-rights related issues with a well for stock use at this location.



Langseth-001 & 002 Groundwater Prospects
Lower Laramie Watershed

Watershed Plan Component: **L/W-009**
Project Name: **Langseth Well Construction Project 1**
Project Sponsor/Number: **Langseth-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,450
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50	300	$ 15,000
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 37,950
	Contingencies (15% of subtotal)				$ 5,693
	Engineering and technical assistance (10% of subtotal)				$ 3,795
	Estimated project cost				$ 47,438

L/W-010: Langseth Well Construction Project 2 (Langseth-002)

This proposed project would involve construction of a new well, installation of a with solar platform/pump, and placement of a 1,200 gallon stock tank. The proposed project would provide a reliable source of water in an area without other sources.

Project components would include:

- Installing well at approximately 300-feet deep
- Installing solar platform and submersible pump.
- Installing 1,200-gallon rubber tire stock tank

Project Location:
Section 11, Township 21 North, Range 67 West.

Land Ownership (Surface):

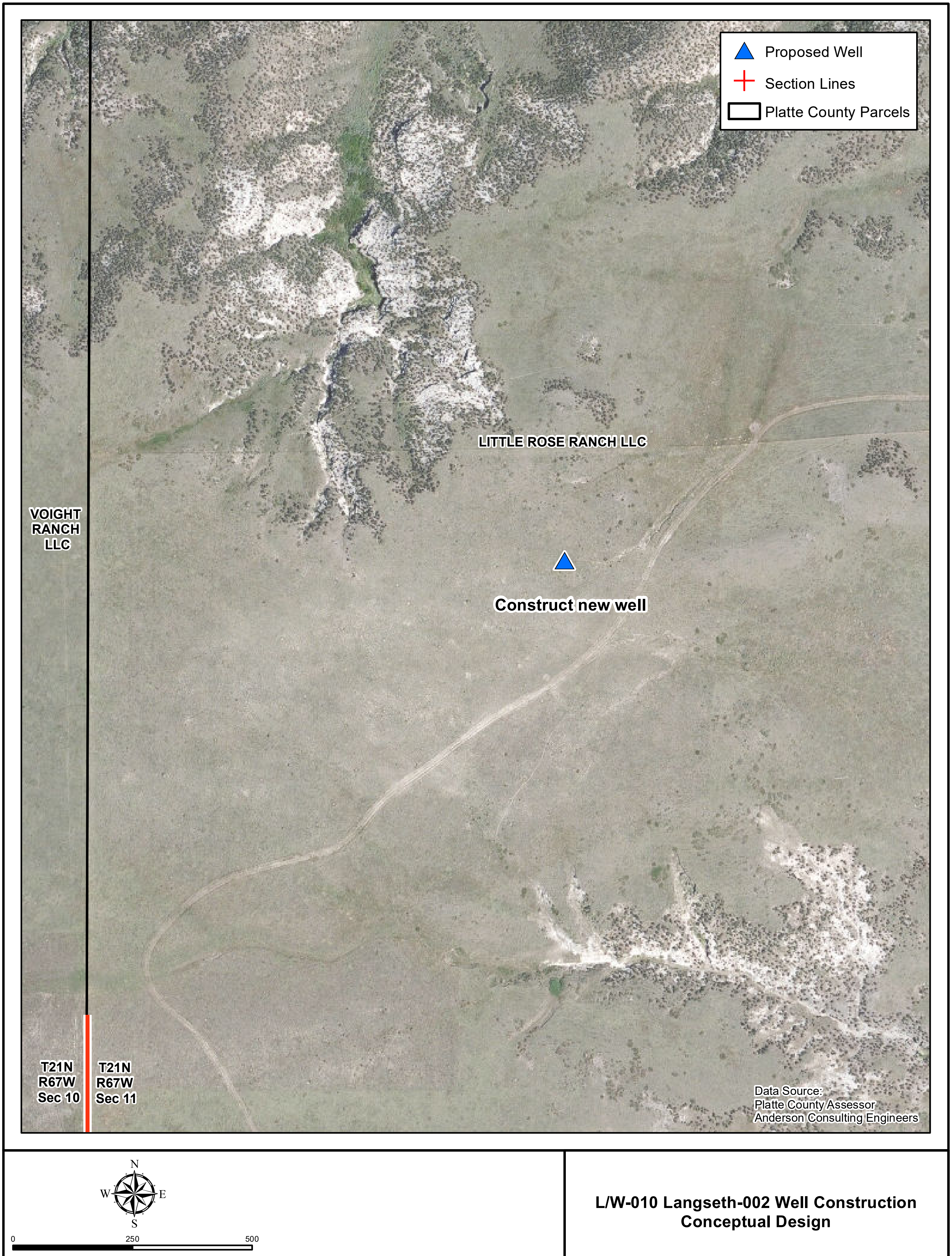
The facility is located on privately-owned lands.

Water Source: new well construction

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

Note: See the included Hydrogeologic Evaluation



L/W-010 Langseth-002 Well Construction Conceptual Design

Hydrogeologic Evaluation

The "Langseth-001 and -002" sites are located in T21N, R67W, Sec. 15 and T21N, R67W, Sec. 11, respectively. They are about 2.5-3 miles northwest of Chugwater, at approximate elevations 5625 and 5575 feet[1], respectively. There are 14 existing groundwater permits in this area. See the attached figure for locations[2].

Permit	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
11521	M.L. Parrish/St. of Wyo.	12.5	60	200(?)
13490	W.J. Brown Jr.	10	Unknown	Unknown
13489	W.J. Brown Jr.	15	Unknown	Unknown
13492	W.J. Brown Jr.	10	Unknown	Unknown
13484	W.J. Brown Jr.	10	48	90
7099	James Collins	160	30	63
7100	James Collins	175	40	79
7098	James Collins	150	23	55
6825	Louis Voight	2.5	65	118
39622	Louis Voight	3	0	5
24980	Harding & Kirkbride Livestock	150	37	220
60652	5W Ranch	20	55	165
190169	Tom West	10	20	100
173183	Don Guidice	25	80	200

At the surface at the prospective well sites (and across the adjacent hilltops) are remnants of the Arikaree Formation, sitting on top of outcrops of the underlying Brule Formation, which forms the Chugwater and Richeau Creek valleys. Right along the creeks are limited alluvial deposits. #39622 is basically a spring, i.e. a shallow, dug well, at the Arikaree / Brule contact. This system captures the benefit of the somewhat more permeable Arikaree receiving local recharge across the hilltop to the

[1]This discussion is based on a specific location and elevation. Some adjustment of projected depths may be appropriate if the precise site is at a different elevation.

[2]The location of the prospective well is accurate; the locations of the State Engineers Office groundwater permits are only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

south, with groundwater flow impeded from continuing downward by the lower permeability of the Brule.

At the prospective wells, there is likely a similar situation, i.e. a small amount of local recharge may "pile up" on top of the underlying Brule. However, that #6825 was drilled on through the Arikaree and found a depth-to-water of 65 feet in the Brule indicates that any "perched" groundwater present was deemed insufficient to usefully develop. Future wells should not rely on shallow water at the Arikaree / Brule interface.

The 2.5, 10, and 10-15 gpm production reported for 6825, 13484, and 11521 are credible for the Brule. Of this set, only 11521 provides a log, identifying the water-bearing zone as a "sand" with a "good flow of water", at 85 - 90 ft., overlain by clay and "cement rock".

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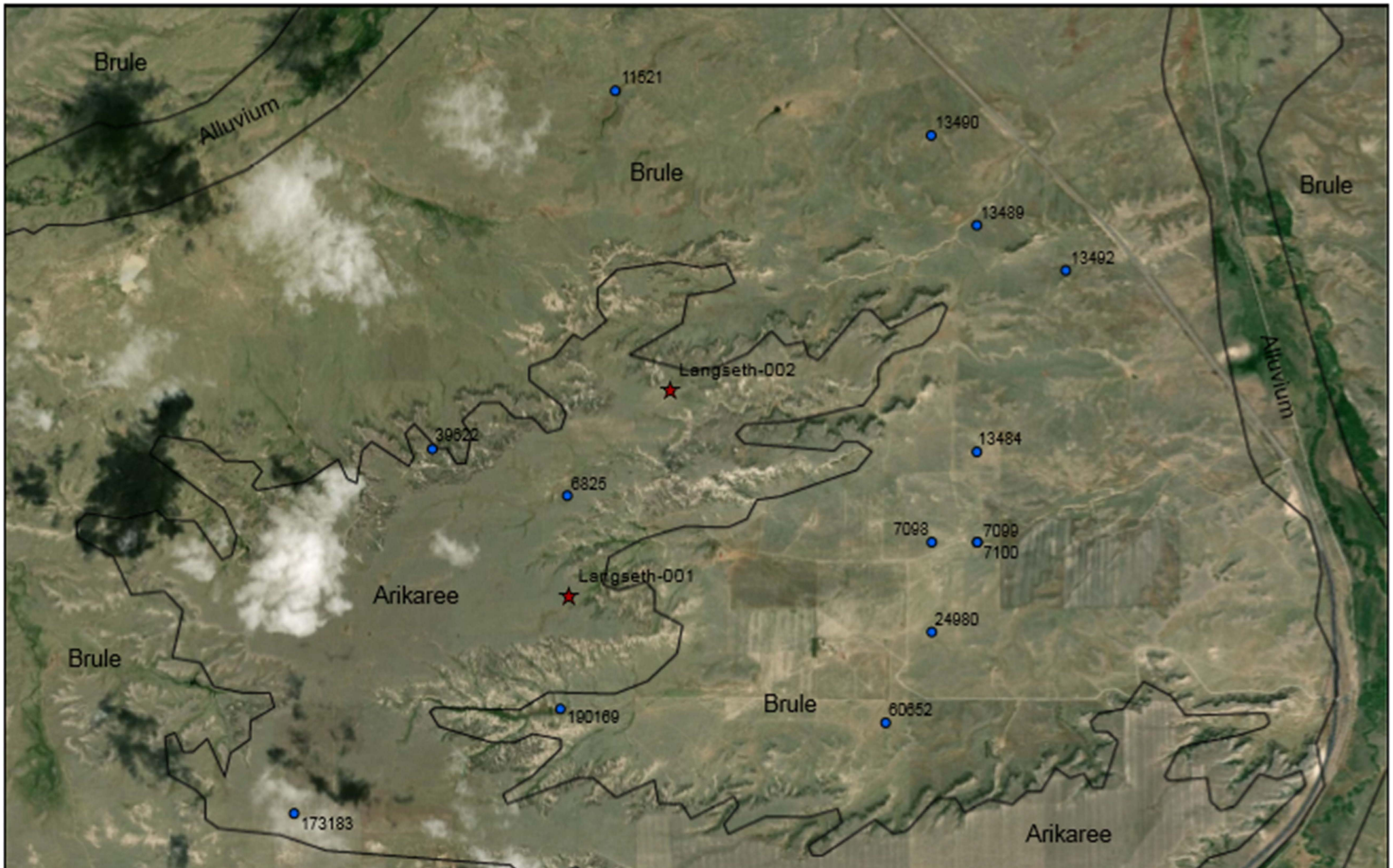
All of these wells reported "good" groundwater quality, i.e. for the intended use of watering stock.

Conclusions:

1. There is a good likelihood of developing groundwater supplies on the order of 5 - 10 gpm from the Brule Formation in this area.
2. Given the relatively high elevation of the prospective site, it may be necessary to drill somewhat deeper than the wells listed above, and a greater depth to water may be anticipated. If the depths-to-water estimated above are approximately correct, it would be prudent to anticipate drilling to approximately 300 feet to provide available drawdown, to increase the chances of accumulating adequate water from many low-yield zones, and to guard against future fluctuations in water level.
3. Groundwater quality at this location is likely adequate for stock use.

4. A groundwater permit from the Wyoming State Engineer's Office will be required, but there should be no special water-rights related issues with a well for stock use at this location.



approximate location of Wyoming State Engineer groundwater permit

Langseth-001 & 002 Groundwater Prospects
Lower Laramie Watershed

Watershed Plan Component: **L/W-010**
Project Name: **Langseth Well Construction Project 2**
Project Sponsor/Number: **Langseth-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,450
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50	300	$ 15,000
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 37,950
	Contingencies (15% of subtotal)				$ 5,693
	Engineering and technical assistance (10% of subtotal)				$ 3,795
	Estimated project cost				$ 47,438

L/W-011: Preston Stock Reservoir Rehabilitation Project (Preston-001)

The proposed project would involve rehabilitation of an existing stock reservoir within the Lower Laramie River watershed. The existing reservoir loses water do infiltration and has no outlet facility.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Rehabilitating existing livestock/wildlife reservoir
- Lining existing reservoir with bentonite/bentomat product
- Installing Agri-Drain reservoir outlet

Project Location:
Section 8, Township 25 North, Range 70 West.

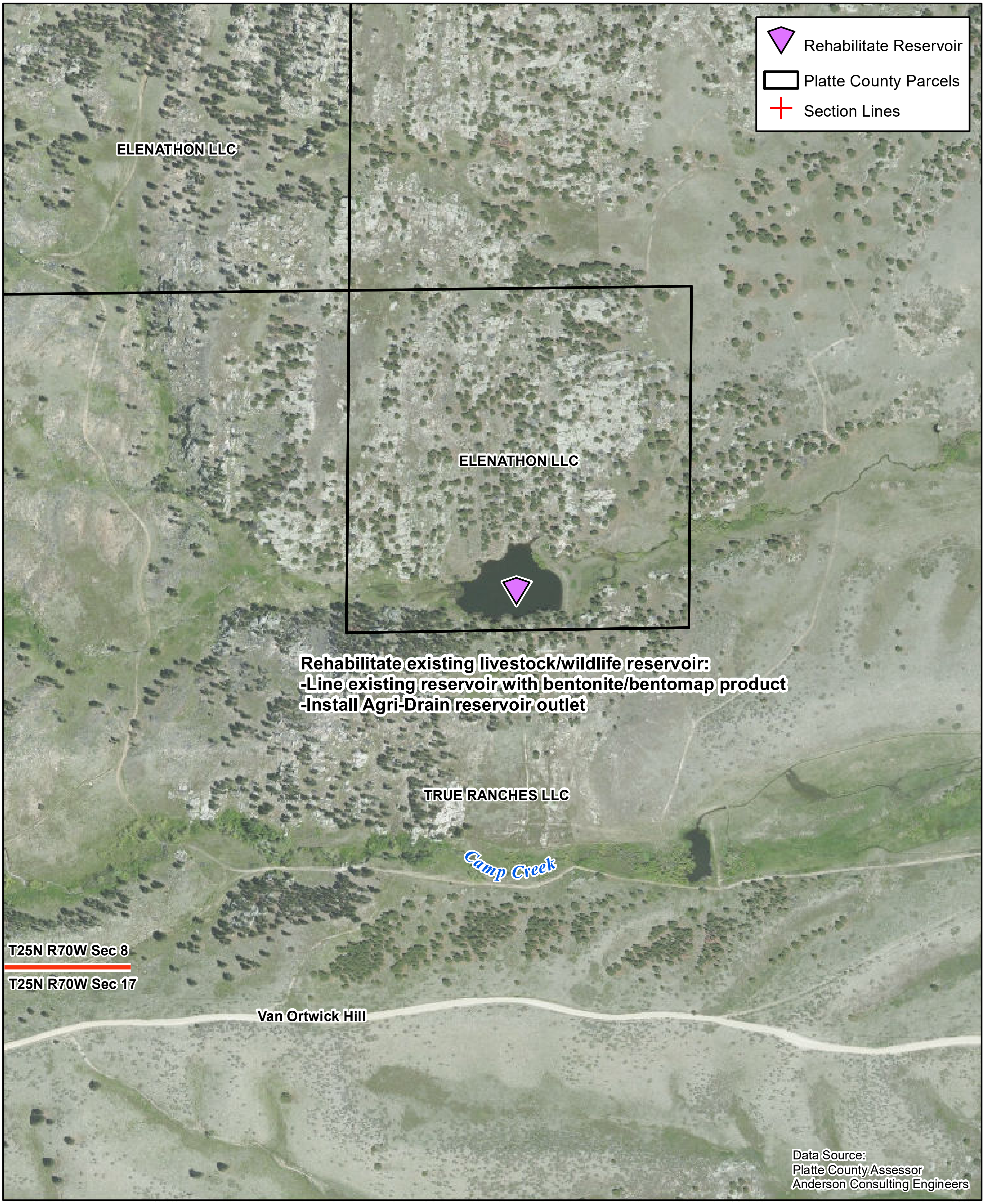
Land Ownership (Surface):

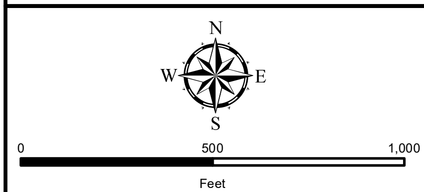
The facility is located on privately-owned lands.

Water Source: unnamed tributary to the North Laramie River

Grazing Allotment: Prosser (BLM)

Sage Grouse Core Area: Not Applicable





L/W-011 Preston 001 Reservoir Rehabilitation
Conceptual Design

Watershed Plan Component: **L/W-011**
Project Name: **Preston Stock Reservoir Rehabilitation Project**
Project Sponsor/Number: **Preston-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 960
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000	1	$ 5,000
17	Unclassified excavation	CY	$ 4	1000	$ 4,000
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12	50	$ 600
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20	3062	$ 61,240
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 71,800
	Contingencies (15% of subtotal)				$ 10,770
	Engineering and technical assistance (10% of subtotal)				$ 7,180
	Estimated project cost				$ 89,750

L/W-012: Preston Stock Reservoir Construction Project (Preston-002)

The proposed project would involve the construction of new livestock/wildlife reservoir within the North Laramie River watershed. The precise location of the reservoir would require a more detailed analysis than provided herein. The existing topography is relatively steep and confined and ultimate design consideration should include incorporation of a reservoir outlet and a spillway.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Installing livestock/wildlife reservoir

Project Location:
Section 8, Township 25 North, Range 70 West.

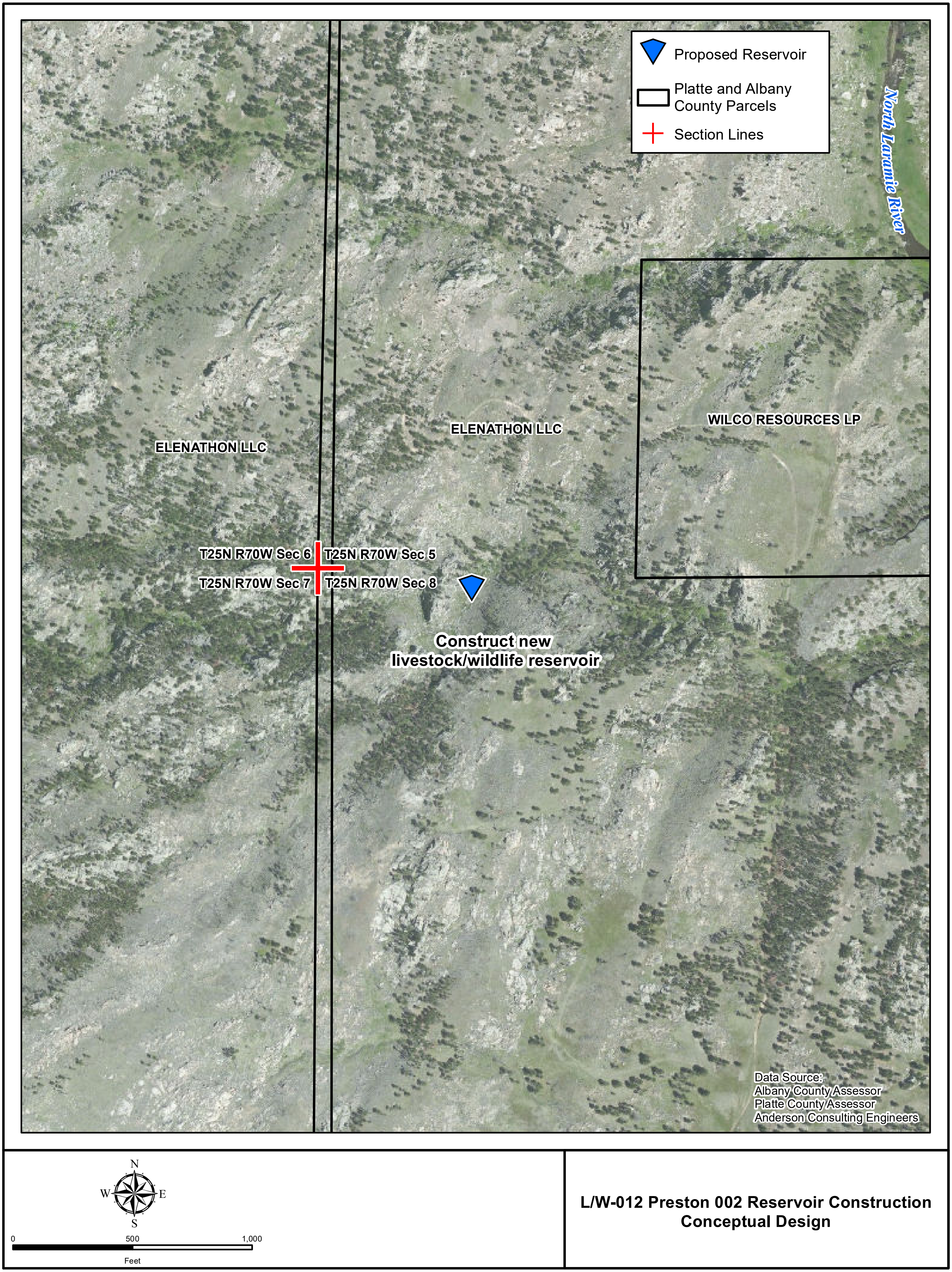
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: unnamed tributary to the North Laramie River.

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



L/W-012 Preston 002 Reservoir Construction Conceptual Design

Watershed Plan Component: **L/W-012**
Project Name: **Preston Stock Reservoir Construction Project**
Project Sponsor/Number: **Preston-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 4,100
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
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5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
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22	8" low level outlet pipe	LF	$ 40		$ -
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24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 45,100
	Contingencies (15% of subtotal)				$ 6,765
	Engineering and technical assistance (10% of subtotal)				$ 4,510
	Estimated project cost				$ 56,375

L/W-013: Purdy Spring Development Project 1 (Purdy-001)

The proposed project would entail the reconstruction of an existing failed spring development.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Removing existing failed spring development infrastructure
- Installing approximately 450 linear feet of buried 1.5” HDPE pipeline
- Installing spring development at existing spring
- Installing 1,200-gallon rubber tire stock tank

Project Location:
Section 6, Township 22 North, Range 71 West.

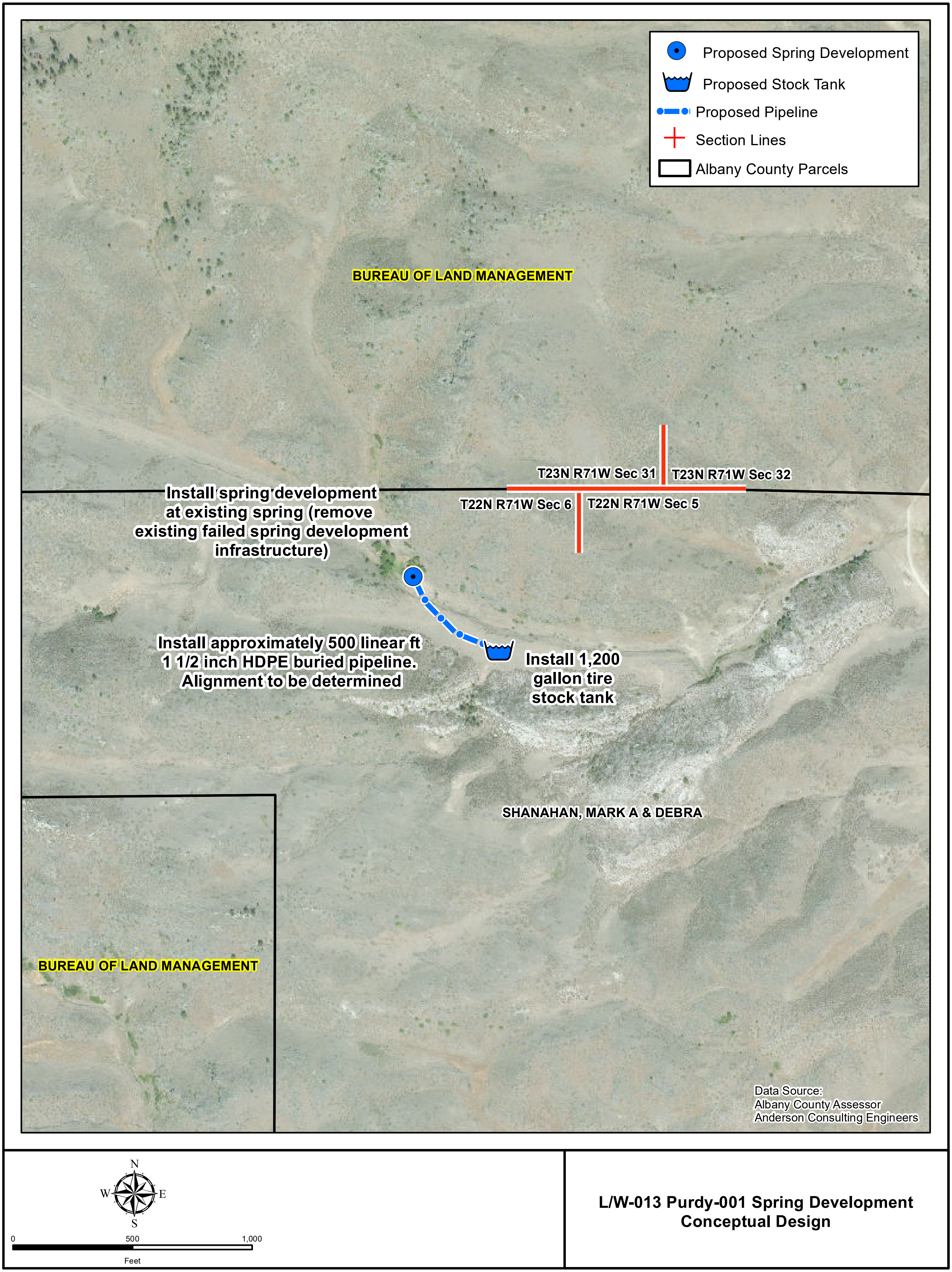
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: existing spring

Grazing Allotment: Wheatland Tunnel (BLM)

Sage Grouse Core Area: Not Applicable



L/W-013 Purdy-001 Spring Development Conceptual Design

Watershed Plan Component: **L/W-013**
Project Name: **Purdy Spring Development Project 1**
Project Sponsor/Number: **Purdy-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,235
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000	1	$ 5,000
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	450	$ 1,350
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5	400	$ 2,000
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 13,585
	Contingencies (15% of subtotal)				$ 2,038
	Engineering and technical assistance (10% of subtotal)				$ 1,359
	Estimated project cost				$ 16,981

L/W-014: Purdy Spring Development Project 2 (Purdy-002)

The proposed project would entail the construction of a spring development and placement of a 1,200-gallon livestock/wildlife stock tank.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Installing spring development
- Installing 1,200-gallon rubber tire stock tank
- Installing approximately 75 linear feet of buried 1.5" HDPE pipeline

Project Location:
Section 31, Township 23 North, Range 71 West.

Land Ownership (Surface):

The facility is located on lands owned by Department of Interior, Bureau of Land Management

Water Source: existing spring

Grazing Allotment: Wheatland Tunnel (BLM)

Sage Grouse Core Area: Not Applicable

L/W-014 Purdy-002 Spring Development Conceptual Design

Watershed Plan Component: **L/W-014**
Project Name: **Purdy Spring Development Project 2**
Project Sponsor/Number: **Purdy-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,235
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000	1	$ 5,000
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	450	$ 1,350
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5	400	$ 2,000
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 13,585
	Contingencies (15% of subtotal)				$ 2,038
	Engineering and technical assistance (10% of subtotal)				$ 1,359
	Estimated project cost				$ 16,981

L/W-015: Watson Pipeline Project 1 (Watson-001)

The proposed project would involve the construction of a pipeline and livestock/wildlife stock tank system with an existing well as the source of water. The project would provide reliable sources of livestock and wildlife water to an area without existing alternative sources.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Installing three 1,200-gallon rubber tire stock tanks
- Installing a 5,000 gallon storage tank
- Installing a booster pump
- Installing approximately 8,200 LF of 1 ½ " HDPE buried pipeline.

Project Location:
Section 33, 34 and 35 of Township 26 North, Range 50 West

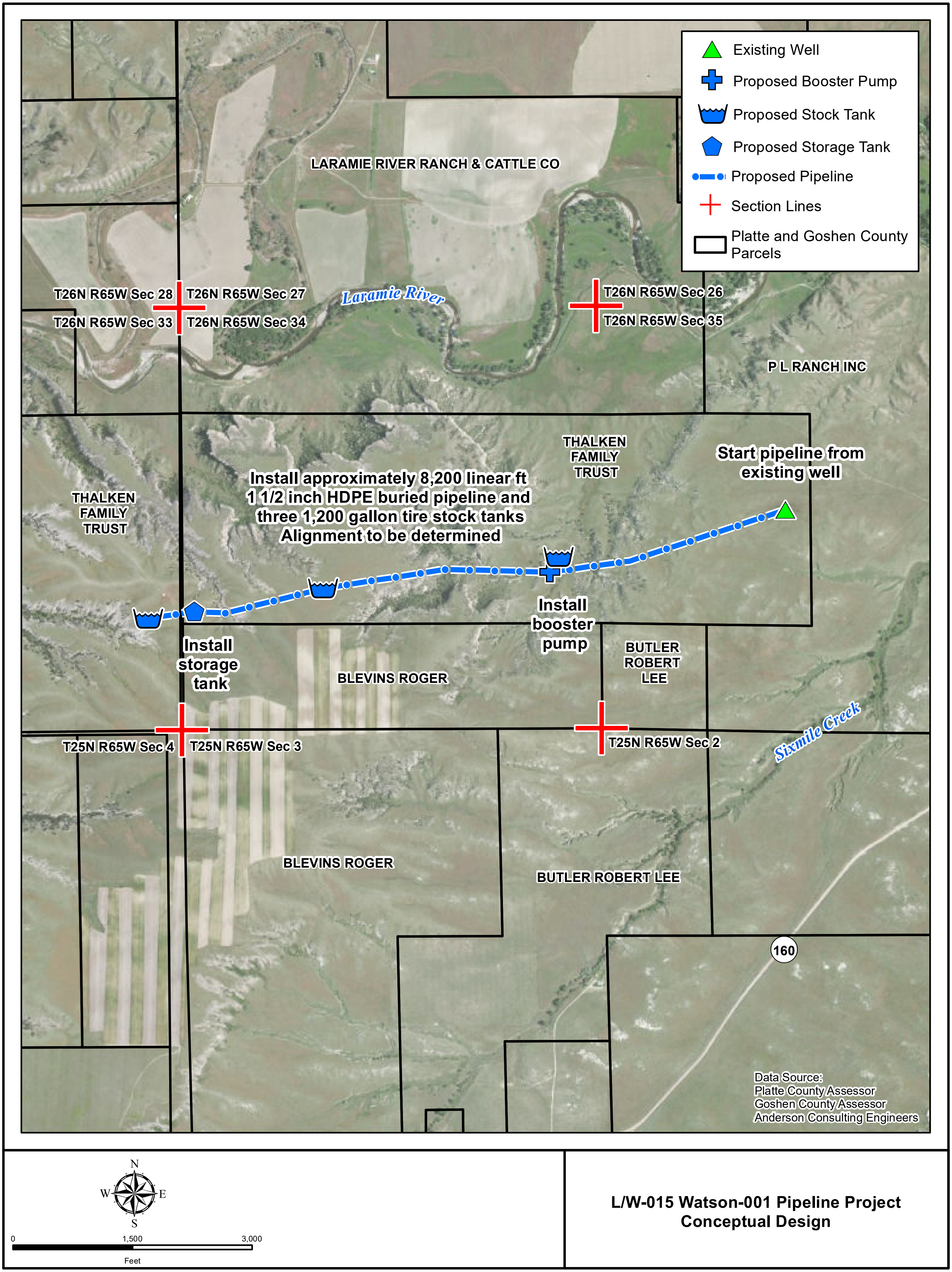
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: existing well

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



L/W-015 Watson-001 Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-015**
Project Name: **Watson Pipeline Project 1**
Project Sponsor/Number: **Watson-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 5,960
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500	1	$ 2,500
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	3	$ 10,500
5e	Storage Tank	gal	$ 1	5000	$ 5,000
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	8200	$ 24,600
7	Misc valves and piping at tank(s)	Ea	$ 500	3	$ 1,500
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 65,560
	Contingencies (15% of subtotal)				$ 9,834
	Engineering and technical assistance (10% of subtotal)				$ 6,556
	Estimated project cost				$ 81,950

L/W-016: Watson Pipeline Project 2 (Watson-002)

The proposed project would involve the construction of a small pipeline and livestock/wildlife tank system from an existing well.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Installing approximately 3,700 linear feet of 1 1/2” buried HDPE pipeline
- Installing a 1,200-gallon rubber tire stock tank

Project Location:
Sections 23 and 26 of Township 26 North, Range 66 West

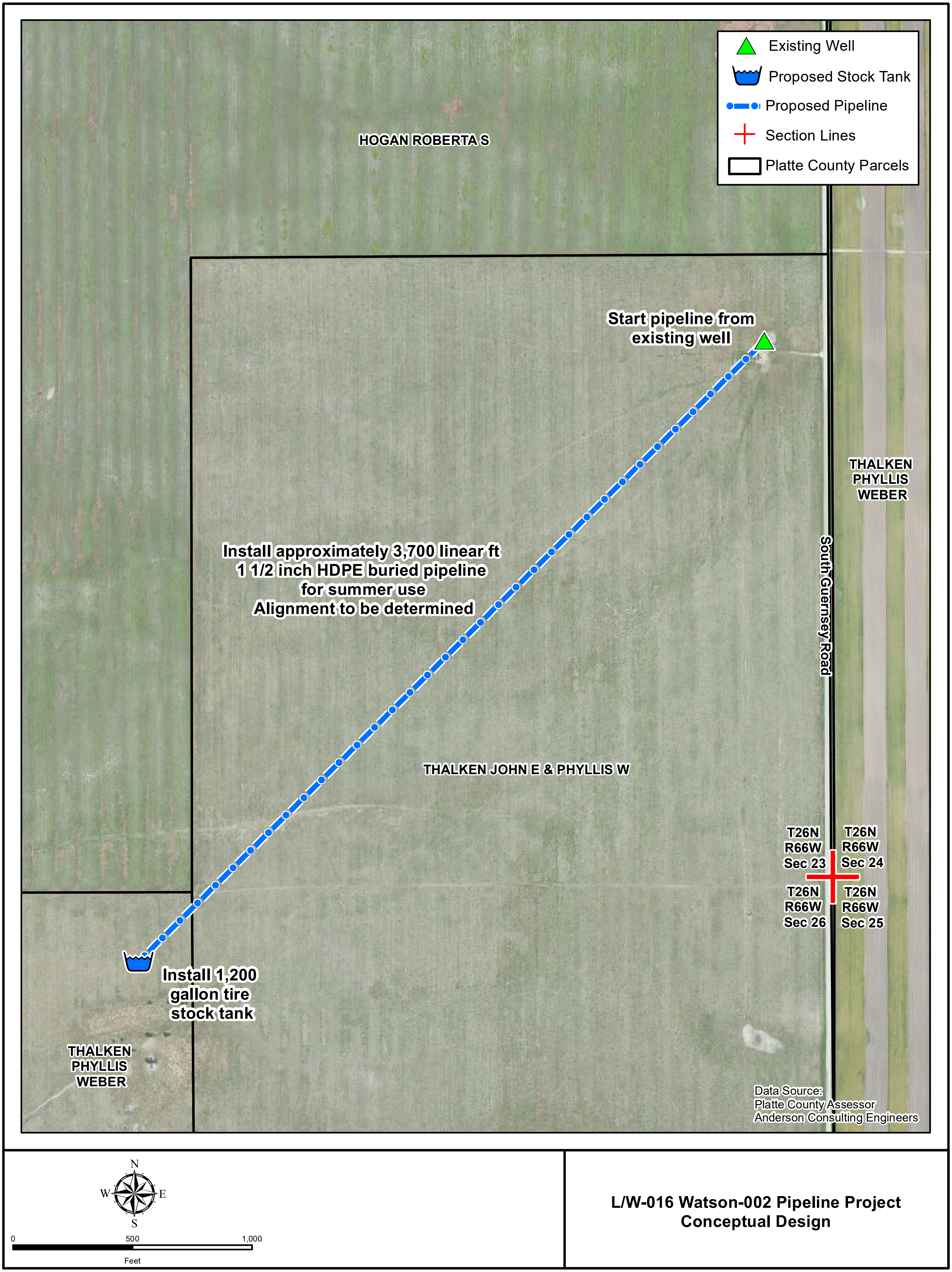
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: existing well

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



L/W-016 Watson-002 Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-016**
Project Name: **Watson Pipeline Project 2**
Project Sponsor/Number: **Watson-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,510
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	3700	$ 11,100
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 16,610
	Contingencies (15% of subtotal)				$ 2,492
	Engineering and technical assistance (10% of subtotal)				$ 1,661
	Estimated project cost				$ 20,763

L/W-017: West Well and Pipeline Construction Project (West-001)

The proposed project would involve the construction of a new livestock/wildlife tank / pipeline / well system within the Chugwater Creek watershed. The project would provide a valuable source of water to an area without existing sources.

Construction of the proposed project would provide a reliable source of water for livestock and wildlife in an area with limited alternatives to the ephemeral streams.

Project components would include:

- Construction of a new well approximately 250 feet in depth
- Installing solar platform and pump system
- Installing four 1,200-gallong stock tanks
- Installing about 1,000 LF of 1.5" diameter HDPE

Project Location::
Sections 1 and 2 of Township 21 North, Range 67 West

Land Ownership (Surface):

The facility is located on lands owned by:

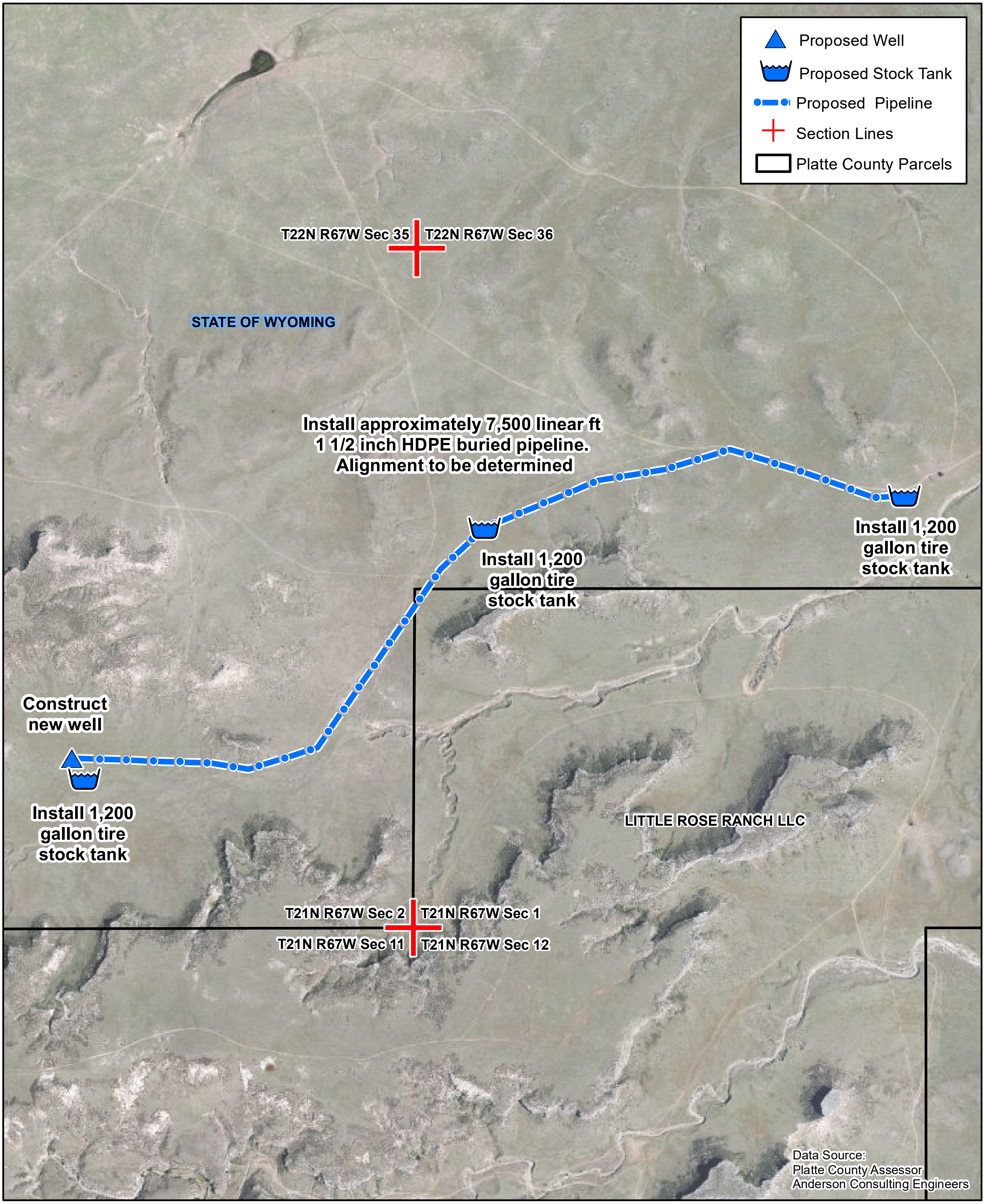
- Privately-owned property, and the
- State of Wyoming

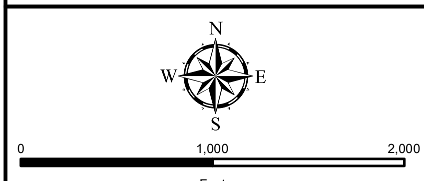
Water Source: new well

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

Note: See the included Hydrogeologic Evaluation





L/W-017 West 001 Well and Pipeline Construction Conceptual Design

Hydrogeologic Evaluation

The “West” site is located in T21N, R67W, Sec. 2, about 4 miles northwest of Chugwater, at approximate elevation 5420 feet[1]. There are 10 existing groundwater permits in this area. See the attached figure for locations[2].

Permit	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
11521	M.L. Parrish/St. of Wyo.	12.5	60	60 [200?]
13490	W.J. Brown Jr.	10	Unknown	Unknown
13489	W.J. Brown Jr.	15	Unknown	Unknown
13492	W.J. Brown Jr.	10	Unknown	Unknown
13484	W.J. Brown Jr.	10	48	90
7099	James Collins	160	30	63
7100	James Collins	175	40	79
7098	James Collins	150	23	55
6825	Louis Voight	2.5	65	118
39622	Louis Voight	3	0	5

The hills around the prospective well location are remnants of the Arikaree Formation, sitting on top of outcrops of the underlying Brule Formation, which forms the Chugwater and Richeau Creek valleys. Right along the creeks are limited alluvial deposits. 39622 is basically a spring, i.e. a shallow, dug well, at the Arikaree / Brule contact. This system captures the benefit of the somewhat more permeable Arikaree receiving local recharge across the hilltop to the south, with groundwater flow impeded from continuing downward by the lower permeability of the Brule. At the prospective well, there is no such recharge area, the Arikaree is absent, and the only available aquifer is the Brule.

The 2.5, 10, and 10-15 gpm production reported for 6825, 13484, and 11521 are credible for the Brule. Of this set, only 11521 provides a log, identifying the water-bearing zone as a “sand” with a “good flow of water”, at 85 - 90 ft., overlain by clay and “cement rock”.

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[1]This discussion is based on a specific location and elevation. Some adjustment of projected depths may be appropriate if the precise site is at a different elevation.

[2]The location of the prospective well is accurate; the locations of the State Engineers Office groundwater permits are only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

The group of wells to the northeast of the prospective site - 13490, 13489, 13492 - are all old wells (drilled prior to 1930) for which no data are available. Yields were apparently sufficient for local stock use, and were reported in 1972 to produce between 10 and 15 gpm.

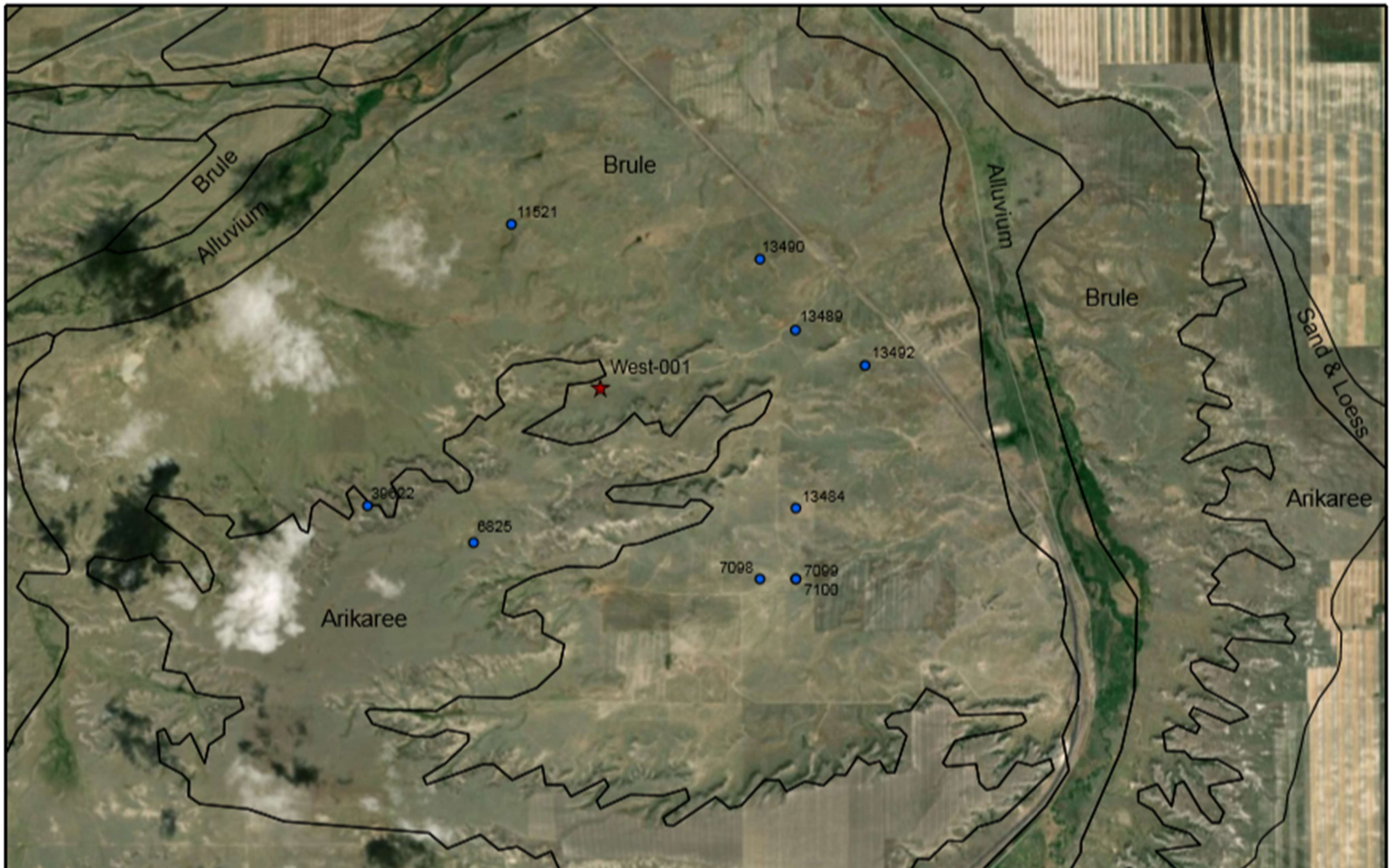
The group of wells to the southeast - 7098, 7099, and 7100 - report hitting a remarkably productive zone in the Brule, with tested yields from 150 to 175 gpm. The water-bearing zone in this case was a sand and gravel unit at approximately 50 feet depth, within the typical clay section. Reported drawdown for these well tests were 50 - 65 ft.

The two closest wells reporting depths to water are 11521 and 13484. For both of these, subtraction from ground surface in the area indicates a groundwater level elevation of approximately 5200 feet, i.e. at a depth of approximately 200 feet at the prospective well location.

All of these wells reported “good” groundwater quality, i.e. for the intended use of watering stock.

Conclusions:

1. There is a good likelihood of developing groundwater supplies on the order of 5 - 10 gpm from the Brule Formation in this area. There is some chance of encountering local zones capable of far greater production.
2. Given the relatively high elevation of the prospective site, it may be necessary to drill somewhat deeper than the wells listed above, and a greater depth to water may be anticipated. Assuming approximately horizontal bedding, the productive zone at 13484, for example, would occur at a depth of 250 feet. The equivalent depth to water would be around 200 feet, although the experience at 6825 suggests useful water could be encountered at somewhat higher elevation due to recharge associated with the Arikaree upland areas.
3. Groundwater quality at this location is likely adequate for stock use.
4. A groundwater permit from the Wyoming State Engineer’s Office will be required, but there should be no special water-rights related issues with a well for stock use at this location.



approximate location of Wyoming State Engineer groundwater permit

West-001 Groundwater Prospect
Lower Laramie Watershed

Watershed Plan Component: **L/W-017**
Project Name: **West Well and Pipeline Construction Project**
Project Sponsor/Number: **West-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 6,500
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50	250	$ 12,500
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000	1	$ 12,000
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500	1	$ 2,500
4b	Electrical work for well	LS	$ 3,500	1	$ 3,500
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500	3	$ 10,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	7500	$ 22,500
7	Misc valves and piping at tank(s)	Ea	$ 500	3	$ 1,500
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 71,500
	Contingencies (15% of subtotal)				$ 10,725
	Engineering and technical assistance (10% of subtotal)				$ 7,150
	Estimated project cost				$ 89,375

ENV-001: Lower Laramie River Bank Stabilization Project 1 (deRyk-001)

The proposed project would provide stream bank protection adjacent to a private residence and restore channel conveyance capacity by removing invasive willows. In recent years, willows have encroached into an area where they are not desired.

Project components would include:

- Excavating old channel alignment
- Installing bank toe protection
- Installing rock J-hook weirs and large woody debris
- Installing large woody debris

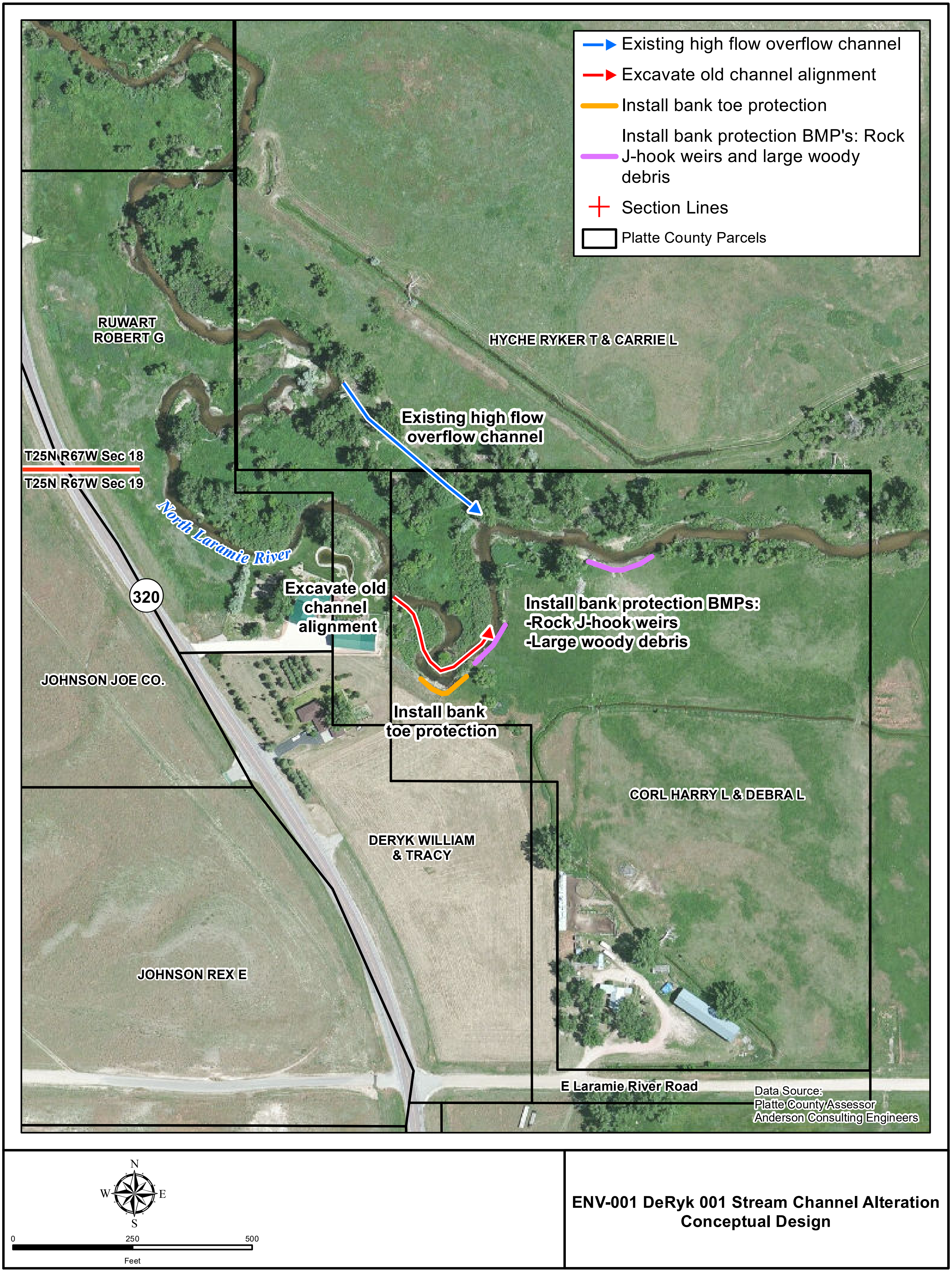
Project Location:
Section 19, Township 25 North, Range 67 West

Land Ownership (Surface): The facility is located on privately-owned lands.

Water Source: Laramie River

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



ENV-001 DeRyk 001 Stream Channel Alteration Conceptual Design

Watershed Plan Component: **ENV-001**
Project Name: **Lower Laramie River Bank Stabilization Project 1**
Project Sponsor/Number: **deRyk-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,400
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000	2	$ 18,000
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4	1500	$ 6,000
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 26,400
	Contingencies (15% of subtotal)				$ 3,960
	Engineering and technical assistance (10% of subtotal)				$ 2,640
	Estimated project cost				$ 33,000

ENV-002: Lower Laramie River Bank Stabilization Project 2 (Lanier-001)

The proposed project would stabilize actively eroding banks of the lower Laramie River. Currently, bank erosion is resulting in a loss of pasture.

Project components would include:

- Installing J-hook rock vanes
- Installing large woody debris

Project Location:
Section 29, Township 26 North, Range 64 West

Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source:

Water Rights:

Grazing Allotment: Gray Rocks (BLM)

Sage Grouse Core Area: Not Applicable

ENV-002 Lanier-001 Bank Stabilization Conceptual Design

Watershed Plan Component: **ENV-002**
Project Name: **Lower Laramie River Bank Stabilization Project 2**
Project Sponsor/Number: **Lanier-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,800
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000	2	$ 18,000
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 19,800
	Contingencies (15% of subtotal)				$ 2,970
	Engineering and technical assistance (10% of subtotal)				$ 1,980
	Estimated project cost				$ 24,750

ENV-003: Chugwater Creek Bank Stabilization Project 1 (Nockels-001)

The proposed project would stabilize actively eroding banks of Chugwater Creek near the confluence with the lower Laramie River. Currently, active erosion threatens irrigated pastures and irrigation infrastructure.

Project components would include:

- Installing J-hook weirs

Project Location:
Section 9, Township 24 North, Range 67 West

Land Ownership (Surface):

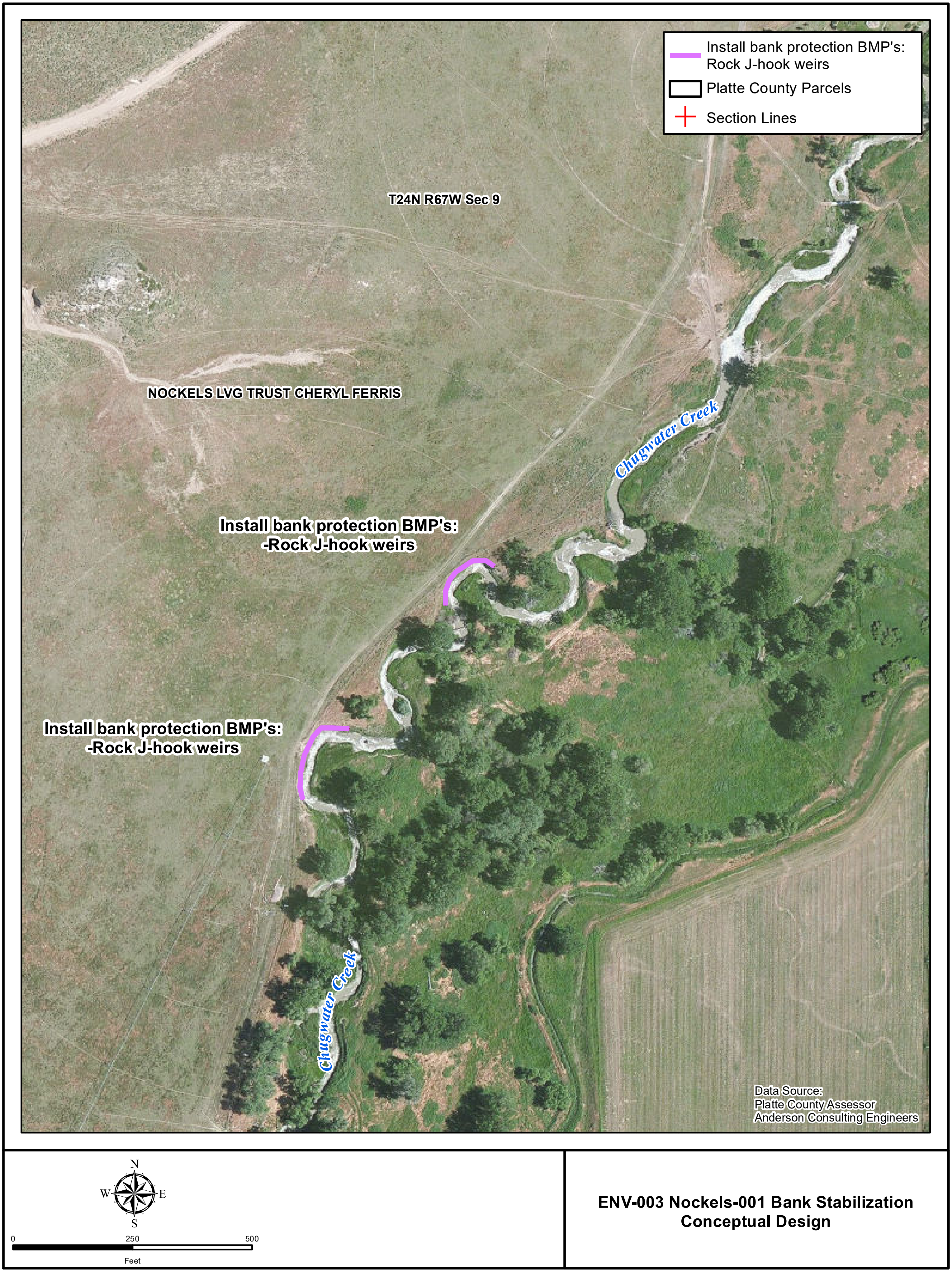
The facility is located on privately-owned lands.

Water Source:

Water Rights:

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



ENV-003 Nockels-001 Bank Stabilization Conceptual Design

Watershed Plan Component: **ENV-003**
Project Name: **Chugwater Creek Bank Stabilization Project 1**
Project Sponsor/Number: **Nockels-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,800
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000	2	$ 18,000
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 19,800
	Contingencies (15% of subtotal)				$ 2,970
	Engineering and technical assistance (10% of subtotal)				$ 1,980
	Estimated project cost				$ 24,750

ENV-004: Wilson No. 2 Ditch Diversion Fish Passage Project (WGF-001)

Wyoming Game and Fish (WGF) has identified this structure as a barrier to fish passage on the North Laramie River. Under this project, fish passage capability would be incorporated into the existing structure facilitating irrigation diversions while providing the ability for fish to move upstream and downstream. Specific design details are not currently available but are being evaluated by WGF.

Project Location:
Section 1, Township 25 North, Range 70 West

Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: North Laramie River

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable

ENV-004 WGF-001 Wyoming Game and Fish
Enhanced Fish Passage
Conceptual Design

Watershed Plan Component: **ENV-004**
Project Name: **Wilson No. 2 Ditch Diversion Fish Passage Project**
Project Sponsor/Number: **WGF-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 7,500
1A	Lump sum based on other information	LS			$ 75,000
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 82,500
	Contingencies (15% of subtotal)				$ 12,375
	Engineering and technical assistance (10% of subtotal)				$ 8,250
	Estimated project cost				$ 103,125

ENV-005: North Laramie Land Company Canal Fish Passage Project (WGF-002)

Wyoming Game and Fish (WGF) has identified this structure as a barrier to fish passage on the North Laramie River. Under this project, fish passage capability would be incorporated into the existing structure facilitating irrigation diversions while providing the ability for fish to move upstream and downstream. Specific design details are not currently available but are being evaluated by WGF.

Project Location:
Section 1, Township 25 North, Range 70 West

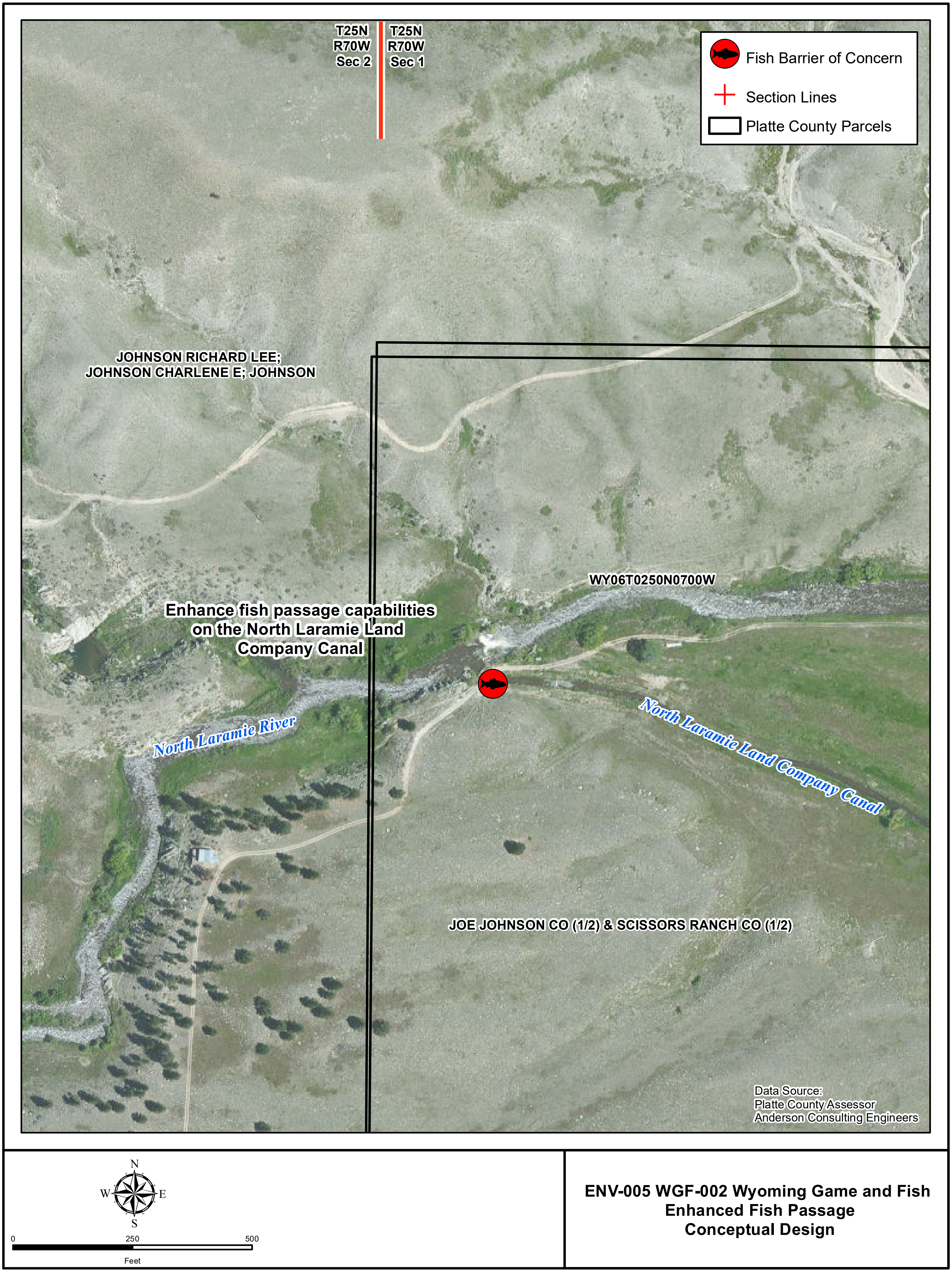
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: North Laramie River

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



ENV-005 WGF-002 Wyoming Game and Fish Enhanced Fish Passage Conceptual Design

Watershed Plan Component: **ENV-005**
Project Name: **North Laramie Land Company Canal Fish Passage Project**
Project Sponsor/Number: **WGF-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 7,500
1A	Lump sum based on other information	LS			$ 75,000
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 82,500
	Contingencies (15% of subtotal)				$ 12,375
	Engineering and technical assistance (10% of subtotal)				$ 8,250
	Estimated project cost				$ 103,125

ENV-006: Burger Ditch Diversion Structure Fish Barrier (WGF-003)

This structure has been identified as a desirable barrier to fish passage. Currently, the structure provides some protection of desirable fish species upstream from species migrating upstream from below. Under this project, the existing structure would be enhanced by providing additional capability to hinder passage of fish upstream and downstream. . Specific design details are not currently available but are being evaluated by WGF.

Project Location:
Section 1, Township 25 North, Range 70 West

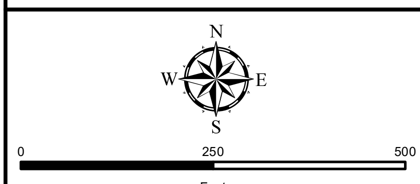
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: North Laramie River

Grazing Allotment: Not Applicable

Sage Grouse Core Area: Not Applicable



ENV-006 WGF-003 Wyoming Game and Fish
Enhanced Fish Passage
Conceptual Design

Watershed Plan Component: **ENV-006**
Project Name: **Burger Ditch Diversion Structure Fish Barrier**
Project Sponsor/Number: **WGF-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,500
1A	Lump sum based on other information	LS			$ 15,000
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 16,500
	Contingencies (15% of subtotal)				$ 2,475
	Engineering and technical assistance (10% of subtotal)				$ 1,650
	Estimated project cost				$ 20,625

ENV-007: Lower Laramie River Stabilization Project 3 (Freeborn-001)

The proposed project would involve stabilization of Lower Laramie River stream banks near Fort Laramie, WY. Currently, the river is cutting actively eroding its right bank resulting in loss of habitat and irrigate pasture.

Construction of the proposed project would stabilize the bank enabling riparian vegetation to reestablish, reduce sediment contribution to the Laramie River and ultimately improve water quality.

Project components would include:

- Construction of approximately 9 rock J-hook barbs on the right bank of the Laramie River.

Project Location:
Section 30, Township 26 North, Range 64 West.

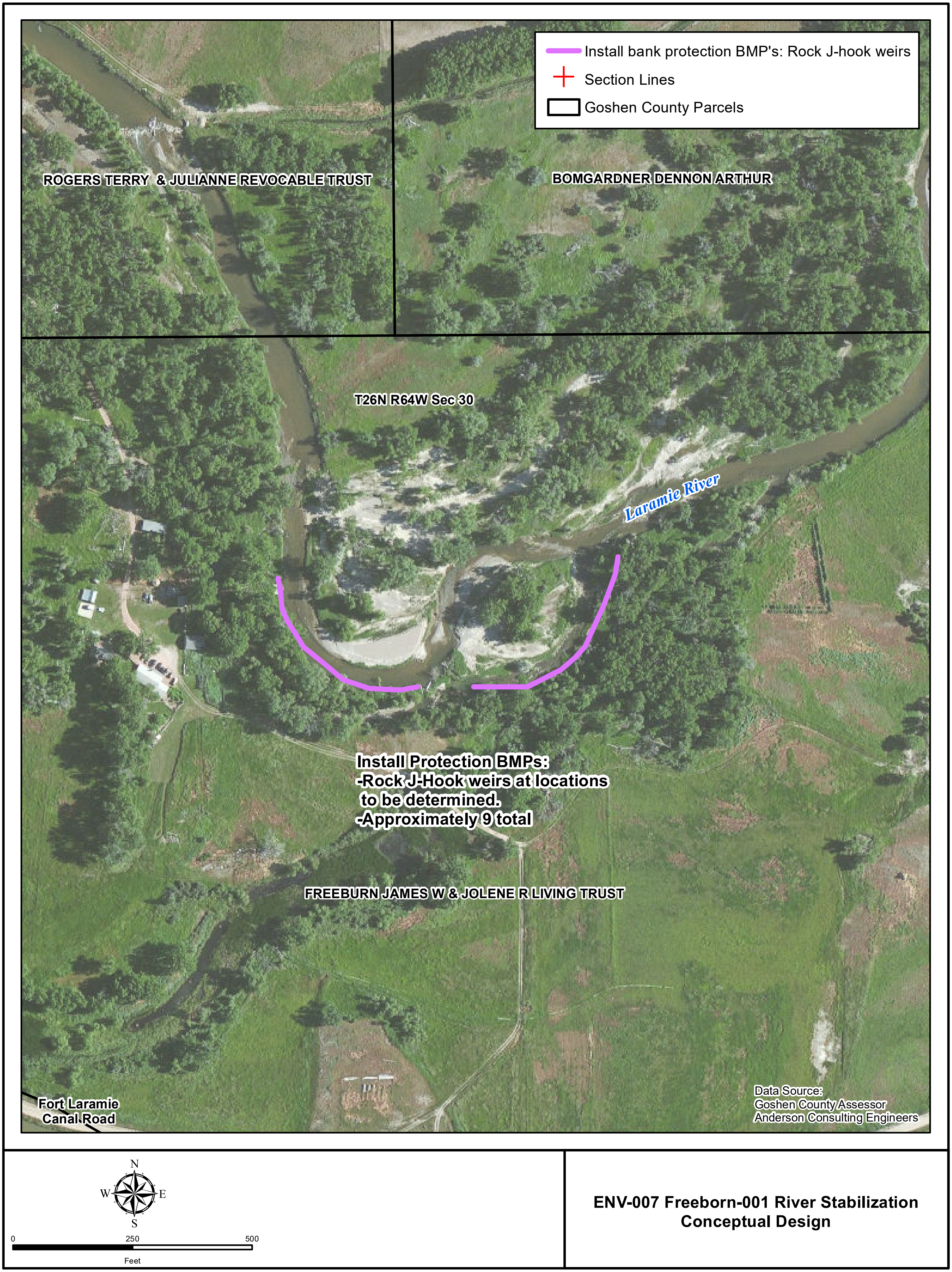
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: Laramie River

Grazing Allotment: Fort Laramie Canal (BLM)

Sage Grouse Core Area: Not Applicable



ENV-007 Freeborn-001 River Stabilization Conceptual Design

Watershed Plan Component: **ENV-007**
Project Name: **Lower Laramie River Stabilization Project 3**
Project Sponsor/Number: **Freeborn-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,700
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250		$ -
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000	3	$ 27,000
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 29,700
	Contingencies (15% of subtotal)				$ 4,455
	Engineering and technical assistance (10% of subtotal)				$ 2,970
	Estimated project cost				$ 37,125

ENV-008: Lower Laramie Stock Reservoir Rehabilitation Project (Freeborn-002)

This project involves the reestablishment of wetlands and open water in oxbows abandoned by the Laramie River. Currently, the oxbows have become filled with sediment and choked with cattails. The project would involve coordination with Wyoming Fish and Game for design criteria for use in reestablishing a mix of open water and submergent vegetation wetlands. Proposed designs would include undulating banks, islands, and varied depths of water.

Project components would include:

- Excavation of sediment in several small sediment-filled wetlands
- Construction of islands to improve habitat
- Construction of water bodies of varied depth to encourage variety of vegetation and habitat value.

Project Location:

Section 30, Township 26 North, Range 64 West.

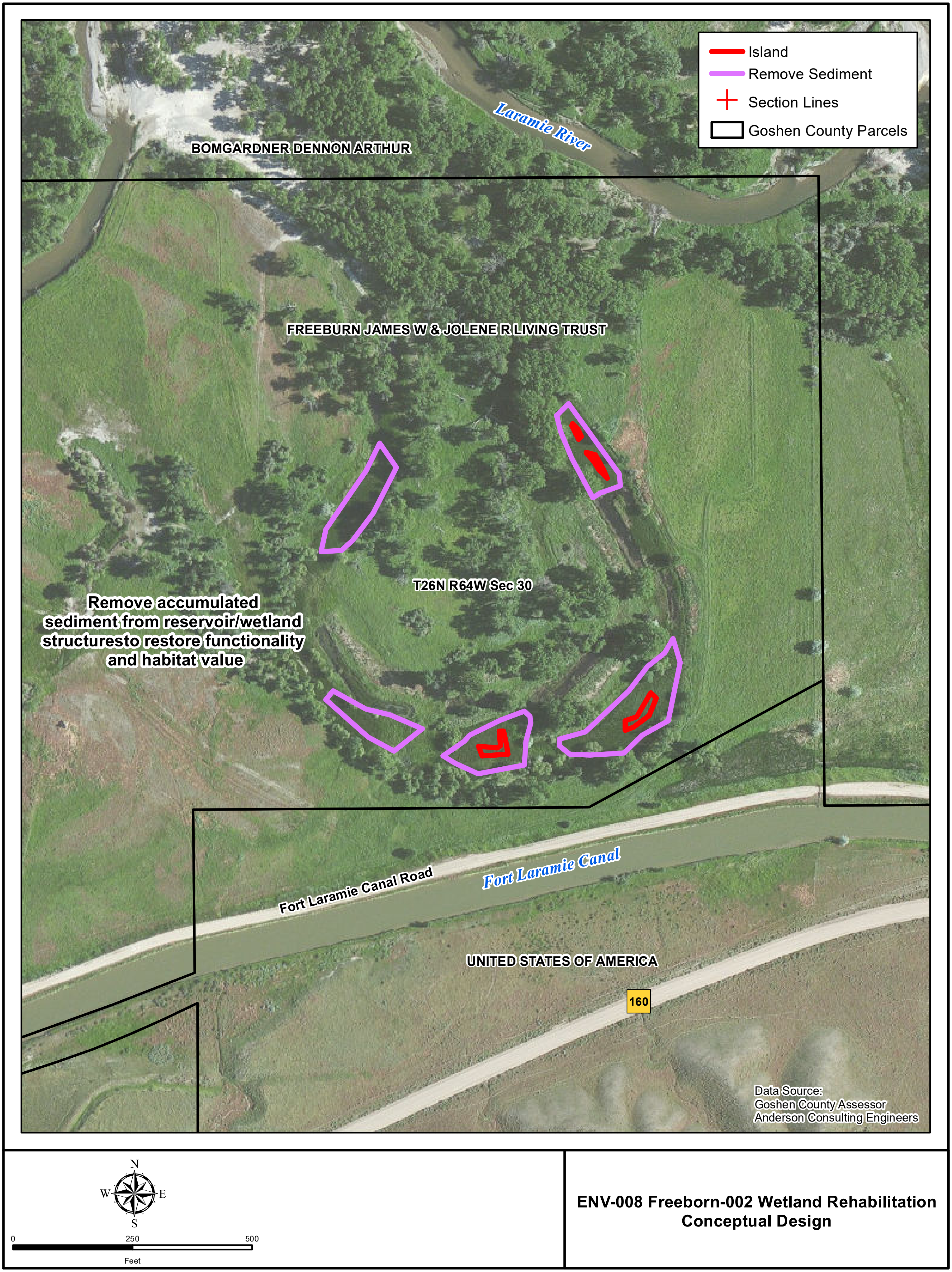
Land Ownership (Surface):

The facility is located on privately-owned lands.

Water Source: abandoned oxbow of the Laramie River

Grazing Allotment: Fort Laramie Canal (BLM)

Sage Grouse Core Area: Not Applicable



ENV-008 Freeborn-002 Wetland Rehabilitation Conceptual Design

Watershed Plan Component: **ENV-008**
Project Name: **Lower Laramie Wetland Rehabilitation Project**
Project Sponsor/Number: **Freeborn-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 6,850
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000		$ -
3b	Solar Pump Sytem -250-400' TDH	LS	$ 12,000		$ -
3c	Solar Pump System >400' TDH	LS	$ 13,000		$ -
4a	1 HP Single Phase Electric Submersible pump set	LS	$ 2,500		$ -
4b	Electrical work for well	LS	$ 3,500		$ -
4c	Powerline extension	MI	$ 20,000		$ -
5a	1100 gal 10' DIA by 2' deep galvanized stock tank	Ea	$ 1,200		$ -
5b	4500 gal 20' DIA by 2' deep bottomless tank	Ea	$ 12,000		$ -
5c	800 gal 8' DIA tire tank	Ea	$ 2,360		$ -
5d	1200 gal 10' DIA tire tank	Ea	$ 3,500		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3		$ -
7	Misc valves and piping at tank(s)	Ea	$ 500		$ -
8a	3 Wire fence with wood posts	LF	$ 5		$ -
8b	12' wire gate	LS	$ 600		$ -
9	Plug and Abandon Existing well	LF	$ 3		$ -
10	Site revegetation and reclamation	Acre	$ 1,250	10	$ 12,500
11	Rock J-Hook vanes (group of 3)	Ea	$ 9,000		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13b	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13c	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13d	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13e	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36		$ -
15	Strip, Stockpile, and Replace Topsoil	CY	$ 5		$ -
16	Reservoir outlet structure	Ea	$ 5,000		$ -
17	Unclassified excavation	CY	$ 4	14000	$ 56,000
18	Excavation and Placement of Embankment Fill	CY	$ 7		$ -
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125		$ -
21	Filter fabric under riprap	SY	$ 4		$ -
22	8" low level outlet pipe	LF	$ 40		$ -
23	8" gate valve and valve box	LS	$ 1,750		$ -
24	Bentonite - lining	CY	$ 35		$ -
25	Material Haul > 1 mile	CY	$ 13		$ -
26	Flexible membrane lining	SY	$ 20		$ -
27	Site revegetation and reclamation	Acre	$ 1,250		$ -
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 75,350
	Contingencies (15% of subtotal)				$ 11,303
	Engineering and technical assistance (10% of subtotal)				$ 7,535
	Estimated project cost				$ 94,188

APPENDIX 6B

BENEFITS OF WATERSHED MANAGEMENT PLANNING

APPENDIX 6B
BENEFITS OF WATERSHED MANAGEMENT PLANNING

Appendix 6B.1 Overview

Appendix 6B.2 Natural Resources Conservation Service Conservation Effects Assessment Program

In 2003, in the interest of government accountability, Congress and the Office of Management and Budget requested information from the U.S. Department of Agriculture (USDA) about the effectiveness of its conservation programs. In response, the Conservation Effects Assessment Project (CEAP) was initiated by NRCS to provide quantitative information about the environmental impacts of its conservation practices on agricultural lands within the contiguous 48 United States. The CEAP is a joint effort of the NRCS, Agricultural Research Service (ARS), National Institute for Food and Agriculture, other federal agencies, and university scientists to quantify the environmental effects of NRCS conservation practices and programs and develop the science base for managing the agricultural landscape for environmental quality. Initially focused on croplands, the CEAP effort has been expanded to include wildlife, wetlands, pastures, and rangelands.

Project findings have been used to guide USDA conservation policy and program development that will assist conservationists, farmers, and ranchers with informed conservation decisions" [Spaeth et al., 2013]. The end product of the CEAP is a literature review and concise collation of information from hundreds of published scientific papers, journals, and additional references. Consequently, the CEAP documents provides a valuable source of information pertaining to various BMPs incorporated in this plan and is referenced throughout the remainder of this section.

Appendix 6B.3 Watershed Function

Identifying improvement opportunities for hydrologic and watershed function, including water quantity, yield and use, is an essential element of the Level I Watershed Study. Hydrologically, there are three fundamental watershed functions: (1) collection of the water from rainfall, snowmelt, and storage that becomes runoff, (2) storage of various amounts and durations, and (3) discharge of water as runoff [Black, 1997]. Watershed characteristics such as geologic structure, soils, landform, topography, vegetation, and climate influence the capture or collection of precipitation, infiltration and storage of surface and ground water, and the runoff or discharge of water.

Appendix 6B.3.1 Water Quantity

Implementation of BMPs and conservation practices can affect water resource quantity through improvement of plant communities, vegetative diversity, and ecological site health achieved from water development and the creation of reliable water sources in areas devoid of such allows for the establishment of grazing systems and changes in grazing distribution.

Hydrological responses to grazing are strongly contingent on the vegetative community composition, with communities that provide greater cover and obstruction to overland flow, such as midgrass-dominated communities having greater hydrological function, including infiltration rate, than shortgrass-dominated communities [Wood and Blackburn 1981b; Thurow 1991; Natural Resources Conservation Service, 2011]. Poor water distribution has been the primary cause of poor livestock distribution [Holecheck, 1997]. Livestock distribution and grazing behavior can be modified by adjusting the location of supplemental feed and water, implementation of patch burns, and herding in addition to the traditional practice of fencing [Williams 1954; Ganskopp 2001; Fuhlendorf and Engle 2004; Bailey 2005]. Natural Resources Conservation Service [2011] reviewed many studies and found that water distribution, steep slopes, and high elevations unequivocally influenced livestock distribution. Also sufficient evidence existed to recommend that NRCS increase the role of herding and supplement placement along with water development and fences for managing livestock distribution [Natural Resources Conservation Service, 2011].

Soil vegetative cover is widely recognized as a critical factor in maintaining soil surface hydrologic condition and reducing soil erosion [Gifford, 1985; Natural Resources Conservation Service, 2011]. Stocking rates, regardless of grazing system, that reduce soil surface vegetative cover below a site-specific threshold increases detachment and mobilization of soil particles due to raindrop impact, decreases soil organic matter and soil aggregate stability, increases soil surface crusting and reduces soil surface porosity, and thus decreasing infiltration and increasing soil erosion and sediment transport [Blackburn, 1984]. Sufficient vegetative cover, critical soil cover, or residual biomass must remain during and following grazing to protect soil surface condition (e.g., porosity, aggregate stability, and organic matter) and hydrologic properties (e.g., infiltration), however, these site-specific vegetation cover requirements vary depending on cover type (e.g., vegetation, litter, or rock), soil type, rainfall intensities, and water quality goals [Gifford 1985]. The erosive energy of water and the long-term reduction of organic matter additions to soil detrimentally affect numerous soil properties, including the increase of bulk density, disruption of biotic crusts, reduced aggregate stability, and organic matter content, which collectively reduce infiltration rate and increase sediment yield and runoff [Natural Resources Conservation Service, 2011].

The rehabilitation efforts described in the following sections can increase water infiltration/percolation, stimulate spring flows and increase flow volume and duration. An example of restoring watershed function and water quantity was in a 74,000 acre watershed in West Texas near San Angelo where West Rocky Creek, a dry, intermittent stream for decades, started flowing again [Moseley, 1983; Wiedenfeld, 1986]. In the early part of the 20th century, West Rocky Creek was a yearlong flowing stream until the late 1910s, when it became an intermittent stream and by 1935, the springs feeding the creek had been dried up by mesquite and other invading woody plants [Moseley, 1983; Wiedenfeld, 1986].

During the 1950s and 1960s, ranchers and landowners on five ranches, covering about half the watershed, began conservation work including root-plowing, reseeding, tree-dozing, aerial spraying, and chaining of mainly mesquite and juniper brush, which limited water availability for native grasses such as sideoats grama, buffalograss, curly mesquite, and tobosa [Moseley, 1983]. About 30,000 acres or 70 percent of the mesquite was removed from the watershed, and the original prairie was restored [Moseley, 1983;

Wiedenfeld, 1986]. In the mid to late 1960s, one of the 5 ranchers noticed that a spring, which was dry since 1935, had started flowing again and by replacing the water-hungry brush with a good grass cover, more rainfall soaked into the aquifer, recharging the dormant springs which began flowing on all 5 ranches by 1970 [Moseley, 1983]. Ongoing grazing management on each ranch enhanced the cover of grasses in the watershed with soils producing an estimated 2,000 to 2,500 pounds of forage per acre which helps retard brush succession; the ranchers periodically must do maintenance brush control to keep the desired vegetation balance [Moseley, 1983].

In southeast Arizona, long-term data on soils, vegetation, hydrology, and climate have been collected for over five decades on the Walnut Gulch Experimental Watershed, which is operated by the USDA's Agricultural Research Service (ARS). The Walnut Gulch Experimental Watershed is one of the most intensively instrumented semiarid experimental watersheds in the world, with a 10 to 100-year record of abiotic and biotic measurements and photographs [Moran et al, 2008]. Researchers studied the interaction between rainfall intensity and soils and vegetation by comparing the frequency of runoff producing summer events between a shrub-dominated watershed and a grass-dominated watershed and found that it takes higher rainfall intensities to produce runoff on the grassed watershed [U.S. Department of Agriculture, 2013]. Results also indicate that the grassland plant community is producing more plant material than the shrubland, with close to the same amount of precipitation input, making the grassland ecosystem more water use efficient [U.S. Department of Agriculture, 2013]. The researchers found that runoff quantities at the watershed scale are controlled more by infiltration of water into alluvial channels and spatial distribution of thunderstorm rainfall [U.S. Department of Agriculture, 2013].

Appendix 6B.4 Ecological Enhancement

An ecological enhancement is any activity that improves an ecosystem such as stabilizing erosive soils, increasing soil quality, planting or maintaining native grasses, shrubs, or trees, removing and controlling invasive species, and improving or maintaining riparian/wetland areas. Ecological sites are complex and varied within the study area as described in Section 4.4.4.3 and Figure 4.4-15. And so are the potential benefits achieved from project activities and implementations that influence the condition of those ecological sites and characteristics.

Conjunctive to soil function is plant community diversity, health and productivity and subsequent forage diversity, production and wildlife habitat. Benefits accrued to water quality are significant as improvements to the chemical, physical, and biological constituents of a water body produce both local site enhancements and those transferred downstream. Wetland enhancement and restoration provides benefits to ecological stabilization as well as contributions to water quality and quantity. Ecologically, watersheds function by providing diverse sites and pathways along which vital chemical reactions occur and furnishing habitat for the flora and fauna that constitute the biological elements of ecosystems [Black, 1997].

Appendix 6B.4.1 Plant and Animal Habitat

Locations of conservation practices and rangeland infrastructure can have a large, indirect impact on overall vegetation change with the spatial design of infrastructure including the locations of fences, watering points, and feeders that are used to modify patterns of animal movement and forage utilization, taking into account livestock behavior and the template of topography and plant communities to which livestock respond [Laca, 2009; Natural Resources Conservation Service, 2011]. The use of rangelands for sustainable livestock production has the potential to ensure the maintenance of wildlife habitat which will ensure that wildlife habitat will persist into the future [Natural Resources Conservation Service, 2011]. Livestock grazing can have negative or positive impacts on game bird habitat, depending on timing and intensity of grazing and the habitat being influenced [Beck and Mitchell, 2000]. Wildlife responses to conservation practices are usually species and even species-habitat specific, meaning not only that each species may respond differently to any specific practice but also that a single species may respond differently to the same practice in different vegetation associations or conditions [Natural Resources Conservation Service, 2011].

Free-stranding water has been considered to be a resource that limits distribution and abundance of many species of wildlife in arid regions of the United States, and water developments have been used since the 1940s to improve wildlife habitat [Simpson et al, 2011]. Simpson et al [2011] compiled and evaluated available literature for evidence of effects of water sources on wildlife populations. Positive effects of water developments on wildlife have been documented, and species thought previously not to use free-standing water developments do so when it is available [Simpson et al, 2011]. Additionally, researchers studied effects of wildlife water developments in southwestern Arizona and found that water developments were used by a diverse array of wildlife, including mule deer, game birds, a number of nongame species [Rosenstock et al, 2004].

Appendix 6B.4.2 Stream Corridors and Riparian/Wetland Areas

Reducing impact to riparian plant communities through the development of upland water resources can result in stream corridor benefits. Riparian plant community diversity and regeneration of desirable important woody species can help restore local water tables, trap sediments, increase wildlife habitat and migration corridors, and stabilize stream banks which can affect localized land loss. In addition, aquatic population benefits can accrue and recreation potential can be realized.

Livestock distribution practices such as water developments, supplement placement, and herding are effective means of managing the intensity and season of livestock grazing in riparian areas [Natural Resources Conservation Service, 2011]. Season of grazing also determines livestock grazing effects on riparian plant communities, particularly woody plants, and can be managed to conserve riparian habitats and their associated services [Natural Resources Conservation Service, 2011]. Sufficient evidence in peer-reviewed studies existed that Natural Resources Conservation Service [2011] suggested riparian grazing management that maintains or enhances key riparian vegetation attributes (i.e., species composition, root mass and root density, cover, and biomass) will enhance stream channel and riparian soil stability, which will in turn support ecosystem services, such as flood and pollutant attenuation and high-quality riparian habitat. Peer-reviewed literature generally supports the effectiveness of water developments, supplement placement and herding for reducing riparian vegetation utilization, or time spent in riparian areas [Natural Resources Conservation Service, 2011].

Appendix 6B.5 Societal Value

Natural resource stewardship not only has economic value in terms of forage, livestock, and wildlife production relationships, but also can have non-economic value placed on those conservation practices by society. Those values can even influence the perception of those implementing conservation practices and can be as much an influence in the decision process to implement conservation as is an economic value. Additionally, it is possible for a BMP or conservation practice that provides an ecological service to accrue more value to society in general than to a local landowner. Ecosystem services are defined as those things or experiences produced by natural systems on which humans place value [Natural Resources Conservation Service, 2011]. Ecosystem services benefit society in numerous and diverse ways while each of the conservation practices can potentially produce different kinds, qualities, and amounts of these goods and services, depending on location, natural potentials, current states, and other factors.

Non-economic values can and should be considered in determining watershed enhancement programs, particularly when considering public investment in conservation. Natural Resources Conservation Service [2011] found little to no research exists showing the direct noneconomic effects of BMPs and conservation practices on individuals, households, or social systems but acknowledged it was likely that producers do realize psychological benefits from conservation because stewardship typically ranks high among the management goals of livestock producers [Huntsinger and Fortmann, 1990; Sayre, 2004]. Moreover, livestock producers who believe strongly in a responsibility to society are more likely to engage in environmentally desirable management practices, such as invasive weed control and riparian protection [Kreuter et al, 2006].

In 2012, in cooperation with the Wyoming Stock Growers Association (WGSA), University of Wyoming, and University of California-Davis, research scientists with the USDA's ARS Rangeland Resources Research Unit in Cheyenne, Wyoming investigating effects of rangeland management decision-making asked WGSA producer members about their goals, ranching operations, and management practices via a mail survey and received a total of 307 rancher responses to the survey [Kacheris et al, 2013; Mealor, 2013]. Livestock production and forage production were the top management goals, with ecosystem characteristics that support these goals (e.g., soil health, water quality) tied for second [Kacheris et al, 2013; Mealor, 2013].

In addition to other social values and ecological enhancements, open spaces have long been held with high value to Wyoming and other western region states. From a ranching industry perspective, tourism interest, outdoor recreationist activity, or a real estate value, open space is significant. Preservation of our custom and culture has been and continues to be a focal point of consideration. Open spaces are critical for upland/riparian conductivity, wildlife migrations and habitat, and recreational opportunity.

Open space is valued for preservation of cultural resources and for the reduction or prevention of land conversion to a condition that can be stewarded to an improved ecological condition.

Appendix 6B.6 Potential Effects and Benefits of Lower Laramie River Watershed Management Plan Components

In the following sections, the potential effects and benefits associated with key BMPs and conservation practices are discussed in relation to the various plan components: Livestock/Wildlife water supply (Components LW), irrigation system rehabilitation (Components I), and storage (Components S). The intent of this discussion is to provide the decision makers with the background necessary to make informed decisions regarding future planning efforts.

The NRCS prepares NEDs of conservation practices or BMPs which act together to achieve desired purposes. The NEDs "are flow charts of direct, indirect and cumulative effects resulting from installation of the practices. Completed network diagrams are an overview of expert consensus on the direct, indirect and cumulative effects of installing proposed practice installation. They show the potential positive and negative outcomes of practice installation, and are useful as a reference point for next steps, and as a communication tool with partners and the public" [Natural Resources Conservation Service, 2014].

Benefits associated with a particular conservation practice or BMP can be classified as direct, indirect or cumulative. Direct and indirect benefits would be considered measureable or tangible benefits. For example, construction of a reservoir designed to augment late season irrigation water supplies provides the direct or measurable benefit, of providing a supply of water commensurate with its storage capacity. An indirect benefit could be the habitat provided to wildlife. Likewise, the same reservoir could provide the cumulative benefit of increased income to producers and improved health of the local economy.
As previously discussed, such benefits can be either quantitative or qualitative or both. Benefits can be local or global and specific or surrogate, depending on multiple factors unique and specific to the BMP, ecological site, watershed, or major land resource area. Project benefits can be related to ecological enhancement, water quantity, economic stability, stream corridor or riverine stability, or maintenance of open spaces. Where appropriate, the NRCS NED for the conservation practice is presented within this document.

Appendix 6B.6.1 Irrigation Rehabilitation Projects

The Watershed Management Plan includes five recommendations. These projects include various forms of irrigation improvements and rehabilitation projects.

Irrigation Water Conveyance—Pipeline
The rehabilitation and replacement of existing irrigation system delivery conveyance structures help to efficiently deliver or convey water from a source of supply or diversion structures to areas of application or storage to facilitate management of irrigation water. The practice reduces erosion, conserves water,

and protects water quality. Underground pipelines serve as an integral part of the irrigation water distribution system and significantly improve the overall efficiency of the system.

Strategies defining placement of irrigation water conveyance pipelines typically involve:

- Rehabilitation/replacement of existing structures
- Mitigation of seepage losses
- Enhanced delivery of irrigation water
- Reduction in annual operation and maintenance costs
- Improvement in ditch management and efficiency through water management
- Facilitation of irrigation water management plans
- Economic practicality
- Physical feasibility.

Effects and benefits of rehabilitating and improving water conveyance for irrigation systems are numerous and are displayed in the NRCS's NED. Direct and indirect benefits associated with this BMP include:

- Water availability for irrigation
    - Plant growth and productivity
- Infiltration and evaporation losses
    - Increased plant growth and productivity
    - Decreased leaching of nutrients
- Erosion associated with practice
    - Decreased sediment delivery to surface waters

Cumulative effects/benefits of provision of reliable water supplies are described as:

- Positive impacts to income and stability of individual producers and the community
- Improved aquatic health of humans, domestic animals and wildlife
- Improved stream fauna and environmental quality.

Appendix 6B.6.2 Livestock/Wildlife Water Supply Projects

The Watershed Management Plan includes 17 livestock/wildlife water supply projects. These projects include various forms of water facilities, water wells, spring developments, pipelines, and stock ponds.

Water Facilities

The development of reliable watering facilities in areas otherwise lacking reliable sources of water for livestock and wildlife, help to promote improved rangeland conditions in several ways. Water facilities may be associated with wells, springs, streams, ponds or hauled water. ***Reliable sources of water are integral aspects of any range management plan involving distribution of livestock.***

Strategies defining placement of water facilities typically involve:

- Facilitation of prescribed grazing management plans
- Alternative water supplies to riparian sources
- Provision of a reliable source where no other sources may exist
- Optimization of upland range resources.

Benefits of providing reliable water facilities for livestock and wildlife are numerous and are displayed in the NRCS's NED in Figure 6B.6-4. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Controlled access to streams, ponds, water supplies, and sensitive areas (when combined with proper fencing),
    - Decreased loading of pathogens, sediments, and nutrients to existing surface waters,
    - Improved water quality, quantity and distribution of livestock and wildlife
    - Increased plant productivity
    - Improved wildlife habitat
    - Increased species diversity
    - Increased livestock food sources

Cumulative benefits of provision of reliable water supplies are described as:

- Positive impacts to income and stability of individual producers and the community,
- Improved aquatic health of humans, domestic animals and wildlife, and
- Improved health of humans, domestic animals and wildlife

Appendix 6B.6.3 Grazing Management Alternatives

These alternatives include conservation practices and BMPs such as water developments, fencing, salting and herding, ecological sites and state and transition models, prescribed fire, and application of chemicals along with other tools that can be used to facilitate and enhance grazing distribution and optimize range conditions through prescribed grazing practices.

Prescribed Grazing

Prescribed grazing is the controlled harvest of vegetation with grazing animals managed with the intent to achieve a specific objective. Prescribed grazing may be applied on lands where grazing and/or browsing animals are managed. A grazing schedule is prepared for allotments, pastures to be grazed. Removal of vegetation by the grazing animals is in conformity with realistic yield goals, plant growth needs, and management goals. Duration and intensity of grazing is based on desired plant health and expected productivity of the forage species to meet management objectives.

Strategies for applying prescribed grazing involve managing the intensity, frequency, duration, distribution, and season of grazing by:

- Defining landowner and/or manager goals and objectives
- Identifying needs for reliable water sources and supplies
- Feed and forage inventories and analyses
- Range condition and health evaluations and assessments
- Managing desirable and undesirable plant communities to meet grazing objectives

Benefits of implementing prescribed grazing and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 6B.6-3. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Increased control of livestock grazing, feeding, watering locations
- Decreased loading of pathogens, sediments, and nutrients to surface waters,
- Increased manure distribution
- Increased soil quality
- Reduced contaminants, pathogens, sediments to receiving waters
- Soil erosion and compaction
- Increased plant productivity and maintenance
- Increased livestock production and health
- Increased wildlife health and populations

Cumulative benefits of implementing prescribing grazing could include:

- Positive impacts to income and stability of individual producers and the community
- Improved water quality and aquatic habitat
- Improved health of humans, domestic animals and wildlife

Appendix 6B.6.4 Stream Channel Restoration Projects

These alternatives include conservation practices and BMPs such as installation of stream channel degradation/incision and streambank erosion mitigation measures based upon site-specific evaluation of conditions along with routine monitoring of completed stream projects to identify necessary maintenance repairs and determine their effectiveness. Appropriate measures could be 'hard' engineering, 'soft' approaches, or combinations of both.

Streambank and Shoreline Protection

Streambank and shoreline protection is the stabilization and protection of streambanks, constructed channels, and shorelines of lakes and reservoirs. Strategies for applying streambank and shoreline protection involve:

- Streambanks of natural or constructed channels and shorelines of lakes and reservoirs where they are susceptible to erosion.
- Various materials may be used for protection of streambanks and shorelines,
- A site-specific assessment should be conducted to determine if the causes are local or systemic and used to select appropriate treatment to achieve the desired objective,
- Functional and stable treatments for design flows and sustainable for higher flows.
- Preventing the loss of adjacent land or damage to land uses or other facilities
- Protecting historical, archeological, and traditional cultural properties
- Reducing the offsite or downstream effects of sediment resulting from bank erosion
- Improving the stream corridor for fish and wildlife habitat, aesthetics, and recreation

Benefits of implementing streambank and shoreline protection and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 4B.6-2. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Decreased streambank and/or shoreline erosion
    - Increased soil quality
    - Decreased sedimentation
- Increased flow capacity of streams and channels
- Increased streambank vegetation and root matrices
    - Increased soil quality
    - Increased native plant recruitment
    - Decreased invasive/noxious species

Cumulative benefits of implementing streambank and shoreline protection could include:

- Positive impacts to income and stability of individual producers and the community,
- Improved water quality and aquatic and/or terrestrial habitat,
- Improved recreational opportunities

Appendix 6B.6.5 Water Storage Facilities / Irrigation Reservoir

Benefits of storage facilities and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 6B.6-1. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Storage of water for late season irrigation supply
- Storage of water for municipal and industrial use
- Supply of flow augmentation
- Flood control and attenuation of peak flows downstream
- Wetland enhancement and development
- Sediment management
- Aquatic habitat
- Recreation opportunities

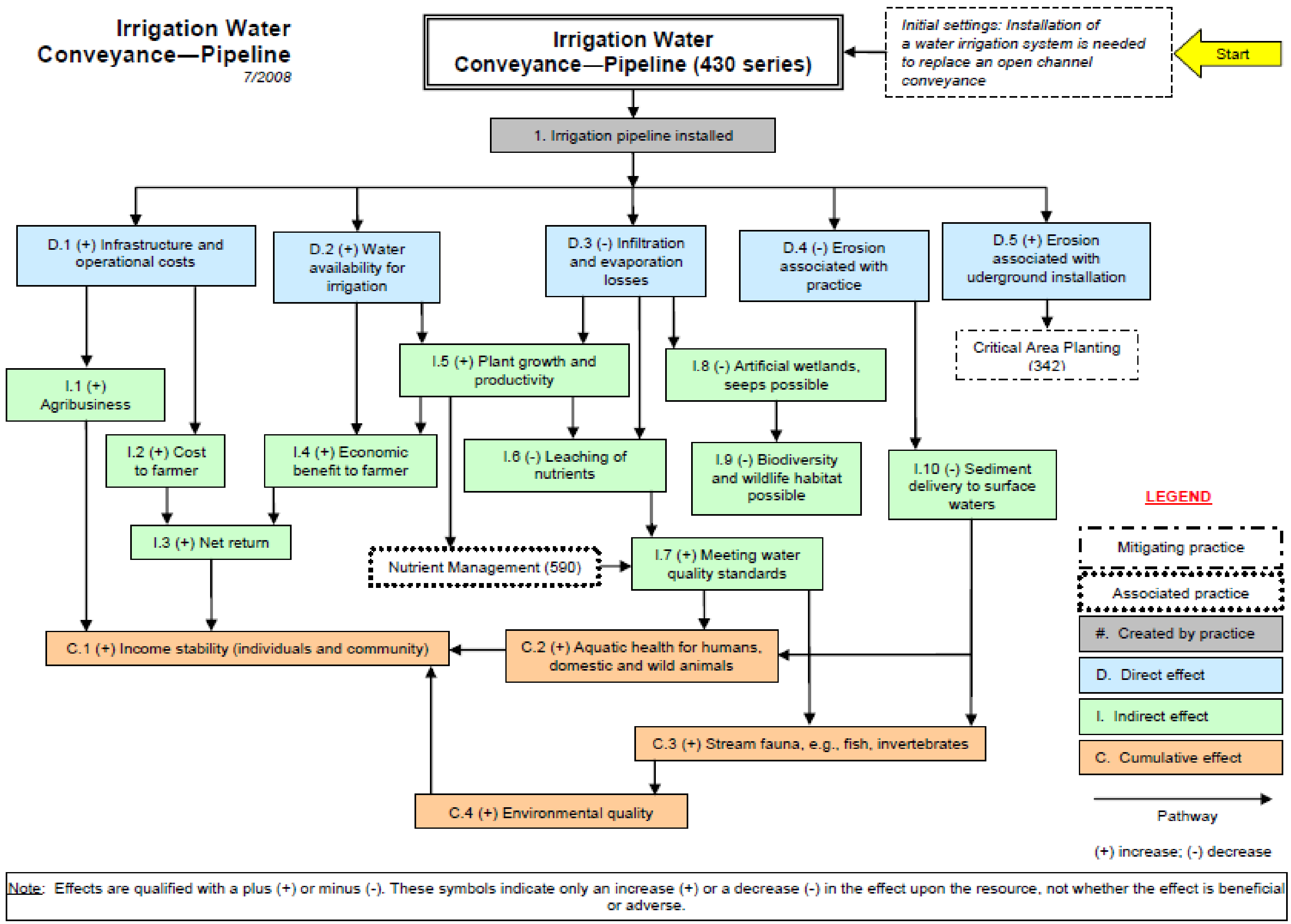
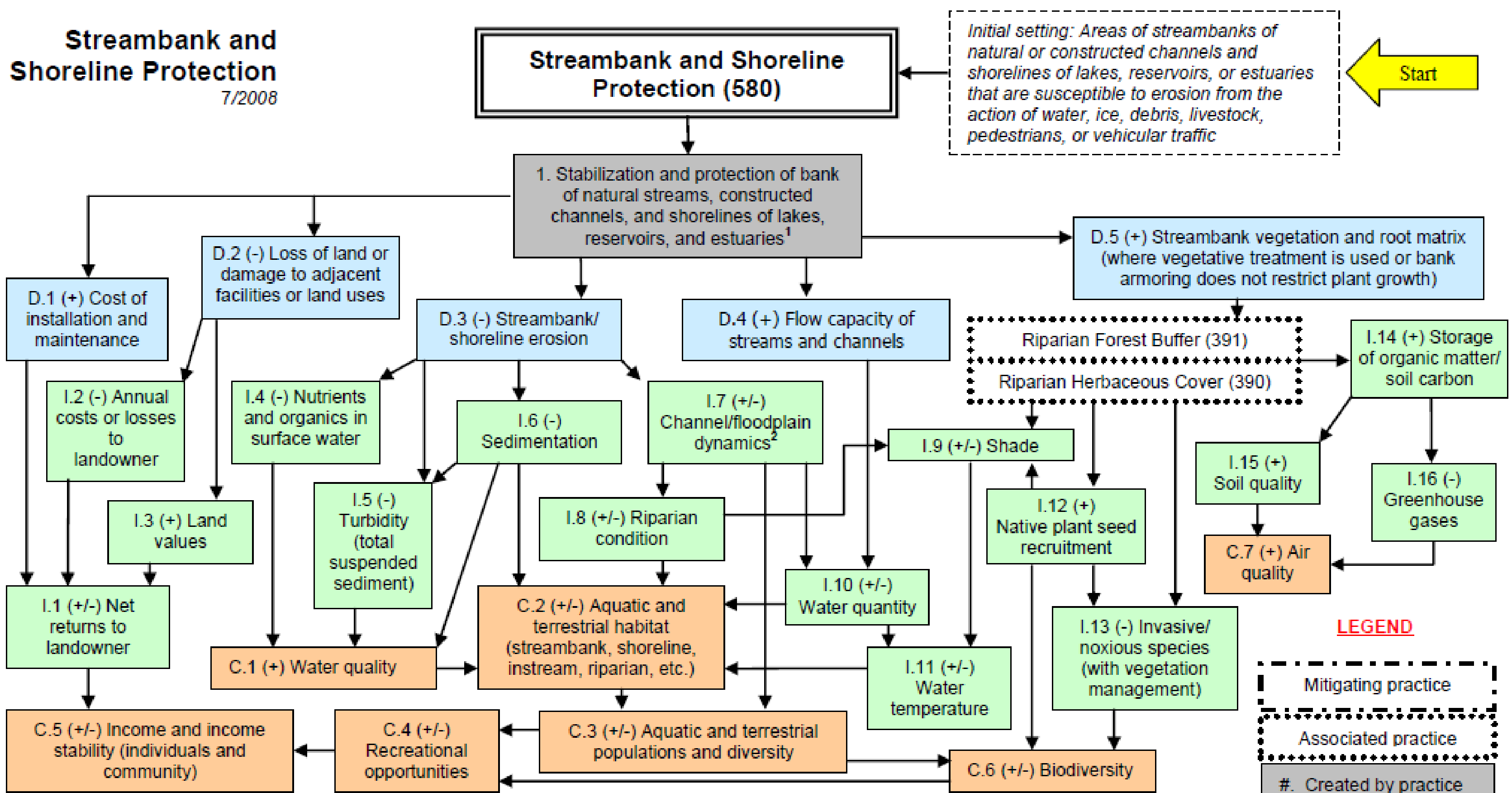


Figure 6B.6-1 Network Effects Diagram for Irrigation Conveyance



Notes: Effects are qualified with a plus (+) or minus (-). These symbols indicate only an increase (+) or a decrease (-) in the effect upon the resource, not whether the effect is beneficial or adverse.

Projects involving long lengths of bank or shoreline, structural controls, substantial earth moving and/or fill, or sensitive waters may need to be evaluated in a site-specific EA or EIS.

[1] Additional information about potential protection measures and their impacts is available in the EIS for the Emergency Watershed Protection (EWP) Program.

[2] Conventional bank armoring (e.g., rip rap, gabions) may result in decreased (-) channel/flood plain dynamics, and associated impacts, while other less intrusive methods (e.g., stream barbs, stone toes with sloped, vegetated banks) may result in increased (+) channel/flood plain dynamics.

Figure 6B.6-2 Network Effects Diagram for Streambank and Shoreline Protection.

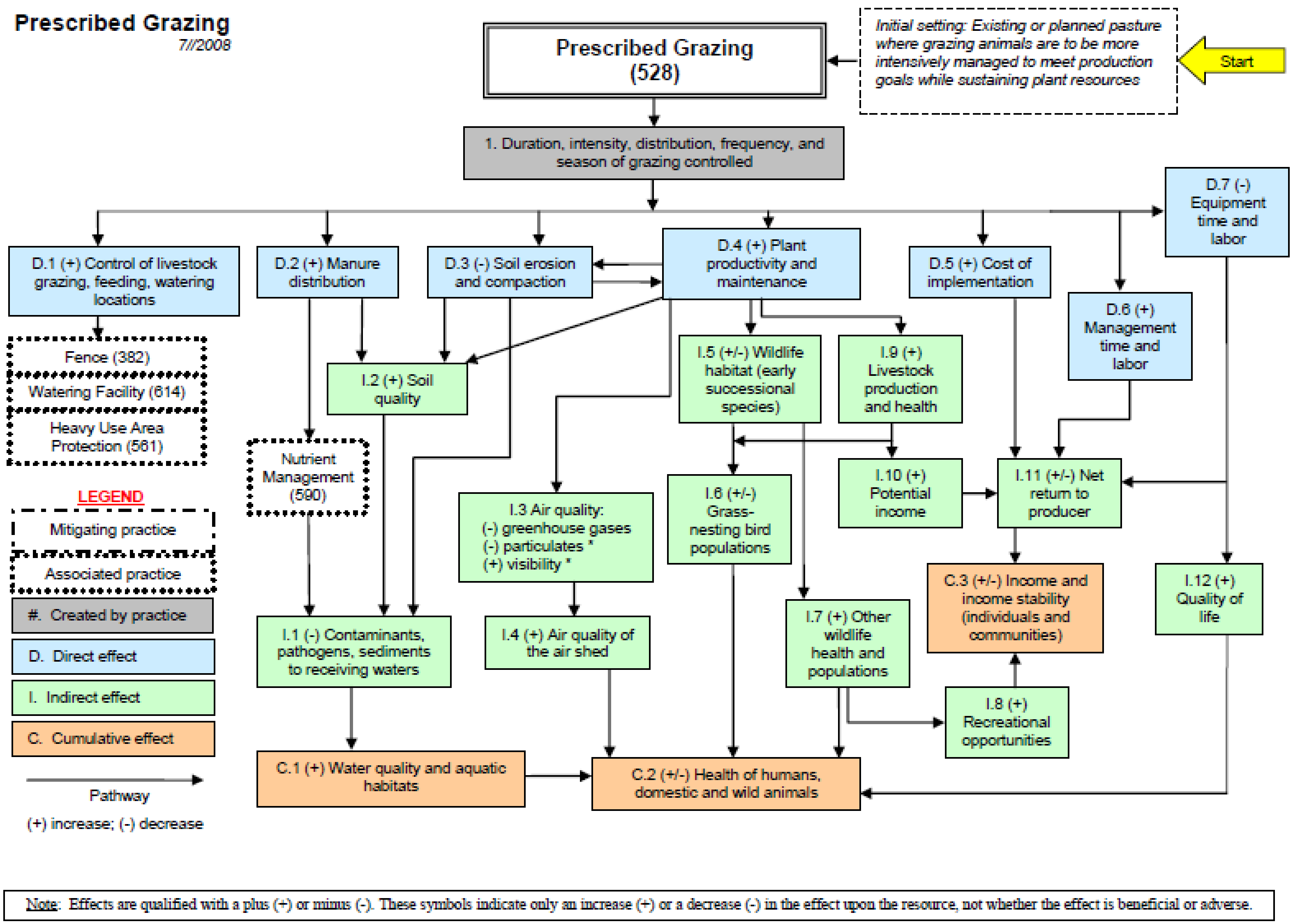
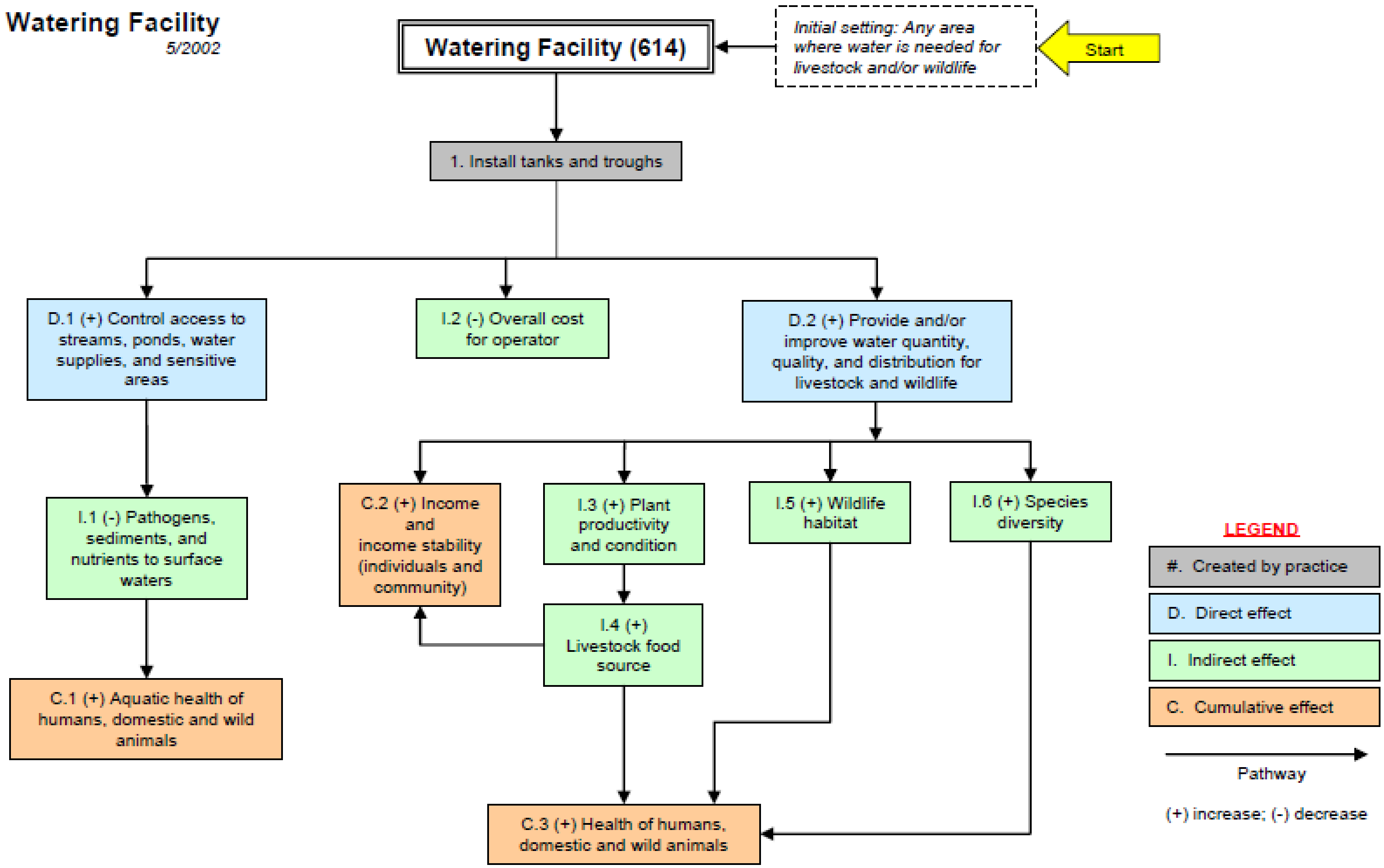


Figure 6B.6-3 Network Effects Diagram for Prescribed Grazing.



Note: Effects are qualified with a plus (+) or minus (-). These symbols indicate only an increase (+) or a decrease (-) in the effect upon the resource, not whether the effect is beneficial or adverse.

Figure 6B.6-4 Network Effects Diagram for Watering Facility.

APPENDIX 6C

WATER RIGHTS ADMINISTRATION IN THE LOWER LARAMIE WATERSHED

APPENDIX 6C: WATER RIGHTS ADMINISTRATION IN THE LOWER LARAMIE WATERSHED

6C.1 Modified North Platte Decree and the Platte River Recovery and Implementation Program

Article 8 of the Wyoming Constitution (1889) states that "the water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state, are hereby declared to be the property of the state" and goes on to establish the State Engineer's Office and the Board of Control.

Under those provisions, Wyoming developed one of the first comprehensive water administration systems in the western United States. That system is founded on the principles that: 1) all beneficial uses of water in the state - groundwater as well as surface water - small uses and large - are required to obtain a permit from the state; and 2) priority to use water is determined by seniority, i.e. "first in time, first in right". The basic parameters of a Wyoming water right are the place and type of use, the date on which the right was acquired, and the rate at which water may be diverted. (Individual water rights may include volumetric and seasonal limitations, expiration dates, reporting requirements, correlation with other water rights, and other special provisions.)

As with many Wyoming watersheds, the Lower Laramie is subject to a variety of additional water administration issues unique to its water supply characteristics and location with respect to neighboring states. The following paragraphs provide an overview of those issues, with a focus on the types of small water projects to which the WWDC watershed studies provide technical support.

Because the Laramie River begins in Colorado and flows into Wyoming, its waters are shared, as apportioned between the two states by the 1922 U.S. Supreme Court Laramie River Decree. However, it was subsequently determined (Nebraska v. Wyoming - 2001) that the Laramie River Decree only reaches downstream as far as the diversions and lands of the Wheatland Irrigation District, leaving the remaining waters of the Laramie River subject to the terms of the 2001 Modified North Platte Decree (see below).

The drought period of the 1930s precipitated the filing of a lawsuit by Nebraska over the waters of the North Platte. That lawsuit culminated with the US Supreme Court North Platte Decree in 1945, which established irrigated acreage limitations on portions of the drainage (not including the Laramie River watershed) and a sharing of the natural flows of the North Platte below Guernsey Dam, between the states of Wyoming and Nebraska. Although the Laramie River is tributary to the North Platte River in that reach, no limitations were placed on use of the Laramie River itself. What flow entered the North Platte was subject to the North Platte Decree, but the volume and timing of that flow was not explicitly addressed.

The 1945 North Platte Decree was amended in 1953 to accommodate the construction of Glendo Reservoir, but no provisions regarding the Laramie River were added.

Plans for the construction of the Laramie River Power Station on the Laramie River downstream of Wheatland generated a complex lawsuit among Nebraska, Basin Electric, and several environmental-advocacy groups that culminated in the 1978 Grayrocks Agreement of Settlement and Compromise. That agreement detailed the water rights and water administration to be applied to the power plant supplies and included requirements for minimum flows in the Laramie River below Grayrocks Reservoir. The latter became an issue in the subsequent Nebraska v. Wyoming litigation on the North Platte (1987 - 2001), the resolution of which provided "protection" of irrigation-season releases from Grayrocks Reservoir so they could not be diverted prior to their downstream contribution to the North Platte River. Thus, these flows were effectively removed from appropriation under routine Wyoming water law.

In 1982, partially as a result of concerns with the development of industrial groundwater supplies associated with the Laramie River Station, a Groundwater Control Area was established in central Platte County. (See Figure 6C-1 for location.) Since that time, all groundwater permits for withdrawals > 25 gpm have been required to receive public notice and review by a local board before decision by the Wyoming State Engineer.

The North Platte Decree was relitigated from 1987 to 2001, resulting in the 2001 U.S. Supreme Court Modified North Platte Decree. Recognizing that the earlier Laramie River Decree did not address the disposition of waters "below" Wheatland Irrigation District, the Modified North Platte Decree imposed on Wyoming a limit of 39,000 acres of irrigation in the Lower Laramie watershed[1], excluding lands irrigated within the Wheatland Irrigation District. This acreage limitation applies to lands irrigated either by surface water, i.e. diversions from streams, or by groundwater that is sufficiently connected with surface water sources that the surface water sources are depleted beyond specified thresholds.

Over the period since conclusion of the Modified North Platte Decree, irrigated acreage has remained well below the specified limit. However, applications to irrigate any additional acreage in the Lower Laramie watershed outside the Wheatland Irrigation District would be reviewed carefully (skeptically) with respect to the Decree limitations.

Included in the settlement of the Nebraska v. Wyoming lawsuit was establishment of the North Platte Decree Committee (NPCD; Wyoming, Nebraska, Colorado, and the US Bureau of Reclamation) along with a "charter" that includes a lengthy series of procedures and requirements in support of the Modified North Platte Decree. Among those is the requirement that Wyoming report all post-2000 groundwater permitting activity within the boundaries of the Wheatland Irrigation District, along with the annual production of any such wells.

Under the provisions of the Modified North Platte Decree and the NPDC Charter, all irrigation groundwater withdrawals in the small portion of the Lower Laramie watershed from 300 feet south of the Fort Laramie Canal to the mouth of the Laramie River require replacement of specified depletions of surface-water flows. And that replacement requirement is greater for wells developed after the year 2000 than for wells in place at the time the lawsuit was settled.

In parallel with the Nebraska v. Wyoming lawsuit, talks among Wyoming, Nebraska, Colorado, and the U.S. Fish & Wildlife Service got underway with respect to ensuring adequate flows in the North Platte and Platte Rivers to protect certain threatened and endangered species in the central Platte basin in Nebraska. These talks resulted in the 1997 "Cooperative Agreement" which established the framework for the subsequent development of the Platte River Recovery Implementation Program (PRRIP) and the associated 2006 Wyoming Depletions Plan. Unlike the earlier Laramie River and North Platte Decrees, which concern irrigation activity, the PRRIP addresses <u>all</u> sources of stream depletion - irrigation, municipal use, industrial

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[1]The precise boundary of the Laramie River basin near the mouth of the Laramie River varies among the various provisions of the Modified North Platte Decree and related documents. For certain provisions, the basin effectively ends at the Fort Laramie Canal; for others, 300 feet above the canal; and for others, at the physical mouth of the river. These differences encompass about 3 mi.^{2} around the Ft. Laramie Historical Site. Any water-related activity in this area should be carefully coordinated with the Wyoming State Engineer's Office.

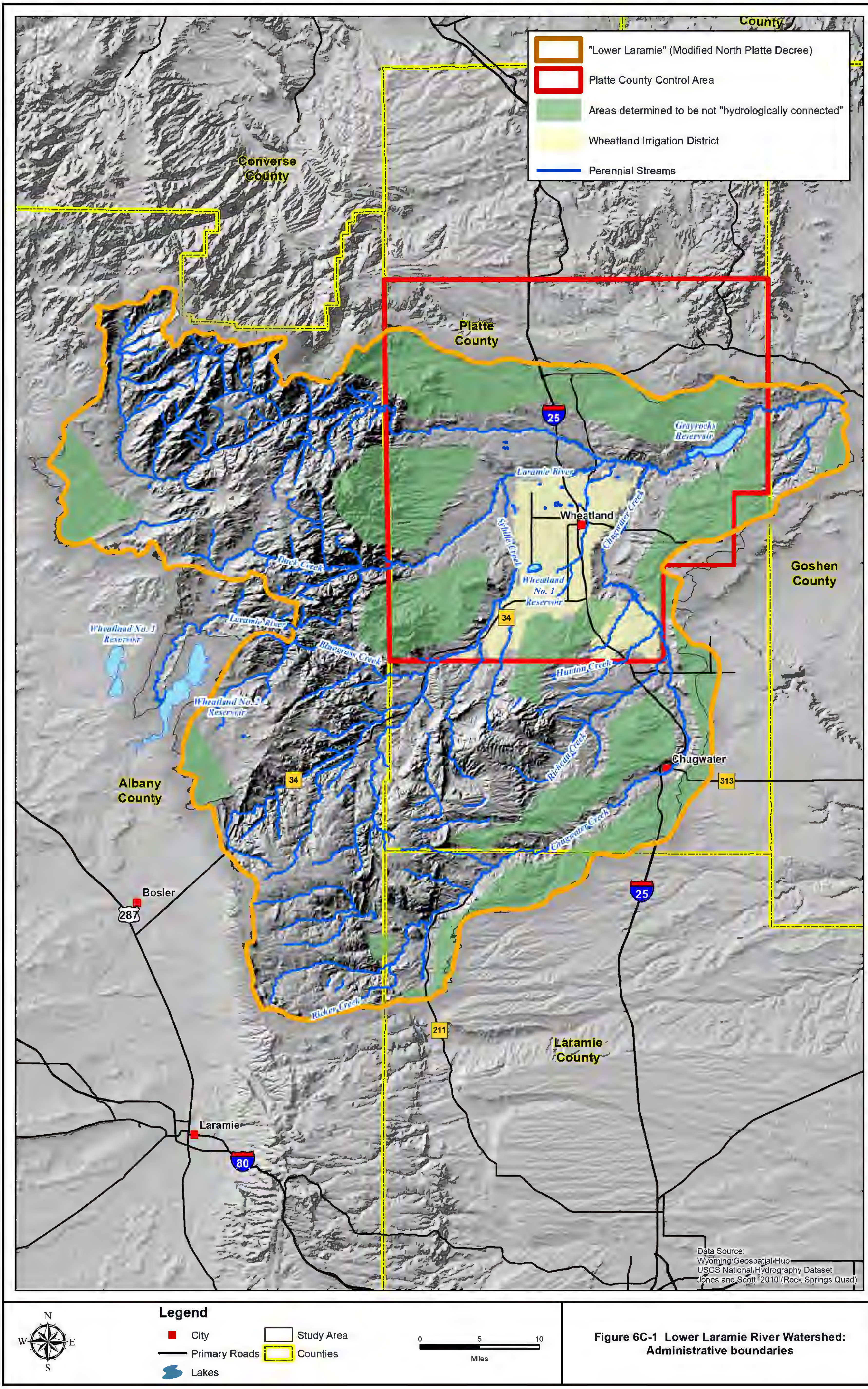

Figure 6C-1 Lower Laramie River Watershed: Administrative boundaries

use, etc. The basic concept is that Wyoming, including the Lower Laramie watershed, agreed to maintain overall depletions[2] of the flow of the North Platte River and its tributaries at levels no higher than were occurring in 1997. Furthermore, depletion limits are accounted separately for the irrigation (May - September) and non-irrigation (October - April) seasons. Within either season, reduced depletions under one type of use may be used to offset increased depletions under a different type of use.

Finally, depletions in the Wyoming areas subject to the PRRIP are accounted in terms of their impact on North Platte River flows at the Wyoming-Nebraska state line through application of a series of "tracking factors". Irrigation-season depletions within the Lower Laramie watershed are assumed to produce a depletion of 50% at the state line. Non-irrigation season depletions are assumed to produce a depletion of 100% at the state line. Requirements for compensating reductions in depletions (in the Lower Laramie watershed or elsewhere in the North Platte River basin in Wyoming) are calculated accordingly.

Also, the PRRIP adopted the same approach to groundwater depletions as the Modified North Platte Decree, i.e. wells in areas determined to not be "hydrologically connected" are exempt from depletions accounting. (See Figure 6C-1 for the current mapping of such areas.)

To establish benchmarks against which to measure post-1997 changes in depletions, Wyoming developed "baseline" values under each water-use type for each of two seasons, irrigation and non-irrigation. To provide continuing monitoring under the PRRIP, the Wyoming State Engineer's Office develops an annual assessment of depletions in the Lower Laramie watershed (along with the rest of the North Platte River basin). That assessment includes direct inventories and reporting of irrigated acreage and of depletions under municipal and industrial water rights.

Rural domestic use is estimated based on population data and the assumption of a constant depletion rate of 0.10 acre-ft per year per person. Under current policy, the impact of domestic wells is considered "de minimus" regarding administration of the PRRIP and there are no special permitting or reporting requirements imposed on the water user.

Livestock use under "stock" water rights, which are limited to a maximum of 25 gpm under routine Wyoming water-rights administration, is considered to be non-depletive. The PRRIP places no restrictions or special permitting or reporting requirements on livestock facilities under 25 gpm. However, stock-related water uses such as stock-water reservoirs, large stock operations like feedlots, stock wells exceeding the 25 gpm threshold, etc. are permitted under other use categories (e.g. "miscellaneous", "reservoir", "industrial") and may require explicit depletions accounting (see below).

The use category of "miscellaneous" under the PRRIP and the Wyoming Depletion Plan is intended to cover all other sources of depletion. These include, for example, domestic and stock uses under permits for > 25 gpm, recreational and commercial uses that are not "municipal" or "industrial", like golf courses, fish propagation facilities, etc. Rather than an annual inventory of all uses under this category, the potential <u>change</u> in depletions is monitored through review of the issuance of new (post-1997) water rights.

All "new" (i.e. post 1997) water rights in the Lower Laramie watershed are currently addressed with respect to their potential for generating significant depletions. "Significant" is not specifically defined, but is a

[2]"Depletion" means the net impact on streamflow, i.e. diversions minus return flows. For many uses, the net depletion may be substantially less than the total diversion (or groundwater withdrawal).

dynamic function of the potential magnitude of the projected depletion, the nature of the use, the relationship between the proposed use and existing water rights, the status of depletions under all other use categories, the seasonality of the anticipated depletions, etc. For example, new water rights involving less than or equal to 5 ac-ft per year of net depletion in the non-irrigation season are likely to be evaluated differently than new water rights involving greater than 20 ac-ft per year of net depletions in the irrigation season.

While the PRRIP establishes a commitment to no increase in the net depletion of the flows of the North Platte River at the Wyoming-Nebraska state line, it leaves the accomplishment of that goal to the State of Wyoming permitting and administration policy. Within the framework of “net depletion”, those policies may exercise considerable latitude, subject to evolution/modification as Wyoming adapts to changes in the depletions profile of the different use types (e.g. irrigation, industrial, municipal), reconciles differences between water rights and historical depletions, and balances a variety of economic and political priorities. Thus, these policies are subject to change as watershed and basin-wide conditions may dictate in the future. Potential water users are cautioned to consult with the Wyoming State Engineer’s Office - North Platte Coordinator if contemplating any new water-use activity potentially increasing depletions in the Lower Laramie watershed.

6C.2 Groundwater Rights and Administration

Figure 6C-1 presents the administrative boundaries relevant to the following discussion.

Due to the prevalence of irrigation wells in the Wheatland area and growing concerns with potential depletion of the aquifer by industrial wells in the late 1970s, the “Platte County Control Area” was created in 1982. In a control area, the process for obtaining or changing a water right is the same as everywhere else, except that all applications for new groundwater rights, and petitions for any changes to existing groundwater rights, for more than 25 gpm must be published for public comment and must be reviewed by the local Control Area Board. In the case of the Platte County Control Area, this has rarely led to an unfavorable recommendation by the Board (the Board is advisory to the State Engineer’s Office, which makes the final decisions), but does require additional expense and time to obtain a permit. The 2017 SEO Annual Report is typical, “The PCCA Advisory Board met on May 10, 2018. The Board provided favorable recommendations for one petition and five applications. Because most (60%) of the irrigation district in the Platte County Control Area fall under the Wheatland Irrigation District canal system, groundwater permitting activity commonly rises and falls in response to the availability of district water. For example, ‘The Platte County Control Area was relatively quiet ... Wheatland Irrigation District had an adequate supply of surface water” (1992 SEO Annual Report, as quoted in Hinckley, 2009).

Irrigation wells in the Lower Laramie watershed receive special treatment under the terms of the Modified North Platte Decree. This is a US Supreme Court Decree that divides the waters of the North Platte River Basin among Wyoming, Nebraska, and Colorado. Note that the boundary of the “Lower Laramie” as administered under the Decree is slightly different than the boundary adopted for the present report. The most conspicuous difference is where the Laramie River exits the Laramie Basin to make its way through the Laramie Mountains, i.e. the difference is in the division point between the “Upper” and “Lower” watersheds.

Another small difference occurs at the mouth of the Laramie River, where groundwater-irrigated acreage from 300 feet above the Fort Laramie Canal to the mouth of the river is administered as part of the "below-Whalen" (diversion dam) reach of the North Platte River, and special limitations, mitigation requirements, and reporting apply.

Under the terms of the Decree, any irrigation wells constructed within the area of the Wheatland Irrigation District after the year 2000 must be reported to the North Platte Decree Committee along with each year's pumping volume. Irrigation wells in the Lower Laramie Basin outside the area of the Wheatland Irrigation District are subject to the irrigated acreage limitations of the Decree, to the extent they have not been determined to be "not hydrologically connected" to surface water sources under the specific criteria of the Decree. Total acreage irrigated from surface sources or from such wells is limited to a total of 39,000 acres each year, as monitored on an annual basis by "acreage inspectors" employed by the Wyoming State Engineer's Office.

The Decree criteria for "not hydrologically connected" is that a well is so located that if pumped continuously for 40 years, the resulting stream depletion at the end of the 40-year period is less than 28% of rate of pumping. An initial evaluation of "not hydrologically connected" areas of the Lower Laramie watershed were developed in association with the 2000 settlement of the Nebraska v. Wyoming lawsuit that produced the Modified North Platte Decree. That evaluation is shown on Figure 6C-1. The areas deemed to not be "hydrologically connected" under the above criteria are shaded in green (and have come to be known as "green areas", i.e. a "green light" with respect to groundwater development). Present and future groundwater development in these areas is exempt from the provisions of the Decree.

Subsequent to settlement of the Decree, Wyoming, Nebraska, Colorado, and the US completed agreement on the Platte River Recovery Implementation Program (PRRIP). That agreement adopted the same "hydrological connection" criteria as the Decree, and qualifying wells are also exempt from the provisions of the PRRIP (which includes all sources of water depletion, not just the irrigation use addressed by the Decree).

As is obvious from Figure 6C-1, this mapping of "hydrologic connection" is basically a stand-back from the Laramie River and its perennial tributaries - a greater distance where the bedrock is more permeable and a lesser distance where the bedrock is less permeable. The "exempt" classification is placed in areas on the drainage divides between major streams. (An exception is the area between Chugwater Creek and Sybille Creek, which is largely occupied by the Wheatland Irrigation District, to which special provisions apply, as discussed above.)

In the hard-rock areas of the Laramie Range, the default "connected" status is not because of the permeability of the aquifer (which is generally quite low), but because of 1) the density of perennial streams, which is itself a function of low permeability combined with higher precipitation; and 2) a lack of consistent aquifer characteristics with which to make connection determinations at the scale of the Figure 6C-1 study. Comparison of the various figures of the present report will find some with a more expansive presentation of "perennial streams" than that of Figure 6C-1. This is because a stream which may be perennial in some, typically upland, reaches, but which does not flow on through to the mainstem is not considered capable of delivering a local depletion into the regulated North Platte River system.

Finally, surface water use in Wyoming is administered under the priority system, i.e. "First in time is first in right". This principle also applies to groundwater rights, i.e. a groundwater (or surface water) right with a senior priority is entitled to file an "interference" complaint against a relatively junior groundwater right, the exercise of which deprives the senior of the water to which they are entitled. In practice, the administration of groundwater by priority is a “work in progress” in Wyoming. Questions of the adequacy of wells, interference within an aquifer, lag times between cause and effect, etc. pose significant problems for routine administration.

The determinations of “hydrological connection” that were developed for the Decree and PRRIP were completed for the specific purpose of delineating areas which have been determined to be insufficiently connected with surface streamflow to warrant limitation under the specific provisions of the documents. There are no implications in those determinations as to the case-by-case evaluation of water-rights interference with respect to the administration of Wyoming water rights. Wells completed in the “green areas” of Figure 6C-1 remain fully subject to applicable Wyoming water law and priority administration.

6C.3 CONCLUSIONS

With respect to the types of small water projects contemplated under this Watershed Plan, the implications of the above discussion are:

1 - all new water uses or changes to existing water uses for which the change involves the type of use, point of diversion, or place of use, or increases the amount of use, require a permit from the Wyoming State Engineer.

2 - permits for stock and domestic wells (<25 gpm) are generally obtained without great difficulty, do not generally require mitigation[3], and do not require review by the Platte County Control Area Board.

3 - permits for groundwater use within areas that have been designated “not hydrologically connected” (i.e. the “green” areas of Figure 6C-1) are not subject to the limitations of the Modified North Platte Decree or the PRRIP.

4 - permits for which equivalent depletions are being retired, e.g. on the same property or elsewhere, do not require further mitigation under the PRRIP.

5 - The degree of scrutiny to which a new water use will be subject and the requirements under which that use will be allowed to proceed are a function of the type, quantity, and season of use. Large, non-irrigation season uses that require new water rights are the least likely to be approved without full mitigation.

6 - Any questions about the information necessary to obtain a new water right or to make significant changes to an existing water right should be directed to the North Platte Coordinator in the Wyoming State Engineer’s Office in Cheyenne.

[3]“Mitigation” means reducing depletion elsewhere to compensate for the depletion resulting from a new use. This can be done through formal “Transfer” of an existing, active water right, a “Temporary Water Use Agreement” under which an existing active use is curtailed, “Abandonment” of an existing, active water right, etc.

APPENDIX 6D

LIVESTOCK AND WILDLIFE WATER SOURCE IMPROVEMENTS

APPENDIX 6D - LIVESTOCK AND WILDLIFE WATER SOURCE IMPROVEMENTS

6D.1 Spring Developments

Individual springs can be developed as local watering sites or supply sources to feed pipelines conveying flows to multiple tanks. The specific method(s) used to develop a spring or seep area depend on the site-specific conditions. In general, the following factors and recommendations should be considered and implemented/adopted as appropriate:

- Carefully examine the spring/seep to determine the source (or "eye"), and to determine if any known or potential sources of contamination exist.
- Observe the rate of flow (estimated or measured) during a dry season or the season of intended use to determine if flow rate will be sufficient or to guide design of the spring development.
- Remove obstructions to spring flow (fine grained soils, surficial deposits, dense vegetation, etc.).
- Remove phreatophytic vegetation that can significantly reduce the amount of spring flow via transpiration (in accordance with any necessary environmental analysis, permitting and mitigation).
- Collect the available flow by appropriate means/methods (perforated pipe; ditching; drainage trench/gallery; etc.).
- Construct a means to settle sediment, protect the spring flow from external debris or contaminants, and facilitate maintenance of the spring (e.g., a spring box).
- Consider lowering the outlet elevation of the spring to increase the head at the discharge and thereby increase the flow.
- Use of explosives for spring development is discouraged as this practice can result in lower instead of higher flows and is dangerous unless performed by fully qualified personnel.
- Protect the spring development from washout or sediment burial during periods of flooding by diking and ditching as appropriate.
- Construct and maintain fencing or other barrier around the source to minimize impact to the source by wildlife or livestock.

Detailed information on the occurrence and characteristics of springs and the design of spring development, collection and protection is included in Chapter 12 – Springs and Wells of the Engineering Field Handbook (NRCS, 1983). This reference may be downloaded at the following website:

https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=32186.wba

Figure 6D.1 shows a typical spring development scheme.

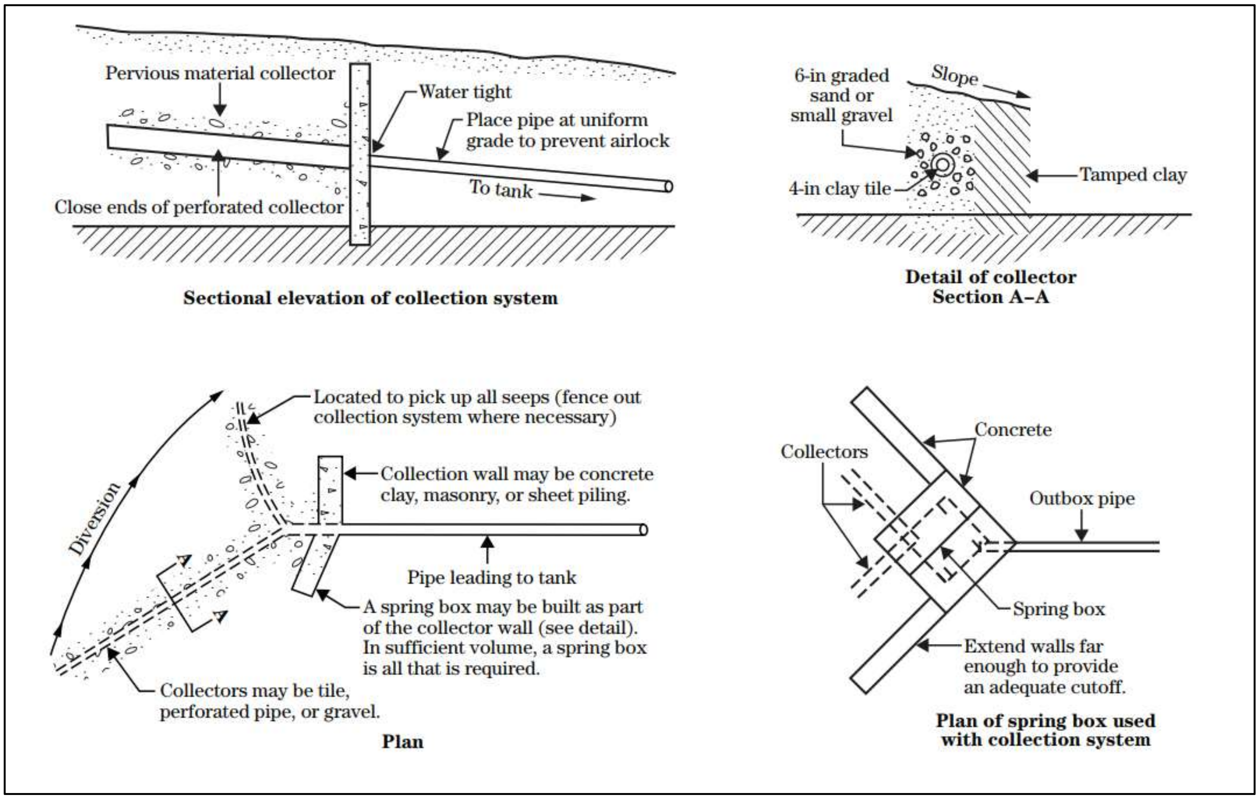

Figure 6D.1 Typical Spring Collection System

6D.2 Existing Wells with Conventional Windmills, Wind Turbines and Combined Solar/Wind Systems

Conventional Windmills. Windmills are a traditional method used to collect groundwater by means of a conventional well equipped with a mechanical pump powered by the wind-driven rotation of a set of high-torque, low-speed gears. Windmills are most typically used where: distance to power lines is greater than about a mile; reliability of supply is not crucial; high pumping rates are not required; ease of maintenance is important or desirable (i.e., no electrical and associated control components); and where cost per gallon of water produced needs to be low compared to other alternatives. Modern windmills are capable of pumping from depths up to about 1000 feet if needed (at low pumping rates); however, most applications are where relatively shallow groundwater is available (typically less than a few hundred feet). Pumping rates from shallow depths typically range from a less than 50 to as much as several thousand gallons per hour (gph) under favorable conditions. Mechanical single action piston pumps are most commonly used. Wind speeds necessary to drive modern windmills may be as low as about 5 miles per hour (mph) for highly efficient designs; more typically winds of at least 12 mph are needed, with efficiency increasing notably at wind speeds greater than about 18 mph. The life of a windmill is usually on the order of 20 years under a normal range of operating and environmental conditions.

A windmill would normally fill a local tank and serve as a single point source of wildlife and livestock watering.

Wind Turbines. A wind turbine can be used as an alternate source of power for a conventional pump installed in a groundwater well. In this type of system a wind turbine is mounted on a tower either at the site of the groundwater well or a more wind-suitable site near the well. The turbine converts wind energy to electrical energy through a generator or alternator that in turn powers a conventional submersible pump. If desired, storage batteries could be included in the system so that pumping could continue during times when the wind velocities are not sufficient. Information about wind turbines in a water pumping application is available from the U.S. Department of Energy Efficiency and Renewable Energy (EERE) website at:

http://www.eere.energy.gov/consumer/your_home/electricity/indeH.cfm/mytopic=10 890.

Information on commercial wind water pumping systems utilizing a Bergey wind turbine and Grundfos submersible pumps are available from Bitterroot Solar at: http://www.bitterrootsolar.com/pumping/windpump.htm. These particular systems range from 4,800 to 40,000 gal/day production with an 11 mph wind and a pumping/head of 100 feet. Additional technical and cost information for these systems is available at:

http://www.bergey.com/Products/XL1.html.

Combined Solar/Wind Powered Systems. An alternative to a conventional windmill or a wind turbine powered pumping system is a combined system that includes both a wind turbine and solar panels as power sources for a generator and conventional submersible water pump. This system allows the pump to be operated by solar power alone, wind power alone, or a combination of both sources depending on environmental conditions at the site at any given time. Although more expensive to install and maintain, this system provides more reliable power for stock water pumping than either single source alone. A commercially available source of this type of system is produced by Grundfos; information on this system is available at:

http://net.grundfos.com/doc/webnet/sqflex/home.htm.

6D.3 Wells

Wells are a potential source of water for wildlife and livestock watering. Because of the cost of drilling and completing a well and the unavoidable uncertainty as to the production that will be achieved (without very expensive prior site-specific exploration), a new well would usually only be considered as a source where no other more practical and cost-effective options are available. On the other hand, conversion of an existing well to serve as a source of wildlife/livestock watering may be very cost-effective. For this to be the case, some or all of the following conditions should be met:

- Located near an area in need of additional watering opportunities
- Sufficient capacity to serve this and any other existing uses (or potential to increase well yield through re-conditioning or possibly deepening)
- Capable of operation by wind or solar power (unless already served by a power line)

It may be possible to convert a dormant oil (or gas) well to water production; however, there are a number of factors that may render this impractical. First, the well must be open to at least the depth of the target aquifers(s). If open deeper, it may be necessary to plug the hole up to or for some distance below the base of the lowest target aquifer to minimize pumping residual oil and/or natural gas. Depending on the nature of the aquifer(s) (hydrocarbon content) it may be necessary to install a "treater" or "skimmer" at the surface to separate the hydrocarbons from the water. If the well is cased across the producing zone(s), it will have to be perforated, and depending on formation properties, protection against piping of the sidewall provided by some means. Unless conditions are generally favorable, the cost of conversion of an existing oil well may end up exceeding the cost of drilling and completing a new well. This is not to say that such opportunities do not exist or are always impractical. Oil wells have been reportedly successfully converted and serve as a year-round watering installation. Any such conversion opportunities should be carefully evaluated on a case-by-case basis.

Conditions most advantageous to use of a new well are summarized as follows:

- Shallow depth to aquifer(s) with adequate transmissivity to meet projected needs.

- Located where hydrogeologic conditions are reasonably well known from prior drilling and/or well installation.
- Either close to existing power lines or suitable for wind or solar operation.
- Location upgradient of an area or areas of significant wildlife/livestock watering
- Shortage.

If a new well is planned, it is recommended that a water well driller with substantial experience in the local area be utilized to take best advantage of prior experience with the relevant geologic units and conditions. Depending on the size (depth and anticipated yield) of the well, it may be worthwhile to consult a groundwater geologist with experience in this or similar geologic settings prior to finalizing a decision as to drilling a new well.

Information on the planning, design, drilling, completion, development of groundwater wells is available from many sources. One source of such information is available from the NRCS (1983) Engineering Field Handbook at the following website:

http://www.info.usda.gov/CED/ftp/CED/EFH-Ch12.pdf.

6D.4 Pipeline/Tank Systems

Pipeline/tank systems are generally considered to be the best method for conveyance of flows from any suitable source of water, since they can put the water where it is needed (at multiple locations), when it is needed. These systems can operate by gravity, be fed by a pumped source, or combine both gravity and pumping reaches (usually with a surge/storage tank in the system). Sources of water may include any of those described in this section, including a groundwater well, developed spring, pond, reservoir, or stream diversion.

Considerations in the layout and design of a pipeline/tank system include, but are not limited to the following:

- *Location of the source relative to the points of use* – ideally the water source will be located upgradient of the points of use so that all delivery can be by gravity
- *Temporary storage* - if necessary, one or more locations for temporary storage of pumped supply can be provided that then feed the remainder of the system by gravity; typically a 2-3 day supply for the wildlife and livestock using the system is provided
- *Terrain* – an alignment with some variation in grade is desirable to minimize problems with air-locking by installation of air relief valves at appropriate locations; very rugged terrain is less desirable due to the higher installation costs
- *Geologic conditions* – ideally pipeline alignments will be located where rock excavation and/or adverse soils conditions are avoided or minimized to the degree practical (adverse soils conditions may include landslides, areas of significant active erosion, etc.)

- *System length/size* – the longer the system and the more tanks planned or desired, the greater the flow capacity from the source required; friction losses in the pipe and through the fittings can be significant over long distances relative to the available energy of the source water
- *Property ownership* – systems may be designed to serve a single landowner; alternatively, there may be opportunities for cooperative projects in which the system is designed to serve two or more entities (see additional discussion later in this section)
- *Environmental conditions/issues* – it is necessary, to the extent feasible, to avoid impacts to the environment including but not limited to wetlands, riparian zones, high value sage grouse habitat, and cultural resources

The pipeline/tank systems planned and/or installed already in the watershed include some or all of the following elements/components:

- Spring development or well as water source
- HDPE piping
- Air release vents/valves
- Pipeline drains
- Tanks (with pressure reducing valves, rescue ladders, gate or ball valves, float valves, air and vacuum release or pressure relief valves, overflow piping, and pump manifold gages, valves and fittings)

There is a wide array of different wildlife/livestock watering tanks that can be used in a pipeline/tank system or with any of the other water sources described in this section. At present, converted heavy equipment tires appear to be the preferred tank type in the watershed. This is due to their relative availability, comparative cost effectiveness, durability, freeze-resistance, long-life, and ease of installation (with the proper equipment available). A typical 12-foot by 2.5-foot tire tank holds on the order of 1500 gallons when full. Other types of tanks that could be considered on a case-by-case basis include, but are not necessarily limited to:

- Cast-in-place or precast concrete tank or trough
- Bottomless corrugated metal tanks
- Pit/pond (sealed or lined where necessary)
- Fiberglass or galvanized tanks

The larger pipeline/tank systems are typically are designed to fill the tanks automatically as the contents are drawn down. There is provision for taking individual tanks out of service when necessary for maintenance or repair. Overflow drainage is provided in the event of malfunction.

6D.5 Ponds

Small ponds can provide seasonal watering opportunities to both wildlife and livestock. Watering can occur directly from the pond, or a pipeline can be fed from the pond to deliver water to one or more tanks downgradient. For purposes of this study, a watering ("stock") pond is defined as a reservoir or pit/dugout (excavation below original grade) with a maximum capacity of less than 20 acre-feet and a dam height less than 20 feet. Reservoirs/pits of this size qualify for application to the State Engineer's Office as "stock reservoirs" and thereby avoid the more restrictive and costly administrative, design, and construction requirements associated with permitting under the standard reservoir regulations.

A pond is typically created by excavation of soils in the pond area and placing the excavated soil as embankment fill to create a dam. This approach is most cost effective initially; however, it may be more cost-effective in the long run to secure soils from areas near but not immediately at the reservoir site depending on the properties of the soils. In particular, clay soils with dispersive properties or with significant percentages of soluble salts should not be used for embankment fill if other more suitable soils are available nearby. Embankment fill should be placed in relatively thin horizontal lifts, compacted with rubber-tired (versus tracked) equipment, and not placed too wet or too dry. This will result in a more erosion resistant embankment.

An overflow earthen spillway should be provided for ponds constructed in ephemeral or intermittent drainages and in swales with relatively large drainage areas. If possible, the spillway section should be excavated in or to rock. If this is not feasible, the spillway should be constructed with as broad a crest and as shallow a discharge channel as practical to lower flow velocities and thereby limit erosion during times of use. Revegetating the spillway with grasses will also increase its erosional resistance.

An outlet pipe is usually only included in this type of pond if it is needed to feed one or more tanks downgradient (supply pipe) or if there is enough spring-fed flow or intermittent runoff events to cause excessive use of the overflow spillway ("trickle tube"). A supply pipe is placed with its inlet near but not at the lowest point of the foundation (to allow for some sediment accumulation). Flow is controlled by a downstream valve (e.g., a float valve regulated by water level in the down-gradient tank or pipeline/tank system being supplied). The trickle tube is an appropriately sized open pipe installed through the embankment dam at an elevation slightly lower than the overflow crest elevation of the spillway.

If direct watering is intended (which allows for watering more animals at a time), then it is recommended that protection of the dam embankment, spillway (and outlet if present) be considered to reduce the need for and cost of future maintenance. Although initially more costly, consideration should also be given to armoring of the pond rim to lessen erosion and excessive sedimentation. This decision should be based on the site soils conditions, planned usage, and estimated cost of future maintenance in the absence of such protection. One alternative on larger ponds may be to selectively armor only portions of the rim and fence the remainder to exclude use by wildlife and livestock. If armoring is used it should consist of reasonably durable gravel (over larger rock if necessary) to encourage use by wildlife/livestock and minimize sloughing and erosion of the pond banks.

Information on the planning, design and construction of small ponds is available from the NRCS at: http://www.info.usda.gov/CED/ftp/CED/EFH-Ch11.pdf. The local NRCS staff in Wheatland

(and other staff they may contact) may also be able to provide technical assistance for projects to be constructed under an NRCS program.

6D.6 Reservoirs

A new surface water storage reservoir could serve as a source of supply to a wildlife/livestock watering system. This could involve direct gravity to one or more pipeline/tank systems arrayed downgradient of the reservoir. Alternatively, the reservoir could serve as the source for pumping water to one or more pipeline/tank systems.

Any new reservoir could also serve as a direct source of wildlife and livestock watering. Depending on the location of the reservoir relative to grazing locations, it may be appropriate to include one or several watering access sites around the reservoir rim. These sites should be sized to accommodate the anticipated or desired use, and designed with appropriate grades to and in the near-shore pool to facilitate watering. The access ramps and watering areas should be adequately armored as described above in the section above regarding stockponds.

6D.7 Guzzlers

A guzzler is a wildlife watering system utilizing direct precipitation as a source of supply, with a storage tank of capacity suitable to the watering need, and designed to discourage use and protect from damage by livestock. A complete guzzler system is comprised of the following components:

- Catchment apron – typically made of textured HDPE; secured with rocks placed on a suitable grid spacing, and protected by suitable fencing from trampling by wildlife or livestock (Figure 6D.5).
- Catchment outlet - pipe boot, clamps and well screen section.
- HDPE pipe – typically 1.5-2-inch, 160 psi, SDR 11.
- Catchment tank – HDPE tank sized to accommodate wildlife or livestock watering needs, with integral drinker (ideally with no float valve required), small animal escape ladder and overflow adapter (1800-gallon tank with patented features is available from Boss Tanks and Elko Bighorns Unlimited, Elko,Nevada).
- Overflow pipe – with erosion protection at discharge.

Figure 6D.2 Guzzler installed in the Cottonwood Creek watershed.

The guzzler operates by intercepting direct rainfall or snowmelt on the catchment, routing the captured water via a pipe to the tank, and controlling the tank level via a simple overflow outlet pipe. Figure 6D.2 shows a typical set up with dual catchments and tanks. Information on a commercially available system compatible with the design described above is available from Boss Tanks and Elkhorn Bighorns Unlimited at: http://www.bosstanks.com/guzzler.htm. A self contained guzzler is available from Wildlife Water Guzzler; information on this product line is available at: http://www.wildlifewaterguzzler.com/.

6D.8 Power Sources

Conventional Electrical Service. In most cases the cost to bring overhead power to a single well or lift station site for wildlife/livestock watering would probably be prohibitive. This option should normally be considered only when the point of power use is close to existing service (usually less than about ¼ to ½ mile) or the power demands are higher than can be feasibly supplied by other sources (wind, solar).

Portable/Remote Generator. Although possible, the use of portable or remotely installed gasoline or diesel powered generators is generally not an economically feasible alternative to operate pumps to supply wildlife/livestock water. This type of power is usually only considered in temporary or emergency conditions. If used, special care is required to ensure safe transport, storage and use of fuel to prevent accidental fires and/or releases of fuel to the environment.

Solar Water Pump. Solar power can be an appropriate, efficient and long-term cost-effective means to power a pump used to extract groundwater from a well or to convey water upgradient from another source of supply (pond, spring, storage tank, etc.) to temporary storage or point of use (watering tank or pipeline/tanks system). This type of system is best suited to remote locations with sufficient sunlight, typical of conditions where additional wildlife/livestock watering is needed in the watershed. Solar water pump systems are typically comprised of one or more photovoltaic (PV) panels, sometimes a set of storage batteries, and a DC-capable pump. Batteries are used where pumping during low-light and nighttime periods is necessary or desirable (e.g., to fill a storage tank or refill a watering tank overnight when watering demands are low).

Overall, solar water pump systems are relatively easy to install and maintain. However, the solar panels are relatively fragile and need to be mounted in a suitable location and well-secured against wind and livestock damage. The other components in the system (pump, controller, switches and possibly batteries) also need to be properly installed, protected from weather and incidental damage, and require some periodic maintenance and/or replacement.

Solar water pumps are specially designed to work efficiently with DC solar power, including during low-light (reduced voltage) conditions. Many different types of pumps can be used depending on the pumping head and flow rates for the particular application. These include positive displacement types (piston and jack pumps, diaphragm, vane and screw pumps) that maintain lift capacity at slow, varying speeds resulting from changing light conditions. In low-lift and/or high-volume applications, centrifugal-type pumps are often used. The pumping rates that can be achieved vary with the lift (head) from the pump to storage or point of use and the amount of power supplied by the solar system. At relatively low heads (say less than 100 feet) and with modest power (say less than 150 watts), pumping rates on the order of 150-200 gph (3.0-3.5 gpm) are possible. With greater available power at low heads (50-100 feet), pumping rates up to several thousand gph (25-75 gpm) are possible with centrifugal pumps. For high lifts (say 400-500 feet) and sufficient power, pumping rates of several hundred gph are attainable with helical rotor pumps.

APPENDIX 8A

ENTITY FORMATION

IRRIGATION DISTRICTS:

This entity is covered in Chapter 7 of Title 41 of the Wyoming Statutes (W.S. 41-7-101 through 1006). An irrigation district is created by a petition to the district court. The lands to be included in the district must be defined and the state engineer is included in the approval process. With existing ditch system, the state engineer approval is usually a mylar map showing the district boundaries and detailing all of the water rights within the district boundaries.

■ An irrigation district is a subdivision *of* the state and as such is capable o£ contracting with the Water Development Commission for funds.

■ The district is split into commissioner districts. A commissioner is elected from each district and function to direct the operation *of* the district.

■ All actions of the District must be approved by the district court.

■ For all non-federal districts, after approval *of* assessment schedule by the district court, the assessments are collected by the county and forwarded to the district for their operation.

■ The District can define their operations through the establishment *of* by-laws.

■ District can act on behalf *of* the landowners in water right matters.

■ Wyoming Statute 41-7-210 lists a number *of* powers for an irrigation district as follows:

- ■ To sue and be sued;
- ■ To adopt and use a corporate seal; .To have perpetual succession;
- ■ To file on and acquire the right to use of water for domestic and irrigation purposes; to acquire sites for reservoirs, and rights *of* way for ditches, canals and laterals;
- ■ To exercise the power *of* eminent domain under chapter 316 (C.S. 1920), and all acts or parts *of* acts amendatory thereto;
- ■ To contract with the state of Wyoming for the reclamation and segregation of public lands pursuant to the laws of the United States and the state of Wyoming and to contract for the sale of water rights by it acquired pursuant to said laws, and to purchase and acquire state lands;
- ■ To acquire by purchase or otherwise irrigation works, water rights, land and other property and to sell, lease or otherwise dispose of the same, to buy, develop, sell and distribute electrical energy as an incident to the ownership, control and operation of irrigation works of the district or the cooperative works of

the district and the United States as the district may deem expedient or suitable for the development of the district.

■ Irrigation districts formed under Wyoming Statute 41-7-201 through 210 are exempt from sale tax (Wyoming Statute 39-6- 405) .

■ The District must advertise for bids on work which will exceed $7,500.

WATERSHED IMPROVEMENT DISTRICTS:

This district is formed under Chapter 8, Title 41 of the Wyoming Statutes.

- District can receive grants and loans from the Water Development Commission.
- District for the prevention and control of erosion, floodwater and sediment damages.
- District may be formed as a subdistrict of conservation districts.
- The land area of a district must lie within the same or adjoining watershed or sub-watershed areas.
- Formed by filing a petition with the board of supervisors of the conservation district.
- District formed by referendum vote after board of supervisors holds a public hearing.
- Board of supervisors holds election for board of directors who will be the governing body for the watershed improvement district.
- Main powers listed in Wyoming Statute 41-8-113:
    - Levy and collect assessments for special benefits accruing to lands
    - Acquire by purchase, exchange, lease, gift, grant, bequest, devise, or otherwise, any property, real or personal, or rights or interests therein; maintain, administer, and improve any such property; and sell, lease, or otherwise dispose of any such property in furtherance of the purposes and provisions of this act;
    - Exercise the power of eminent domain and in the manner provided by law for the condemnation of private property for public use;
    - Construct, improve, operate and contract for the maintenance of such structures as may be necessary for the performance of any authorized function of the watershed improvement district;
    - Borrow such money as is necessary to carry out any of the purposes and provisions of this act, and issue, negotiate, sell its bonds or other evidence of indebtedness as provided in section 14[41-8-114];
    - Cooperate with, and receive from or grant assistance to, towns, cities, counties, and state and federal agencies in carrying out the purposes and provisions of the act.

WATER CONSERVANCY DISTRICTS:

These districts are formed under Article 7, Chapter 3 of Title 41 of the Wyoming Statutes. The District is to provide for the conservation of water resources of the state of Wyoming and for the greatest beneficial use of water within this state.

- The organization of water conservancy districts and the construction of works as herein defined by such districts are a public use and will:
  - Be essentially for the public benefit and advantage of the people of the state of Wyoming;
  - Indirectly benefit all industries of the state;
  - Indirectly benefit the state of Wyoming in the increase of its taxable property valuation;
  - Directly benefit municipalities by providing adequate supplies of water for domestic use;
  - Directly benefit lands to be irrigated or drained from works to be constructed;
  - Directly benefit lands now under irrigation by stabilizing the flow of water in streams and by increasing flow and return flow of water to such streams;
  - Promote the comfort, safety and welfare of the people of the, state of Wyoming, and it is therefore declared to be the policy of the state of Wyoming:
    - To control, make use of and apply to beneficial use all unappropriated water in this state to a direct and supplemental use of such water for domestic, transportation, industrial, manufacturing, irrigation, power, recreation and other beneficial uses;
    - To obtain from water in Wyoming the highest duty for domestic uses and irrigation of lands in Wyoming within the terms of interstate compacts;
    - To cooperate with the United States under the federal reclamation laws now existing, or hereafter enacted, and agencies of the state of Wyoming for the construction and financing of works in the state of Wyoming as herein defined and for the operation and maintenance thereof;
    - To promote the greater prosperity and general welfare of the people of the state of Wyoming by encouraging the organization of water conservancy districts.

- A water conservancy district is formed by petition to the district court.

- The district court must hold a hearing on the formation of the district and the state engineer shall become an interested party in all court proceedings.

- Subdistricts may be formed upon petition of the district court.

- District controlled by a board of directors.

- General powers:
    - To have perpetual succession;
    - To obtain or dispose of water, water works, water rights and sources of water supply; to acquire construct or operate, control and use any and all works, facilities and means necessary or convenient to the exercise of its powers.
    - To have and to exercise the power of eminent domain.
    - To construct and maintain works and establish and maintain facilities and obtain the necessary rights-of-ways for same.
    - To contract with the United States or any agency thereof , or with an agency of the state of Wyoming
    - To list in separate ownership the lands within the district which are susceptible of irrigation from district sources and to make an allotment of water to all such lands; to levy assessments.
    - To fix rates at which water not allotted to lands shall be sold, leased or otherwise disposed of.
    - To enter into contracts, employ and retain personal services and employ laborers; to create, establish and maintain such offices and positions as shall be necessary and convenient for the transaction of business of the district; and to elect, appoint and employ such officers, attorneys, agents and employees therefore as shall be found by the board to be necessary.
    - To adopt plans and specifications for the works for which the district was organized.
    - To appropriate and otherwise acquire water and water rights within or without the state for use within the district.
    - To invest any surplus money in the district treasury .To adopt rules and regulations for investing funds. .To incur bonded indebtedness and to borrow money. .To adopt by-laws.

- The district is capable of contracting with the Water Development Commission for funds.

Districts	Authority	Purpose	Formation	Structure	Authorities	Funding
Watershed Improvement Districts	WS 41-8-101 through 41-8-126	Provide for the prevention and control of erosion, floodwater and sedimentation damages, ag uses, and the storage, conservation development, utilization and disposal of water, preserve and protect land and water resources	-Petition to the Conservation District Board of Supervisors. -Hearing and referendum held. - A majority of votes representing the majority of acreage must be obtained to form the district.	-5 member board elected by electors and landowners within the district -Board members Must be landowners within the district -Annually elected on staggered terms	-Levy and collect assessments -Acquire, maintain, and dispose of property -Have power of eminent domain -Construct structures -Borrow money -Cooperate with towns, cities, counties, state and federal agencies	-Levy taxes - Obtain grants and receive gifts -Issue Bonds

Districts	Authority	Purpose	Formation	Structure	Authorities	Funding
Irrigation Districts	WS 41-7-101 through 41-7-1006	Provide irrigation; improve the existing water supply; or purchase, extend, operate, or maintain constructed irrigation works; or to cooperate with the United States under the federal reclamation laws.	-Petition to the County District Court -Majority of private landowners embracing the majority of the land must sign petition to be valid. -Hearings are held by the court -Court makes the final decision to form district	-3 or 5 commissioners appointed by the court and at all times under the direction of the court. -After original appointments, commissioners are elected by landowners within the district. -Staggered terms -Landowners may cast 1 vote per irrigable acre.	-Established and have the powers of a corporation -Own, operate, maintain, construct, improve, or purchase any irrigation works. -Powers of eminent domain -Acquire water rights. -Court can levy assessments to be enforced by commissioners. -Perpetual succession -Undertake hydroelectric power projects	-Levy assessments -Obtain grants and receive gifts -Issue interest bearing warrants

Districts	Authority	Purpose	Formation	Structure	Authorities	Funding
Water Conservancy Districts	WS 41-3-701 through 41-3-779	Provide for the conservation of water resources; provide adequate municipal water supplies; benefit irrigation by stabilizing the flow of water in streams by increasing stream flows; to control, make use of and apply to beneficial use of all unappropriated water; promote the comfort, safety and welfare of Wyoming citizens	-Petition filed with the clerk of District court -Petition signed by at least 25% of the owners on not less than 25% of irrigated land. -Bond filed with petition to cover formation costs. -Hearing held by the District court or judge -State Engineer becomes an interested party -District court determines if district is feasible -District becomes a corporation	-District court appoints a board of directors consisting of not less than 5 or more than 9 -Board members must be landowners within the proposed district. -Staggered terms -After the initial appointment, directors are then elected by landowners within the district -Subdistricts can be formed	-Perpetual succession -Hold water rights; own and control water works and sources of supply; own real and personal property - Power of eminent domain -Construct and maintain water works -Enter into maintenance contracts with the state -Allocate water within the district -Sell or lease water -Acquire water rights -Borrow money -Invest money	-Levy and collect taxes -Issue bonds -Obtain grants and receive gifts

APPENDIX 9A

AGENCY REQUIREMENTS AND NOTIFICATIONS

Appendix 9A AGENCY REQUIREMENTS AND NOTIFICATIONS

Several permits and clearances would need to be submitted to and approved by federal, state, and local agencies prior to the construction and/or installation of any of the proposed projects presented in the Watershed Management and Implementation Plan along with any future projects. The permits and clearances that could potentially be required from the associated agencies are listed in Table 9.3-1.

Appendix 9A.1 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers' (USACE) Wyoming Regulatory Office administers and enforces Section 404 of the CWA in Wyoming for the Omaha District. Under the CWA, a Section 404 permit is required for the discharge of dredged or fill material into waters of the United States. Because many waterbodies and wetlands are considered waters of the United States, they are subject to the USACE's regulatory authority. Permit applications can be obtained by contacting the USACE Wyoming Regulatory Office in Cheyenne by telephone (307) 772-2300 or via the website (http://www.nwo.usace.army.mil/Missions/Regulatory-Program/Wyoming/). Numerous nationwide permits have been developed as of 2012; the applicable permit depends upon the nature of the proposed activity.

Appendix 9A.2 U.S. Fish and Wildlife Service

The Endangered Species Act's (ESA) Section 7 requires federal agencies to conserve threatened and endangered species and ensure their actions do not adversely affect the listed species or its critical habitat. Informal and formal Section 7 consultations take place between a federal agency and the USFWS when that federal agency implements, finances, or approves a project that may affect a threatened or endangered species or its critical habitat. Typically, an informal consultation between the federal agency and the USFWS is conducted early in the planning of a project or program to ascertain if the agency's proposed project or program may affect the listed species. Normally, the federal agency completes a biological assessment to determine the proposed project's effect on the listed species. If the federal agency's biological assessment findings indicate that the listed species is likely to be adversely affected by the project or program, then the agency would request a formal consultation with the USFWS. After reviewing information about the proposed action and listed species, the USFWS issues an opinion about whether the proposed project would harm the existence of the listed species.

Also, a non-federal agency can be approved by the USFWS for an incidental take permit of threatened or endangered species under Section 10 of the ESA. However, the USFWS's approval is usually dependent upon a habitat conservation plan (HCP), which when followed would minimize the taking of the listed species to the maximum extent practicable. Information can be obtained by contacting the USFWS's Wyoming Ecological Services Field Office in Cheyenne by telephone (307) 772-2374 or website (https://www.fws.gov/wyominges/index.php). Additionally, the USFWS's Information for Planning and Conservation (IPaC) is web-based application and planning tool available to anyone who needs assistance in determining how their activity or project may affect migratory birds, ESA proposed or listed species, other sensitive resource. The IPaC can be accessed via the website (https://ecos.fws.gov/ipac/).

Appendix 9A.3 Wyoming State Engineer's Office

The majority of proposed projects included in this watershed study would require a permit from the Wyoming State Engineer's Office (WSEO). Proposed livestock/wildlife water, irrigation rehabilitation, and water storage projects would require obtaining or modifying a water right approved by the State Engineer in accordance with Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 1 Generally (W.S. 41-3-101). Any project that includes construction of a new dam and reservoir or the rehabilitation of an existing dam and reservoir exceeding 20 acre-feet in capacity or having a dam height greater than 20 feet cannot commence construction until a permit is approved by the State Engineer pursuant to Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 3 Reservoirs (W.S. 41-3-301).

The SEO also administers the Wyoming's Safety of Dams program (W.S. 41-3-307 through 41-3-318), which applies to reservoirs when the dam height is more than 20 feet high and reservoir capacity is more than 50 acre-feet. Any proposed construction, enlargement, major repair, alteration or removal of a dam or diversion system with headgates or diversion structures carrying 50 cfs must have plans and specifications prepared a Wyoming licensed registered professional engineer and shall be submitted to the state engineer for approval pursuant to Title 41 Water, Chapter 3 Water Rights; Administration and Control, Article 3 Reservoirs (W.S. 41-3-308). Necessary water right applications, regulatory information, and instructions can be accessed via the website (https://sites.google.com/a/wyo.gov/seo/regulations-instructions). SEO permits can also be accessed via the e-Permit website (http://seoweb.wyo.gov/e-Permit/).

Appendix 9A.4 Wyoming State Historic Preservation Office

Proposed projects within the watershed that are located on federal land, use federal funding, or need to secure a federal permit should have a review of cultural resources completed by the Wyoming State Historic Preservation Office (SHPO) in accordance with Section 106 of the National Historic Preservation Act of 1966 and the Wyoming Antiquities Act of 1935 (W.S. 35-1-114 to 116). The Wyoming State Historic Preservation Office reviews cultural resource reports, issues compliance letters for proposed projects, provides comments on activities potentially affecting historic properties or cultural resources, and recommends additional investigations if necessary. Additional SHPO compliance and review information can be obtained by contacting the State Historic Preservation Office by telephone (307) 777-6311 or via the website (http://wyoshpo.state.wy.us/Section106/Index.aspx).

Appendix 9A.5 Wyoming Game and Fish Department

The Wyoming Game and Fish Commission encourage project sponsors, permitting agencies, and land managers to coordinate with the WGFD in the initial planning stage of a proposed project. The WGFD's involvement is essential in avoiding adverse impacts to fish and wildlife during project development and implementation. The Commission adopted a mitigation policy in 2016 to provide an approach in avoiding impacts when possible and formulating mitigation measures when necessary. The Commission has directed the WGFD to resolve conflicts between land use activities and fish and wildlife and their habitats pursuant to Wyoming Statutes and in cooperation with the USFWS and other federal agencies under the NEPA, the ESA, Section 404 of the federal CWA, and the Federal Fish and Wildlife Coordination Act. WGFD's habitat information can be obtained via the website (https://wgfd.wyo.gov/habitat/habitat-information).

In July 2015, Executive Order 2015-4, Greater Sage-Grouse Core Area Protection, was signed by the Governor Mead, which requires state agencies to encourage development outside of the core areas and to focus management to the greatest extent possible on the maintenance and enhancements of habitat within them. Additional information about Wyoming's sage grouse management including mitigation, de minimus activities, core area maps and data, and the Density Disturbance Calculation Tool (DDCT) can be found at the website (https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management). Sponsors for a proposed project within the watershed should contact the WGFD at least 60 days prior to submitting an application for a permit or project so any sage-grouse related issues can be identified and any stipulations could be incorporated before commencing project activities.

Appendix 9A.6 Wyoming Department of Environmental Quality

Appendix 9A.6.1 Section 401 Water Quality Certification

For a proposed project requiring a USACE Section 404 permit, a pre-construction notification (PCN) is submitted by the applicant to the USACE. The PCN is then forwarded to the WDEQ for review under Section 401 of the CWA to determine compliance with Chapter 1, Wyoming Surface Water Quality Standards (W.S. 35-11-101). If the project is compliant, the WDEQ issues a 401 Water Quality Certification. WDEQ could require special conditions to the certification in order to guarantee compliance with surface water quality standards or TMDLs. Information about the WDEQ's 401 Certification process can be obtained by visiting their website (http://deq.wyoming.gov/wqd/401-certification/).

Appendix 9A.6.2 Permit to Construct

Storm water discharges are regulated under the federal CWA by the WDEQ's Wyoming Pollutant Discharge Elimination System (WYPDES) Program. For any proposed project within the watershed, the project sponsor should contact the WDEQ to determine if a Large or Small Construction General Permit (CGP) is needed to construct the project components. WYPDES requires that construction activities disturbing 5 or more acres to obtain a Large Construction General Permit (LCGP) or construction activities disturbing at least one acre, but less than five acres to obtain a Small Construction General Permit (SCGP). In order to obtain a LCGP, the applicant must also complete a Storm Water Pollution Prevention Plan (SWPPP). Additionally, the WDEQ may authorize temporary increases in turbidity above the numeric criteria of Section 23, Chapter 1, Wyoming Surface Water Quality Standards (W.S. 35-11-101) for certain short-term, construction-related activities conducted in live waters. Proposed projects involving irrigation diversions or streambank work typically occur in flowing water and would require application for a temporary turbidity waiver. For additional information or to obtain a WYPDES CGP or a temporary turbidity waiver, please contact the WDEQ by telephone (307) 777-7781 or the WDEQ's Water Quality Division website (http://deq.wyoming.gov/wqd/).

Appendix 9A.7 Wyoming Office of State Lands and Investments

Some of the proposed projects within the watershed would be located on Wyoming State lands. When a project is on State land a grazing and agricultural lessee is required to obtain permission from the Board of Land Commissioners prior to construction in accordance with Title 36 State Lands, Chapter 2, Board of Land Commissioners Article 1, In General (W.S. 36-2-107). The lessee must submit an Application for Construction of Improvements on State Land to the Wyoming Office of State Lands and Investments (OSLI), which would include the location, value, construction date, type of improvement, federal aid received, and applicable water rights for the improvement. Applications can be obtained by contacting the OSLI by telephone (307) 777-7331 or via the website (http://lands.wyo.gov/lands/leasing/agricultural).

Appendix 9A.8 Wyoming Department of Fire Protection and Electrical Safety

For any proposed project within the watershed that includes installing electrical equipment, the project sponsor should contact the Wyoming Department of Fire Protection and Electrical Safety to determine if a wiring permit is required before commencing work. A wiring permit is required when installing electrical equipment in new construction or remodeling of a building, mobile home or premises and the electrical installation must be performed by licensed electricians in accordance with Title 35 Public Health and Safety, Chapter 9 Fire Protection, Article 1 Department of Fire Prevention and Electrical Safety (W.S. 35-9-120 and W.S. 35-9-123). There may be applicable exemptions to these for work done by an owner or lessee on their own property or on a farm or ranch of 40 acres or more on deeded land pursuant to Title 35 Public Health and Safety, Chapter 9 Fire Protection, Article 1 Department of Fire Prevention and Electrical Safety, Division 3 Electrical Licensing (W.S. 35-9-123). More information and the Application for Electrical Wiring Permit can be obtained by contacting the Wyoming Department of Fire Protection and Electrical Safety by telephone (307) 777-7119 or via the website (http://wsfm.wyo.gov/electrical-safety/wiring-permits).

Appendix 9A.9 Platte and Albany Counties

Both Platte County and Albany County have adopted regulations for land use zoning, aquifer protection, wastewater, and floodplain development within the project area. The County’s Land Use Departments issue permits for activities in the unincorporated areas of the county including but not limited to building structures, wastewater systems, wind energy systems, and aquifer protection. The project sponsor should contact the pertinent planning department to determine if any permits are needed to construct a proposed project within the watershed. More information and the permit applications can be obtained by contacting:

- Platte County Land Use Department by telephone (307) 322-1341
  Website: http://plattecountywyoming.com/PlanningandZoning/Default.aspx
- Albany County Land Use Department at (307) 721-2568
  Website: http://www.co.albany.wy.us/planning.aspx